

## Nutritive value of new chickpea (*Cicer arietinum*) varieties

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### Abstract

The nutritional quality of chickpea (*Cicer arietinum*) was studied on new varieties: JGG -1, JG-218, JG-322, SAKI-93130 and JG-11. The proximate analysis of seeds included moisture (5.62-8.17%), total ash (2.50-3.15%), crude protein (19.68-22.75%), lipids (4.18-4.92%), total carbohydrates (37.2-50.4%), calcium (0.068-0.149%), phosphorus (0.31-0.62%) and crude fibre (0.26-1.43%). Highest values were found for methionine (0.15 g/100 g of seeds) in JGG-1 and for cystine (6.8 g/100 g of seeds) in JG-218. Toxic factors found in these new varieties were cyanide (HCN 1.35-4.05 mg/100 g), oxalate (0.18-0.45 g/100 g), tannin (0.01-0.05 g/100 g) and trypsin inhibitor activity (0.438- 1.205 g of tyrosine inhibited/30' at 37°C/g). The feeding experiments on six weeks old eighteen white rats (male Albino) gave following results: feed utilization 3.33-4.89 g, nitrogen utilization 0.119-0.181 g and protein efficiency ratio +2.39, +1.77, +1.37, +1.59 and +1.83. Estimation of proximate and amino acid composition and toxic constituents of these new hybrid seeds gave the overall estimate of their nutritive value. Development of hybrid seeds has been considered important to produce seeds with better nutritive value and to minimize the presence of toxic substances. However, attention is being paid also to factors like low-cost production, improved storage quality and general acceptability.

**Key words:** Leguminous seeds, *Cicer arietinum* varieties, JGG-1, JG-218, JG-322, SAKI-93130 and JG-11, Albino rats, nutritive value, chemical composition, amino acid composition, toxic constituents.

### Introduction

Chickpea (*Cicer arietinum* L.) is the principal food legume in India. Proteins from pulses are considered to be of inferior quality as compared to that of the animal proteins mainly due to the deficiency of two essential amino acids, viz., methionine and tryptophan. Presence of polyphenols in pulses, which interfere with the utilization of proteins, further deteriorates their nutritive quality. Though pulses are good source of minerals, the major proportion of phosphorus exists in its phytate form<sup>11</sup>.

Protein and calorie deficit has been the key factor for malnutrition leading to impaired mental and physical performance. The type of starch, its digestibility, amount of flatulence causing oligosaccharides and the content of crude fibre are important from a nutrition point of view. Chickpea seeds contain total carbohydrates 52.4 to 70.9% of which major portion is contributed by starch<sup>7</sup>. The involvement of dietary fibre in lowering the blood cholesterol level has been reported<sup>42</sup>. The chickpea is a good source of iron and its availability is highest as compared to other food legumes<sup>10</sup>. In developing countries like India, cultivation of pulses like chickpea is the quickest way to augment the production of food proteins<sup>25</sup>. The purpose of the present investigation was to study the nutritional quality of some new chickpea varieties.

### Materials and Methods

The seeds of *Cicer arietinum* varieties were procured from the Department of Plant Breeding and Genetics, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur.

**Proximate composition analysis:** The seeds were analyzed in the powder form for proximate composition by using standard methodologies. Moisture, ash (and its analysis) and calcium

contents were determined by the method described by Pearson<sup>28</sup>. Crude fibre content was determined by the method recommended in the fertilizers and feeding stuffs regulations<sup>29</sup>. Phosphorus was determined according to the procedure of Sumner<sup>46</sup>. Total lipids were estimated gravimetrically by the method of Colowick and Kaplan<sup>9</sup>. Carbohydrates and reducing and non-reducing sugar were estimated by the method of Nelson<sup>26</sup>. Crude protein was obtained by multiplying the total nitrogen content (Semi Micro Kjeldahl method) by a factor of 6.25<sup>30</sup>.

**Analysis of amino acid composition:** The samples were hydrolyzed in 6 N hydrochloric acid for 18 hours at 110°C. The hydrolysate was filtered and analyzed by Jasco High Performance Liquid Chromatograph UV-975, Amino acid analysis system. Since tryptophan is destroyed during hydrolysis, the method involving the hydrolysis of the samples in 5 N sodium hydroxide was used for tryptophan.

**Antinutritional factors analysis:** Cyanide and tannin contents of the seeds were determined by the method of AOAC<sup>2</sup>. Oxalate was determined by using the method of Talpatra *et al.*<sup>47</sup>. Trypsin inhibitor activity was determined by the method of Kakade *et al.*<sup>20</sup> and Gupta and Deodhar<sup>13</sup>. Haemagglutinating activity was determined by the method of Liener and Hill<sup>22</sup> and Liener<sup>21</sup>.

**Nutritive value analysis:** The experiment was performed on the white male Albino rats. Eighteen white rats of aged six weeks were distributed to six groups, each having three rats. Rats selected were of body weight nearest to the mean of the population. They were housed in individual cages and feed and water fed *ad libitum*.

This experiment was done in terms of feed utilization, nitrogen utilization and protein efficiency ratio. Protein efficiency ratio and feed efficiency ratio were calculated by the method given by Osborne *et al.*<sup>27</sup> and Sarjekar and Shrivastava<sup>35</sup> respectively.

The composition of experimental diets fed to the rats is given in Table 1. The diets were iso-nitrogenous (20% approximate crude protein) and iso-caloric (3000 kcal/kg approximately). Adequate proportion of minerals and vitamins as recommended by I. S. I. (565.4 Part I - 1970) for Albino rats were added. The seed meals used in the study were autoclaved for 30 minutes at 15 lb pressure<sup>18</sup> before being incorporated in the diets to destroy the toxic constituents<sup>45</sup>. Crude protein content and other proximate constituents<sup>43, 44</sup> are not affected by autoclaving<sup>14</sup> and protein digestibility is enhanced by 4 to 40% as compared to raw material<sup>33</sup>. The experimental diets were fed for ten days<sup>6</sup> including the three days of pre-experimental period. The excreta were collected at 24 hours interval and were dried in hot oven at 100°C. The nitrogen content of the experimental diets and excreta were determined by Semi Micro Kjeldahl method<sup>30</sup> as usual.

**Statistical analysis:** The data collected were statistically analyzed according to analysis of variance method for one way classified data<sup>31</sup>.

## Results and Discussion

**Proximate composition:** Moisture content in seeds of *Cicer arietinum* varieties was highest (8.17%) in JG-218 and lowest (5.62%) in JG-11 (Table 2). Moisture contents of these varieties differed significantly from each other and also from values of the other varieties under study. The crude fibre content was highest (1.43%) in JG-322 and lowest (0.26%) in JGG-1. Crude fibre contents of all studied varieties were lower than the value 6.03% reported by Saxena *et al.*<sup>37</sup> but in resemblance with the value 0.2% reported by Harsha *et al.*<sup>15</sup> and in close accordance with values of other legumes<sup>12, 15, 34, 35, 40</sup>. However, these varieties of *Cicer arietinum* under study showed significant variation for their crude fibre content. The total lipid content of varieties (4.92-4.18%) was in close proximity with each other and also with that of other legumes<sup>4, 12, 15, 34, 35, 37, 40</sup>. The crude protein content (22.75-19.68%) was in close proximity with values of other *Cicer arietinum* varieties and other legumes<sup>12, 15, 34, 37, 40</sup>. JGG-1 had the highest (22.75%) crude

**Table 1.** Composition of experimental diets g/kg and protein values %.

Diet ingredients	Balance diet	Diet with <i>Cicer arietinum</i> JGG-1	Diet with <i>Cicer arietinum</i> JG-218	Diet with <i>Cicer arietinum</i> JG-322	Diet with <i>Cicer arietinum</i> SAKI-93130	Diet with <i>Cicer arietinum</i> JG-11
Maize yellow	610	500	470	470	480	460
Fat	20	40	40	40	40	40
Groundnut cake	270	220	230	210	210	250
Legume	-	140	160	180	170	150
Fish meal (Jawala)	80	80	80	80	80	80
Mineral mixture	19.6	19.6	19.6	19.6	19.6	19.6
Vitamin mixture	0.4	0.4	0.4	0.4	0.4	0.4
Calculated value of protein, %	20.12	20.22	20.31	20.05	20.08	21.17
Analyzed value of protein, %	21.43	20.56	21.87	22.75	21.00	22.31

**Table 2.** Proximate composition of air-dried seeds of *Cicer arietinum* varieties (g/100 g).

Variety	Moisture	Crude fibre	Total lipid	Crude protein	Total carbohydrate	Reducing sugar	Non-reducing sugar
JGG-1	6.95 (15.28769) b	0.26 (2.92279) e	4.92 (12.80388) a	22.75 (28.48994) a	49.2 (44.54152) a	30.0 (33.07991) a	19.2 (25.54178) a
JG-218	8.17 (16.61175) a	0.99 (5.71025) b	4.18 (11.79251) a	19.68 (26.33160) d	37.2 (37.55842) c	32.0 (34.42261) a	5.2 (13.15620) b
JG-322	7.04 (15.38648) b	1.43 (6.87604) a	4.20 (11.82104) a	20.56 (26.96641) cd	40.8 (39.69430) bc	24.0 (29.12064) a	16.8 (23.42885) a
SAKI-93130	6.70 (14.99813) b	0.90 (5.44351) d	4.61 (12.40045) a	21.43 (27.57527) bc	45.6 (42.47375) ab	28.0 (31.93875) a	17.6 (24.69357) a
JG-11	5.62 (13.70236) c	0.96 (5.62263) c	4.89 (12.76318) a	21.87 (27.87921) ab	50.4 (45.22922) a	26.0 (30.64640) a	24.4 (29.56961) a
Mean	6.89 (15.19728)	0.90 (5.31504)	4.56 (12.31621)	21.25 (27.44848)	44.6 (41.89944)	28.0 (31.84166)	16.6 (23.27800)
S.E.(m)	0.00230 (0.27536)	0.0000165 (0.02329)	0.00331 (0.32979)	0.00174 (0.23949)	0.02627 (0.92875)	0.13075 (2.07229)	0.27421 (3.00170)
S.E.(d)	0.00461 (0.38943)	0.0000330 (0.03294)	0.00662 (0.46640)	0.00349 (0.33869)	0.05254 (1.31345)	0.26140 (2.93066)	0.54793 (4.24505)
C.D. at 5%	0.02456 (0.89802)	0.000175 (0.07595)	0.03523 (1.07551)	0.01857 (0.78101)	0.27918 (3.02881)	1.38480 (6.75810)	2.89075 (9.78908)

Figures in parenthesis denote angular (arc sin) transformation. Values having the same "Alphabets" as suffix are not significantly ( $p < 0.05$ ) different.

**Table 3.** Mineral and ash content of air-dried seeds of *Cicer arietinum* (g/100 g).

Variety	Total ash	Water insoluble ash	Water- soluble ash	Acid insoluble ash	Acid- soluble ash	Alkalinity of H <sub>2</sub> O soluble ash in meq.	Calcium	Phosphorus
JGG-1	3.06 (10.07905) a	1.48 (6.99553) a	1.58 (7.22106) e	0.16 (2.29244) e	2.90 (9.81058) b	8.8 (17.25638) d	0.148 (2.20723) b	0.50 (4.06827) c
JG-218	3.15 (10.22846) a	1.16 (6.18289) b	1.99 (8.11644) c	0.20 (2.58431) d	2.95 (9.89554) a	9.6 (18.08184) a	0.140 (2.14686) c	0.37 (3.50293) d
JG-322	3.10 (10.15148) a	0.98 (5.68129) c	2.12 (8.37877) a	0.34 (3.35906) c	2.76 (9.56884) c	9.0 (17.49088) c	0.149 (2.21466) a	0.62 (4.52826) a
SAKI-93130	2.96 (9.91712) a	0.87 (5.36222) d	2.09 (8.31226) b	0.86 (5.33134) a	2.10 (8.33228) d	8.0 (16.42994) e	0.068 (1.49791) e	0.31 (3.19174) e
JG-11	2.50 (9.03207) a	0.54 (4.21416) e	1.96 (8.04782) d	0.60 (4.44256) b	1.90 (7.92290) e	9.2 (17.68977) b	0.080 (1.62078) d	0.56 (4.30437) b
Mean	2.95 (9.88163)	1.00 (5.68721)	1.94 (8.01527)	0.43 (3.60194)	2.52 (9.10602)	8.9 (17.38976)	0.117 (1.93748)	0.47 (3.91911)
S.E.(m)	0.00425 (0.37381)	0.0000241 (0.00890)	0.0000214 (0.00840)	0.0000492 (0.01271)	0.00000558 (0.00428)	0.0000196 (0.02542)	0.00000131 (0.00208)	0.00000442 (0.01205)
S.E.(d)	0.00851 (0.52865)	0.0000482 (0.01259)	0.0000430 (0.01188)	0.0000984 (0.01798)	0.0000111 (0.00605)	0.0000393 (0.03595)	0.00000263 (0.00294)	0.0000884 (0.01704)
C.D. at 5%	0.04526 (1.21906)	0.0000256 (0.02903)	0.0000228 (0.02739)	0.0000523 (0.04146)	0.00000592 (0.01395)	0.000209 (0.08290)	0.0000139 (0.00677)	0.0000470 (0.03929)

Figures in parenthesis denote angular (arc sin) transformation. Values having the same "Alphabets" as suffix are not significantly ( $p < 0.05$ ) different.

**Table 4.** Amino acid composition of seed proteins of *Cicer arietinum* (g/100 g of seeds).

Amino acid	Seeds				
	<i>Cicer arietinum</i> JGG-1	<i>Cicer arietinum</i> JG-218	<i>Cicer arietinum</i> JG-322	<i>Cicer arietinum</i> SAKI-93130	<i>Cicer arietinum</i> JG-11
Lysine	absent	0.14	0.23	0.05	absent
Phenylalanine	0.136	0.46	0.63	0.6	0.166
Methionine	0.15	0.10	0.056	0.034	0.028
Cystine	6.5	6.8	6.4	1.01	3.04
Tryptophan	1.09	1.38	0.86	0.89	0.61
Threonine	0.54	0.094	0.34	0.107	0.096
Arginine	1.44	1.20	1.25	0.73	0.25
Glutamic acid	1.41	0.511	0.57	1.6	0.47
Leucine	0.48	0.36	0.85	1.17	0.22
Tyrosine	0.38	0.39	0.40	0.15	0.135
Histidine	0.31	0.103	0.166	0.24	0.106
Valine	0.016	0.003	0.011	0.34	0.5

protein content, which did not differ from the value of JG-11 (21.87%). The lowest (19.68 %) crude protein content was found in JG-218, and it did not differ significantly from the value of JG-322 (20.56%). Total carbohydrate contents (50.4-37.2%) exhibited general agreement with values of other *Cicer arietinum* varieties and other legumes<sup>12, 15, 34, 37, 40</sup>. JG-11 had the highest (50.4%) total carbohydrate content, which was not significantly different with contents in JGG-1 (49.2%) and SAKI-93130 (45.6%). The lowest (37.2%) total carbohydrate content in JG-218 was not significantly different from value of JG-322 (40.8%). The major portion of seed carbohydrates was present in non-reducing form. Non-reducing sugar content was highest (24.4%) in JG-11 and lowest (5.2%) in JG-218. JGG-1, JG-322, SAKI-93130 and JG-11 were not significantly different for their non-reducing sugar content, but JG-218 differed

from rest of the varieties. There was no significant differences in reducing sugar contents of varieties.

The ash content (2.50-3.15%) of *Cicer arietinum* seeds closely resembled with each other and other legumes<sup>12, 15, 34, 37, 40</sup> (Table 3). Highest ash content was found in JG-218 and lowest in JG-11, however, these varieties were not significantly different for their total ash content.

All the varieties, under study were significantly different for their water insoluble ash, water-soluble ash, acid insoluble ash, acid-soluble ash and alkalinity of ash content. Water-soluble (2.12%) and acid-soluble (2.95%) ash

content was highest in JG-322 and JG-218 respectively. Alkalinity of water-soluble ash was found to be maximum (9.6 %) in JG-218. Calcium values (0.068-0.149%) were in general agreement with those of other legumes<sup>12, 15, 19, 34, 35, 37, 40</sup>. Calcium contents of varieties were significantly different, the highest value being in JG-322. Phosphorus content (0.62-0.31%) was in general accordance with values of other *Cicer arietinum* varieties<sup>12, 15, 34, 40</sup>, but higher than the value 0.425% reported by Saxena *et al.*<sup>37</sup>. There were significant differences in phosphorus contents of all varieties. The daily Ca and Mg requirements can be met easily while the diet may need to be supplemented with food materials high in K, P and Na. Iron, magnesium and calcium deficiencies in foods can lead to abnormal bone development and anemia<sup>32</sup>, their presence in JG-322 seeds is therefore advantageous.

**Table 5.** Antinutritive factors in *Cicer arietinum* seeds under investigation.

Variety	Cyanide HCN mg/100g	Tannin g/100 g	Oxalate g/100 g	Trypsin inhibitor activity g of tyrosine inhibited/30' at 37°C/g
JGG-1	4.05 (11.61467) a	0.02 (0.81031) b	0.33 (3.30972) b	0.856 (5.30861) d
JG-218	2.70 (9.51593) b	0.03 (0.98291) b	0.23 (2.74842) c	1.205 (6.30220) a
JG-322	1.35 (6.68049) c	0.01 (0.57296) c	0.45 (3.87462) a	1.147 (6.14805) b
SAKI-93130	1.35 (6.67223) c	0.05 (1.32204) a	0.18 (2.47545) d	1.108 (6.04223) c
JG-11	2.70 (9.45329) b	0.02 (0.79190) bc	0.31 (3.22556) b	0.438 (3.79469) e
Mean	2.43 (8.78732)	0.02 (0.89602)	0.30 (3.12675)	0.950 (5.51915)
S.E.(m)	0.000275 (0.09508)	0.000157 (0.07185)	0.0000324 (0.03262)	0.000000402 (0.00115)
S.E.(d)	0.000550 (0.13447)	0.000314 (0.10162)	0.0000648 (0.04614)	0.000000809 (0.00163)
C.D. at 5%	0.00292 (0.31008)	0.00167 (0.23433)	0.000344 (0.10639)	0.000000428 (0.00375)

Figures in parenthesis denote angular (arc sin) transformation. Values having the same "Alphabets" as suffix are not significantly ( $p < 0.05$ ) different.

**Table 6.** Feed intake, feed utilization, % feed utilization, nitrogen intake, nitrogen utilization and % nitrogen utilization /rat/day.

Diet	Feed intake (g)	Faeces voided (g)	Feed utilization (g)	Feed utilization %	Nitrogen intake (g)	Nitrogen voided (g)	Nitrogen utilization (g)	Nitrogen utilization %
Balance diet	2.20	0.45	1.75	79.62	0.07	0.010	0.065	86.68
JGG-1	4.25 (11.89699) d	0.92 (5.50062) c	3.33 (10.51441) e	78.36 (62.27759) b	0.13 (2.06525) d	0.020 (0.79190) b	0.119 (1.97688) e	85.27 (67.43362) d
JG-218	4.21 (11.84020) d	0.81 (5.16360) d	3.40 (10.63088) d	80.77 (63.99291) a	0.14 (2.16941) c	0.018 (0.76872) b	0.129 (2.05829) d	87.69 (69.46031) a
JG-322	5.09 (13.03875) c	1.18 (6.24504) b	3.91 (11.40465) c	76.83 (61.22850) d	0.18 (2.43095) b	0.026 (0.92976) ab	0.158 (2.28046) c	85.74 (67.81613) c
SAKI-93130	6.38 (14.63061) a	1.49 (7.01919) a	4.89 (12.77560) a	76.65 (61.10418) e	0.21 (2.64715) a	0.033 (1.04088) a	0.181 (2.43833) a	84.44 (66.76759) e
JG-11	5.31 (13.32264) b	1.17 (6.20963) b	4.14 (11.73994) b	77.97 (62.00715) c	0.18 (2.43158) b	0.026 (0.92378) ab	0.163 (2.31620) b	86.18 (68.17625) b
Mean	5.04 (12.94583)	1.11 (6.02761)	3.93 (11.41309)	78.11 (62.12206)	0.16 (2.34886)	0.024 (0.89100)	0.150 (2.21403)	85.86 (67.93078)
S. E. (m)	0.0000116 (0.01955)	0.000118 (0.06224)	0.00000911 (0.00547)	0.00000202 (0.00258)	0.0000285 (0.03060)	0.0000906 (0.05456)	0.00000142 (0.00216)	0.00000323 (0.00326)
S. E. (d)	0.0000232 (0.02765)	0.000236 (0.08803)	0.00000182 (0.00774)	0.00000405 (0.00365)	0.0000570 (0.04328)	0.000181 (0.07716)	0.000000283 (0.00305)	0.000000647 (0.00461)
C. D. at 5%	0.000123 (0.06376)	0.00125 (0.20299)	0.00000969 (0.01784)	0.00000215 (0.00841)	0.000303 (0.09980)	0.000964 (0.17793)	0.00000150 (0.00703)	0.00000344 (0.01063)

Figures in parenthesis denote angular (arc sin) transformation. Values having the same "Alphabets" as suffix are not significantly ( $p < 0.05$ ) different.

**Amino acid composition:** The results of amino acid composition of new *Cicer arietinum* varieties are given in Table 4. JG-322 had the highest contents of lysine (0.23 g/100 g of seeds) and phenylalanine (0.63 g/100 g of seeds). Both these amino acids are essential for the synthesis of new body protein needed for growth and repair<sup>5</sup>. Therefore, JG-322 is better than the other varieties under study. Lysine was absent in JGG-1 and JG-11. The two sulfur amino acids, methionine and cystine are the first limiting amino acids in pulses<sup>48</sup>. JGG-1 was found to contain methionine in maximum amount (0.15 g/100 g of seeds) and JG-218 contained highest amount of cystine (6.8 g/100 g of seeds). Tryptophan and threonine are also deficient in some cultivars of pulses<sup>48</sup>. Tryptophan was found to be highest (1.38 g/100 g of seeds) in JG-218 and threonine (0.54 g/100 g of seeds) in JGG-1.

**Antinutritional factors:** The results of anti-nutritional factors,

cyanide, tannin, oxalate, trypsin inhibitor activity and haemagglutinating activity, of the seeds are given in Table 5. Cyanide contents (HCN 1.35-4.05 mg/100 g) were in general agreement with levels in other legumes<sup>8, 23, 24, 36</sup>, but higher than the value (HCN 3.78 mg/100 g) reported by Saxena *et al.*<sup>39</sup>. JGG-1 was significantly different from all the other varieties under study. There was no significant difference between JG-218 and JG-11 and also between JG-322 and SAKI-93130, but, JG-218 and JG-11 were significantly different from JG-322 and SAKI-93130.

Oxalate contents (0.18-0.45 g/100 g) were higher than the value (0.06 g/100 g) reported by Saxena *et al.*<sup>39</sup>. In JG-218, JG-322 and SAKI-93130 oxalate contents were significantly different with each other and also from other varieties under study, while no significant difference was found between JGG-1 and JG-11.

Tannin contents (0.01-0.05 g/100 g) were in close proximity with each other and also with values of other legumes<sup>3, 17, 36, 39</sup> but

**Table 7.** Gain in body weight, total feed consumed, total protein consumed, protein efficiency ratio and feed efficiency ratio/rat /10 days.

Diet	Protein in diet %	Gain in body weight (g)	Total feed consumed (g)	Total protein consumed (g)	Protein efficiency ratio (PER)	Feed efficiency ratio (FER)
Balance diet	21.43	(+) 16. 6	23.76	5. 09	(+) 3.26	(+) 0. 698
<i>Cicer arietinum</i>	20.56	(+) 21. 6	43.84	9. 01	(+) 2.39	(+) 0.492
JGG-1		(27.71774) a b	(41.46351) c	(17.46760) e	(8.89338) a	(4.02354) a
<i>Cicer arietinum</i>	21.87	(+) 16. 6	42.86	9. 37	(+) 1.77	(+) 0.387
JG-218		(24.04348) bc	(40.89504) d	(17.82462) d	(7.64535) c	(3.56816) c
<i>Cicer arietinum</i>	22.75	(+) 13. 3	42.46	9. 65	(+) 1.37	(+) 0.313
JG-322		(21.38860) c	(40.66335) e	(18.10130) c	(6.72990) e	(3.20716) e
<i>Cicer arietinum</i>	21.00	(+) 23. 3	69.68	14. 63	(+) 1.59	(+) 0.334
SAKI-93130		(28.88451) a	(56.58934) a	(22.48811) a	(7. 24400) d	(3.31311) d
<i>Cicer arietinum</i>	22.31	(+) 20. 0	48.96	10. 92	(+) 1.83	(+) 0.408
JG-11		(26.56505) ab	(44.40408) b	(19.29634) b	(7.77466) b	(3.66225) b
Mean		(+) 18. 9 (25.71987)	49.56 (44.80306)	10.71 (19. 03559)	(+) 1.79 (7. 65745)	(+) 0.386 (3. 55484)
S.E. (m)		0.04969 (1.27738)	0.000000402 (0.00115)	0.000000364 (0.00346)	0.00000128 (0.00650)	0.000000101 (0.000577)
S.E. (d)		0.09937 (1.80648)	0.000000809 (0.00163)	0.000000728 (0.00489)	0.00000257 (0.00920)	0.000000202 (0.000816)
C. D. at 5%		0.52768 (4.16574)	0.000000428 (0.00375)	0.00000386 (0.01127)	0.0000137 (0.02121)	0.000000107 (0.00188)

Figures in parenthesis denote angular (arc sin) transformation. Values having the same "Alphabets" as suffix are not significantly ( $p < 0.05$ ) different.

lower than the value (0.74 g/100 g) reported by Harsha *et al.*<sup>17</sup>. JG-322 and SAKI-93130 were significantly different with each other and also from all the other varieties under study, while JGG-1, JG-218 and JG-11 did not have significant difference.

Trypsin inhibitor activity was 0.438-1.205 g of tyrosine inhibited/30' at 37°C/g. The studied varieties were significantly different for their trypsin inhibitor activity.

**Nutritive value:** In the present study feed intake denoted the food consumed in last three days. Feed intake, faeces voided, feed utilization, percentage of feed utilization, nitrogen intake, nitrogen voided, nitrogen utilization and percentage of nitrogen utilization per rat per day are given in Table 6. The feed utilization for *Cicer arietinum* varieties was 3.33-4.89 g, whereas nitrogen utilization was 0.119-0.181g. These values were in close resemblance with feed utilization (1.75 g) and nitrogen utilization (0.065 g) of control diet, but lower than those reported<sup>35, 41</sup> for other legumes and other *Cicer arietinum* varieties<sup>16, 38</sup>. The studied *Cicer arietinum* varieties were significantly different for their feed utilization and nitrogen utilization.

Gain in body weight, total feed consumed, total protein consumed, protein efficiency ratio and feed efficiency ratio per rat for ten days are given in Table 7. The protein efficiency ratio of all the five varieties under study were in general accordance with one another and also with control diet. The studied varieties were significantly different for their protein efficiency ratio.

These five varieties under study showed almost same nutritive value in spite of having different chemical composition<sup>43, 44</sup>. It may be due to inclusion of crude protein on the iso-nitrogenous basis<sup>41</sup>.

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