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# Biochemical and protein quality analysis in different genotypes/varieties of chickpea

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**Abstract**
In vegetarian diets, chickpeas (*Cicer arietinum* L.) are a popular and plentiful source of legume protein that is frequently substituted for animal protein. The objective of the current investigation was to ascertain the biochemical composition and protein quality of ten distinct genotypes/varieties of chickpea, namely NDG-14-3, Pant-G-186, Uday, BG-372, NDG-18-4, NDG-19-3, NDG-18-7, NDG-18-2, RSG-888, and Vaibhav. The study examined various biochemical parameters in chickpeas *viz.* total sugar, reducing sugar, non-reducing sugar, protein, lysine, tryptophan, methionine, and ash. The results showed a range of values between 54.10 and 63.77%, 4.25 and 5.19%, 1.45 and 1.76%, 2.80 and 3.43%, 21.80 and 24.30%, 6.49 and 8.10 g/16 g N, 0.11 to 0.23 g/16 g N, 1.83 to 2.65 g/16 g N, and 1.93 to 3.28%, respectively. The biochemical and protein quality of chickpea genotypes/varieties provide valuable information for breeding programs and establish chickpea as a well balanced diet for under nutrition population.

**Keywords:** Carbohydrate, protein, protein quality, total ash and chickpea

## Introduction
Chickpea (*Cicer arietinum* L.) is commonly known as Bengal gram, garbanzo bean, Indian pea and channa. It belongs to the *Fabaceae* family and comes in two main varieties: Desi and Kabuli. The main states in India that grow chickpeas are Madhya Pradesh, Rajasthan, Uttar Pradesh, Maharashtra, Karnataka, and Andhra Pradesh; these states account for more than 90% of the total acreage and more than 88% of the country production Singh and Shiv (2007) [1]. A chickpea is a good source of carbohydrates and protein and its protein quality is superior to that of other legumes *viz.* pigeon pea, black gram, and green gram, Kaur and Singh (2005) [2]. The most popular ways for people to eat it are as a green vegetable or as dried pulse grain. Chickpea having good quantity of nutrient such as calcium, iron and niacin (Singh, *et al*., 2003) [3]. Chickpeas are indeed a highly nutritious and affordable source of protein, making them a valuable food item in efforts to combat malnutrition in developing countries. Chickpeas are a rich source of protein, which is essential for growth, muscle repair, and overall health. This is particularly important in regions where protein deficiency is a common issue. In addition to protein, chickpeas are packed with essential nutrients, including fiber, vitamins (such as B vitamins), and minerals (such as iron, magnesium, and potassium). These nutrients contribute to overall health and can help prevent various deficiencies. As a legume, chickpea have the ability to fix nitrogen in the soil, increasing soil fertility and lowering the demand for chemical fertilizer. This makes them an environmentally sustainable crop option. Promoting the cultivation and consumption of chickpeas in developing countries can play a significant role in addressing malnutrition and improving food security (Gupta *et al*., 2021) [4]. Desi and Kabuli chickpea type varieties are valuable in terms of nutrition and can be used in various culinary applications, but they may be preferred in different dishes or regions based on their specific characteristics. The desi varieties have thick, vibrant seed coats, pink flowers, and colored stalks due to anthocyanins. Varieties of Kabuli have smooth surfaces with a thin seed coat, white blooms, stems devoid of anthocyanins, and white or beige seeds (Gaur *et al*., 2016) [5]. Chickpeas are not only a valuable food source for humans but also play an important role as animal feed in many countries.

The green husk of chickpeas can be fed to animals, providing them with a nutritious and fibrous component of their diet. After harvesting the chickpeas, the stems and straw left behind can be used as fodder. This helps in utilizing the entire plant, reducing waste, and providing a cost-effective feed option for animals. Using chickpeas in these various forms helps improve the sustainability of farming practices and provides a reliable source of nutrition for livestock, supporting the agricultural economy and food security. In different chickpea varieties the biochemical component ranged from such as soluble protein (14.35 to 19.88%), crude protein (19.74 to 27.55%), fat (4.12 to 6.16%), carbohydrate (64.04 to 69.13%,), ash (2.16 to 3.16%), total soluble sugar (4.15 to 7.16%), reducing sugar (0.97 to 1.69%), non-reducing sugar (3.17 to 5.48%) and calorific value (334.63 to 382.90K cal/ 100 g), respectively (Tripathi *et al*., 2016) [6]. The majority of chickpea is utilized by human with only a minor fraction used as feed. Chickpeas are used to make different wonderful cuisine products *viz*. sprouts, salads, soups, and stews. Chickpea is also used in formulation of herbal medicine and cosmetics, Khan *et al*., (2009) [7]. This study was planned to find out the different biochemical parameters responsible to assess quality of different genotypes of chickpea.

## Materials and Methods

Ten different genotypes/varieties of chickpea (*Cicer arietinum* L.) *viz*. NDG-14-3, Pant-G-186, Uday, BG-372, NDG-18-4, NDG-19-3, NDG-18-7, NDG-18-2, RSG-888 and Vaibhav were collected from the Department of Genetic and Plant Breeding, Acharya Narendra Deva University of Agriculture and technology Kumarganj, Ayodhya (U.P.). The powdered samples of all genotypes/varieties of chickpea were used for the analysis of different biochemical parameters.

### Estimation of Biochemical parameters of chickpea:

Carbohydrate was determined using anthrone reagent as described by Mc Cready *et al.,* (1950) [8]. 100 mg of chickpea flour was taken in a conical flask and 100 ml distilled water was added. It was mixed with the help of glass rod and 13 ml of 32% $HClO_4$ was added. It is mixed properly for 20 minutes with the help of vortex mixture. Wash the flask 3-4 times with distilled water. Finally the intensity of colour was recorded at 620 nm on spectrophotometer.

Total sugar was determined by the method of (Dubois *et al*., 1956) [9] using phenol reagent 0.1 ml sugar extract was taken in test tube and volume was made up to 1 ml with distilled water. 0.1 ml of 80 percent phenol and 4 ml conc. $H_2SO_4$ was poured in the test tube and cooled down at room temperature. The data was recorded at 480 nm by Spectrophotometer.

Reducing sugar content was estimated the method given by Miller (1959) [10], 1 ml sugar extract was taken and mixed with 3 ml dinitro-salicylic acid (DNS). The reagent was kept on water bath for 10 minutes. The test tube was collected and cooled at room temperature. The colour intensity was recorded at 575 nm by spectrophotometer.

Protein content in the grain was determined by Lowry's method, (1951) [11], 100mg of dried powder sample was taken and homogenized with 10 ml of buffer. The sample was centrifuged at 5000 rpm for 10 minutes. An aliquot of 0.2ml of protein solution was taken in a test tube and volume was made up to 1ml with distilled water. To each tube 5ml of mixed reagent C (2% $Na_2CO_3$ in 0.1N NaOH (Reagent A) and 0.5% $CuSo_4.5H_2o$ in 1% Sodium-Potassium Tartrate (Reagent B) mixed in the ratio of 50:1 (just prior to use) was added and mixed thoroughly and allowed to stand at room temperature for 10 min. Then 0.5ml Folin–Ciocalteau reagent (1:1 N) was added into each test tube and mixed rapidly after each addition and kept at room temperature for 30 min. The intensity of blue colour was measured after 30 min in a Spectrophotometer (Systronics 169) at 630 nm against a reagent blank.

### Methionine content

Methionine content was determined using the method of Horn *et al.,* (1946) [12]. 0.5 g sample was taken in flask and 6mL of 2N HCL was added and autoclaved for 1hours. A pinch of activated charcoal was added to hydrolyzed and heated up to boil. The filtrate was collected and the volume was make up 25 ml with distilled water after cooling to ambient temperature. Finally, 4mL of metaphosphoric acid was added after adding 0.1mL sodium nitroprusside. 2mL glycine was added in the solution. The data was recorded at 450nm by spectrophotometer.

### Tryptophan content

The tryptophan content in chickpea was estimated by (Spice and Chambers 1949) [13]. 100 mg of defatted powdered chickpea sample was taken and transferred in to a 50mL conical flask. 30 mg p- dimethylamino benzaldehyde and 10 mL of 19N $H_2SO_4$ solution was added and shaked well. The test mixture content was kept in dark for 12 hours. After completing the incubation process the mixture was centrifuged for 15 min at 5000 rpm and the supernatant was collected. Then 0.1mL of 0.45% NaNO2 solution was added and properly mixed by vortex mixture. After 30 min the colour intensity was measured at 545nm by spectrophotometer.

### Lysine content

Lysine content was determined by Felker *et al.,* (1978) [14]. 50 mg chickpea flour sample was taken. It was mixed with 50 ml of buffer solution (0.05 M tetra sodium pyrophosphate /HCL buffer, ph- 9.4) and kept on the mechanical shaker for 2 hours at room temperature. The sample was centrifuged at 10,000 rpm for 10 minutes. The supernatant was collected and absorbance was recorded at 420nm by spectrophotometer.

### Total ash content in chickpea seeds

Total ash in chickpea was estimated by the method of Hart and Fisher (1971) [15]. 2 g flour sample was taken in ashless filter paper. The crucible was placed into a muffle furnace and temperature was maintained at 550ºC for about 5-6 hours. The crucible was transferred into desiccators for 20 min. Ash content was calculated by the formula.

**Statistical analysis**: The data collected in three replications and calculate the mean value. The results were statistically analyzed by Gomez and Gomez (1984) [16] method. Statistical significance was accepted at a level of 5% level.

## Results and Discussion

The biochemical parameters *viz.* carbohydrate, total sugar, reducing sugar, non-reducing sugar, soluble protein, lysine,

tryptophan, methionine and ash content of different chickpea genotypes are presented in Table 1. The data depicted in Table 1 revealed that the carbohydrate content in chickpea ranged from 54.10% to 63.77%. The maximum carbohydrate content was recorded in BG-372 (63.77%) followed by NDG-18-7 (62.81%) and NDG-19-3 (59.80%). The minimum carbohydrate content was shown in Uday (54.10%) which varied significantly. The findings are in good agreement with the results reported by Tripathi *et al*., (2016) [6] and Khan *et al*., (1995) [7]. These results are also in accordance with the results reported by Shad *et al*. (2009) [17] for carbohydrate content in chickpea which varied from 64.9 to 66.5%. The data pertaining to total sugar, reducing sugar and non-reducing sugar content are presented in table 1. It was estimated that the total sugar content in chickpea ranged from 4.25 to 5.19%. The maximum total sugar content was recorded in RSG-888 followed by NDG-18-4 (5.11%) and the minimum total sugar was recorded in NDG-19-3 (4.25%). It was reported that the maximum reducing sugar content was recorded in RSG-888 (1.76%) followed by NDG-18-7 (1.70%) and Pant-G-186 (1.67%). The minimum reducing sugar content was recorded in NDG-19-3 (1.45%). The non reducing sugar content was ranged from 2.80 to 3.43%. The maximum non-reducing sugar content was recorded in RSG-888 (3.43%) followed by NDG-18-4(3.37%) and Pant-G-186 (3.24%). The minimum non reducing sugar content was recorded in NDG-19-3(2.80%). This result is in accordance with Veenakumari *et al.,* (2017) [18]. The soluble protein content among ten genotype of chickpea was ranged from 21.80 to 24.30%. The maximum soluble protein content was recorded in NDG-19-3(24.30%) followed by NDG-18-7 (24.0%) and BG-372 (23.90%). The minimum soluble protein content was recorded in NDG-18-2 (21.80%) which varied significantly. The findings are in good agreement with the result reported by Sharma *et al.*, (2013) [19] for crude protein content in chickpea which varied from 18-31%. Among all the ten chickpea genotypes/varieties the lysine content was ranged from 6.49 to 8.10 g/16 g N. Among then genotypes of chickpea the maximum lysine content was recorded in NDG-19-3(8.10 g/16 g N) followed by BG-372 (7.86 g/16 g N) and NGD-14-3 (7.62 g/16 g N). The minimum lysine content was recorded in NDG-18-2 (6.49 g/16 g N). The findings are fairly similar with Clemente *et al*., (1998) [27], reported that the lysine content in raw chickpea seed was 8.28 g/100 g raw protein) supporting the results of other authors (Chavan *et al*., (1986) [20]; Singh *et al*., (1988) [21]. The tryptophan content in chickpea was ranged from 0.11 to 0.23 g/100 g protein. Among the ten genotype of chickpea the maximum content of tryptophan was recorded in Vaibhav (0.23 g/100 g Protein). The minimum tryptophan content was recorded in Pant-G-186 (0.11 g/100 g protein). These results are found in accordance with Bala *et al*., (1994) [22] who reported that tryptophan content was ranged from 0.41 to 1.45mg/g in chickpea. The methionine content of chickpea was ranged from 1.83 to 2.65 g/16 g protein. Among ten genotypes of chickpea the highest methionine content was recorded in Vaibhav (2.65 g/16 g N) followed by NDG-19-3 (2.23 g/16 g N) and BG-372 (2.21 g/16 g N). The minimum methionine content was found in NDG-18-2 (1.83 g/16 g N). The findings are accordance with EL-Adawy (2002) [23], Alajaji and El-Adawy (2006) [24], Daur *et al.*, (2008) [25] and Abu-Salem and Abou-Arab (2011) [26], reported that methionine content was ranged from 1.54 to 1.6 g/16 g N in chickpea seeds. Total ash content in chickpea was ranged from 1.93 to 3.28%. Among ten genotype the maximum total ash content was recorded in Pant-G-186 (3.28%) followed by NDG-19-3 (3.07%) and NDG-14-3 (2.95%). The minimum content was recorded in NDG-18-2 (1.93%). These findings are in agreement with the results of Shad *et al*., (2009) [17].

**Table 1:** Biochemical composition of different genotypes/varieties of chickpea

| S. No | Variety Name | Carbo-hydrate | Total Sugar | Reducing Sugar | Non-reducing sugar | Protein | Lysine | Tryptophan | Methionine | Total Ash |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | NDG-14-3 | 55.96 | 4.50 | 1.53 | 2.97 | 23.70 | 7.62 | 0.15 | 2.13 | 2.95 |
| 2 | Pant-G-186 | 59.45 | 4.91 | 1.67 | 3.24 | 22.80 | 7.51 | 0.11 | 2.01 | 3.28 |
| 3 | Uday | 54.10 | 4.73 | 1.61 | 3.12 | 21.90 | 6.81 | 0.15 | 1.89 | 2.54 |
| 4 | BG-372 | 63.77 | 4.51 | 1.53 | 2.98 | 23.90 | 7.86 | 0.16 | 2.21 | 2.44 |
| 5 | NDG-18-4 | 55.80 | 5.11 | 1.74 | 3.37 | 22.90 | 6.98 | 0.17 | 1.89 | 2.41 |
| 6 | NDG-19-3 | 59.80 | 4.25 | 1.45 | 2.80 | 24.30 | 8.10 | 0.19 | 2.23 | 3.07 |
| 7 | NDG-18-7 | 62.81 | 4.99 | 1.70 | 3.29 | 24.00 | 7.41 | 0.15 | 2.04 | 2.64 |
| 8 | NDG-18-2 | 56.82 | 4.72 | 1.61 | 3.11 | 21.80 | 6.49 | 0.16 | 1.83 | 1.93 |
| 9 | RSG-888 | 55.24 | 5.19 | 1.76 | 3.43 | 23.00 | 7.03 | 0.13 | 1.93 | 2.34 |
| 10 | Vaibhav | 58.40 | 4.57 | 1.45 | 3.12 | 23.60 | 7.34 | 0.23 | 2.65 | 2.88 |
| | Mean | 58.22 | 4.75 | 1.61 | 3.14 | 23.19 | 7.32 | 0.16 | 2.08 | 2.65 |
| | SEm± | 1.52 | 0.139 | 0.064 | 0.087 | 0.46 | 0.195 | 0.004 | 0.06 | 0.073 |
| | CD@5 | 4.52 | 0.413 | 0.191 | 0.285 | 1.53 | 0.579 | 0.0013 | 0.17 | 0.218 |

## Conclusion

The findings concluded that among ten genotype/varieties of chickpea RSG-888, NDG-19-3 and BG-372 were found relatively better for biochemical and nutritional point of view. On the basis of biochemical analysis it was suggested that chickpeas are an important source of carbohydrates and proteins. The findings will be beneficial for breeding programs to further optimize the nutritional value of chickpea. Genotypes with high protein content can be used to prevent malnutrition among rural populations and assist enhance the overall nutritional quality of functional food components in developing countries. In respect of protein quality aspects Vaibhav and Pant-G-186 were found best genotype/varieties.

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