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ORIGINAL ARTICLE

# Effect of dehusking and cooking on protein and dietary fibre of different genotypes of desi, kabuli and green type chickpeas (*Cicer arietinum*)

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**Abstract** Dehusking and cooking are essential and important component of processing of chickpea to enhance the digestibility of essential nutrients of grains. Protein and dietary fibres are important due to their role in lowering plasma cholesterol and other health advantages. Changes during dehusking and dehusking followed by cooking on soluble protein, cellulose, hemicellulose, lignin and pectin contents of four genotypes of *desi* type (BG 256, JG 74, KWR 108 and DCP 92-3), four genotypes of *kabuli* type (BG 1053, KAK 2, JKG 1 and L 550) and two genotypes of green type (Sadabahar and BDG 112) of chickpeas (*Cicer arietinum*) were studied. The cellulose, hemicellulose and lignin of grain decreased to an extent of 21.6 %, 29.6 % and 27.3 % respectively on dehusking, whereas pectin recorded an increase of 26.2 % on dehusking. The cooking of dehusked grain registered a marginal increase in cellulose, lignin and pectin, but a decrease in hemicellulose content. The soluble protein recorded an increase of 21.3 % on dehusking and 26.6 % increase on cooking, as compared to unprocessed grain.

**Keywords** Chickpea · Dehusking · Cooking · Protein · Cellulose · Hemicellulose · Lignin · Pectin

Chickpea is a highly nutritious pulse and placed third in the important list of the food legumes that are cultivated throughout the world. The world's total production of chickpea hovers around 8.5 million metric tons annually and is grown over 10 million hectares of land approximately. India is the largest producer of chickpea contributing around 70 % of the world's total production. Other important producers of chickpea are Pakistan, Turkey, Iran, Australia, Canada, US, Myanmar, Bangladesh and Ethiopia. In India, chickpea is grown in the states of Madhya Pradesh, Uttar Pradesh, Rajasthan, Punjab, Maharashtra and Andhra Pradesh. Based on seed colour and geographic distribution, the chickpea is grouped into two types: *desi* (Indian origin) and *kabuli* (Mediterranean and Middle Eastern origin). *Kabuli* cultivars are white to cream coloured and are used exclusively by cooking whole seeds as a vegetable. The seeds of *desi* cultivars are wrinkled at the beak with brown, light brown, fawn yellow, orange, black or green colour. The cultivars are normally dehulled to obtain *dahl* which is directly cooked or milled to flour. The bold seeded cultivars of *desi* type are often used for roasting or puffing. The green seed type chickpea is gaining popularity and considered delicacy due to its unique look and taste; therefore varieties having green seed coat are becoming more popular specially as sprouts.

Processing techniques such as soaking followed by cooking, soaking followed by germination, dehusking and cooking or pressure cooking are usually employed for better digestibility, enhanced nutritive value and good amount of flavour (Chavan et al. 1989). It has been recognized for many years that the nutritive value and digestibility of legumes are very poor unless subjected to processing (Liener 1976). The reduction in protein value and digestibility has been generally attributed to the presence of certain anti-nutritional factors such as trypsin and chymotrypsin inhibitors, oligosaccharides, lectins and tannins (Muzquiz et al. 1999). Dehusking is a processing technique usually used for preparation of *dahl*. During this process, the seed is passed through milling machine so as to remove its husk. The dehusked and split grain is commonly called *dahl*. Dehusking has a pronounced effect on composition of grain especially protein and dietary fibre content of the grain (Kadam and Salunkhe 1989). The protein content of grain generally increases and insoluble fibre

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decreases on dehusking. The dehusked grain (*dahl)* can be stored for a reasonable period in dried condition. It is boiled to cook or pressure cooked so as to make it soft and palatable before consuming with cereals such as rice, wheat and maize. The dehusked grain is powdered to coarse or fine flour commonly called as *besan*, which is used for preparation of sweets such as *laddus, mysore pak* and *soan papri*, and snacks such as *dhokla, khamam, chakli, khara sev, pakoda* and *namkeens.* During the process of dehusking and cooking of dehusked grain, certain changes occur in soluble protein and dietary fibre. These changes were studied in various genotypes of chickpeas.

The dietary fibre mainly consists of cellulose, hemicelluloses, lignin and pectin (Vidal-Valverde et al. 1992). The concentration of dietary fibre is directly related to the seed coat content and a large variation in the seed coat content of chickpea cultivars has been reported (Singh 1984). The hypocholesterolemic effect of dietary fibre of pulses has been reported (Soni et al. 1982; Singh et al. 1983). The involvement of dietary fibre in protection against cancer and other health benefits have also been reported (Dhingra et al. 2012). The benefits of dietary fibre in human diet is gaining importance in developed countries. A fibre rich diet helps to promote body fat loss and lower triglycerides in individuals with coronary heart disease who are overweight and have high triglycerides (Jenkins et al. 2003). Fatal and nonfatal myocardial infarctions have been inversely related with a total fibre intake (Rimm et al. 1996). Individuals who regularly take fibre rich food have lower risk of cardiovascular disease compared to individuals who do not consume adequate quantity of fibre (Jacob and Gallaghar 2004). Cellulose is the most important component of dietary fibre and changes during processing. The effect of different processing techniques on dietary fibre of different food legumes has been studied earlier (Vidal-Valverde and Frias 1991; Rehinan et al. 2004, and Ghavidel and Prakash 2007). Vasishtha and Srivastava (2011) reported cellulose, hemicellulose, lignin and pectic substances of grain of different genotypes of *desi* and *kabuli* type chickpeas during soaking and cooking of soaked grain. This study was intended to work out changes in soluble protein and dietary fibres of different type of chickpea genotypes during dehusking and cooking of dehusked grain commonly called *dahl.*

## Materials and methods

*Seed material and processing* Three type of chickpeas - *desi, kabuli* and green seed types were selected. Seeds from four cultivars of *desi* type *viz*., DCP 92-3, KWR 108, JG 74 and BG 256; four cultivars of *kabuli* types *viz*., L 550, BG 1053, JKG 1 and KAK 2; and two cultivars of green seed type *viz*., Sadabahar and BGD 112 were collected from the crop grown at Indian Institute of Pulses Research, Kanpur, India during 2006-07 in three replications. Each replication of seed of all the genotypes was divided into two lots. One smaller lot of seed (50 g) was dried at 70 °C and powdered to a uniform particle size in a seed grinder Perten model 3303, and the second larger lot of seed (450 g) was used for milling so as to produce dehusked grain or *dahl.* A part of dehusked grain was powdered for chemical analysis and another part was cooked in distilled water in open vessel till it became soft and palatable. The cooked *dahl* was dehydrated in a freeze dryer and used for chemical analysis. All determinations were done in triplicate and calculated on dry weight basis.

*Determination of protein and dietary fibre* Protein in grains of different genotypes in raw as well as processed (dehusked and cooked) were estimated by Lowry's method (1951) and reported as percent soluble protein on dry weight basis. The cellulose was determined by the method of Updegroff (1969) and results expressed as percent on dry weight basis. The hemicellulose was determined according to method of Goering and Van Soest (1975) and the results calculated as difference of NDF (neutral detergent fibre) and ADF (acid detergent fibre), and reported as g/100 g of seed on dry weight basis. The lignin was determined by the method of AOAC (1980) and the ADL (acid detergent lignin) was reported as lignin g/100 g seed on dry weight basis. The pectin was determined by the method of Ranganna (1979) and reported as percent on dry weight basis.

*Statistical analysis* The data were statistically analysed using SPSS version 13 by one-way analysis of variance (ANOVA). A multiple comparison of the treatment means was performed by Duncan's new multiple range test for various parameters and presented in Table 1. The mean and standard deviation of means of all genotypes for protein, cellulose, hemicellulose, lignin and pectin were calculated and presented in Tables 2, 3, and 4. Significance of the differences was defined as $P<0.05$. The data of different genotypes were also grouped into *desi, kabuli* and green types.

## Results and discussion

*Soluble protein* The dehusking of chickpea grain caused a remarkable increase in protein content of dehusked grain. The dehusked grain had significantly higher protein than raw seed and an average increase of 21.3 % was observed in protein content of chickpea (Table 1). The average soluble protein in dehusked grain of *desi*, *kabuli* and green types was 25.6 %, 24.5 % and 25.4 %, respectively (Table 2). Highest increase in soluble protein content on dehusking

**Table 1** Changes in soluble protein and dietary fibre components of chickpea on processing

| Processing technique | Soluble protein | Cellulose | Hemicellulose | Lignin | Pectin |
|---|---|---|---|---|---|
| Raw grain | 20.7±1.06[a] | 3.7±1.91[a] | 2.7±0.62[a] | 2.2±0.65[a] | 4.2±1.67[a] |
| Dehusked grain | 25.1±0.91[b] | 2.9±1.33[a] | 1.9±0.47[b] | 1.6±0.55[a] | 5.3±1.67[a] |
| Dehusked and Cooked | 26.2±1.15[c] | 3.4±1.50[a] | 1.6±0.48[b] | 2.0±0.64[a] | 5.6±1.94[a] |
| CD($P$<0.05) | 1.8 | 2.7 | 0.8 | 1.0 | 3.1 |

Values are expressed as Mean ± standard deviation of three replications of 10 genotypes

Mean values of each column followed by different superscript letter significantly differ when subjected to Duncan's multiple range test ($P$<0.05)

was observed in *desi* and green types. The increase in protein content in dehusked grain was due to removal of hull, which is mainly dependent on amount of hull removed from seed during the process of dehusking/dehulling. The *desi* and green type varieties of chickpeas had higher content of hull as compared to *kabuli* types and therefore higher protein was observed on dehusking of *desi* and green types. Increase in protein on dehusking of grain has also been reported earlier for chickpea and other pulses (Jambunath and Singh 1980; Ghavidel and Prakash 2007; Khalil et al. 2007).

The cooking also increased protein content of grain significantly (Table 1). The average soluble protein in cooked dehusked chickpea was 26.2 %. The *desi* and green type chickpeas had relatively higher soluble protein on cooking than *kabuli* types (Table 2). BG 256 had recorded highest soluble protein in cooked chickpea *dahl.* Varieties such as JG 74, KWR 108 and BGD 112 showed higher soluble protein in cooked chickpeas. Nestares et al. (1997), Candela et al. (1997), De-Almeida Costa et al. (2006) and Wang et al. (2010) have reported an increase in protein content on cooking of chickpea. The increase in protein during cooking may be attributed to the loss of soluble solids during cooking, which would increase the concentration of protein in cooked seeds. Alajaji and El-Adawy (2006), have however reported no significant change in protein on cooking of chickpea seeds.

**Table 2** Effect of dehusking and cooking on soluble protein of chickpeas

| Genotypes | Raw Grain | Dehusked | Cooked |
|---|---|---|---|
| Desi type | | | |
| BG 256 | 21.6±0.63 | 26.5±0.07 | 28.4±0.06 |
| JG 74 | 20.4±0.63 | 25.6±0.08 | 27.5±0.07 |
| KWR 108 | 21.3±0.31 | 25.8±0.07 | 26.5±0.07 |
| DCP 92-3 | 19.0±0.10 | 24.4±0.09 | 25.5±0.06 |
| Mean | 20.6 | 25.6 | 26.9 |
| Kabuli type | | | |
| KAK 2 | 22.0±0.82 | 25.7±0.05 | 26.4±0.03 |
| JKG 1 | 19.7±0.41 | 24.0±0.12 | 25.0±0.08 |
| BG 1053 | 22.2±0.79 | 24.7±0.11 | 25.5±0.08 |
| L 550 | 19.3±0.32 | 23.8±0.11 | 25.0±0.11 |
| Mean | 20.8 | 24.5 | 25.5 |
| Green type | | | |
| BGD 112 | 21.7±0.77 | 25.8±0.08 | 27.0±0.08 |
| Sadabahar | 19.9±0.10 | 25.0±0.13 | 26.3±0.07 |
| Mean | 20.8 | 25.4 | 26.6 |
| CD($P$<0.05) | 0.3 | 0.2 | 0.1 |

Mean values of three determinations ± standard deviation

*Cellulose* The cellulose content reduced drastically in chickpea on dehusking of grain. The cellulose in dehusked grain of chickpea genotypes was observed in the range of 1.2 to 4.6 %. The cellulose content on dehusking reduced drastically, but the reduction was not statistically significant. The average cellulose in dehusked grain of *desi*, *kabuli* and green types was 3.8 %, 1.4 % and 3.9 %, respectively. The *desi* and green types recorded a significant decrease of 24.0 % and 26.4 % respectively, whereas *kabuli* types decreased their cellulose by 12.5 %, which was due to thin seed coat of *kabuli* type genotypes.

Cooking of dehusked grain caused an increase in cellulose content. The cellulose in cooked dehusked grain was in the range of 1.4 to 5.7 %. The *desi* and green types had significantly higher cellulose in cooked dehusked grain than *kabuli* types. The cellulose in *desi* and green types was almost two and half times higher than *kabuli* type chickpeas. Vidal-Valverde and Frias (1991) also reported an increase in cellulose content on cooking of lentils. Ramulu and Udayasekhararao (1997) reported an increase in total and insoluble dietary fibre in chickpea, pigeonpea and lentils on cooking. Similar results were reported by Chang and Morris (1990).

*Hemicellulose* The hemicelluloses decreased on dehusking of grain of chickpea. The hemicellulose in dehusked grain of chickpea was found in the range of 1.4 to 2.7 %. The *desi* and green type chickpeas had higher hemicellulose in dehulled grain than *kabuli* types. Lowest hemicellulose was observed in JKG 1, KAK 2, BG 1053 and L 550 genotypes of *kabuli* types on dehusking, whereas BG 256 and DCP 92-3 of *desi* types contained highest hemicellulose in dehusked grain. Singh (1984) also reported higher hemicellulose in dehusked *desi* types as compared to *kabuli* type chickpeas. The hemicellulose content in chickpeas reduced significantly by 29.6 %

**Table 3** Effect of dehusking and cooking on cellulose and hemicellulose content of chickpeas

| Genotypes | Cellulose | | | Hemicellulose | | |
|---|---|---|---|---|---|---|
| | Raw Grain | Dehusked | Cooked | Raw Grain | Dehusked | Cooked |
| Desi type | | | | | | |
| BG 256 | 4.0±0.04 | 3.1±0.14 | 3.4±0.18 | 3.4±0.17 | 2.7±0.09 | 2.4±0.04 |
| JG 74 | 5.9±0.05 | 3.8±0.10 | 4.4±0.19 | 3.0±0.15 | 1.9±0.04 | 1.6±0.12 |
| KWR 108 | 4.2±0.05 | 3.7±0.14 | 4.1±0.13 | 3.0±0.14 | 1.8±0.08 | 1.5±0.10 |
| DCP 92-3 | 5.9±0.06 | 4.6±0.20 | 5.7±0.17 | 3.5±0.15 | 2.7±0.10 | 2.4±0.26 |
| Mean | 5.0 | 3.8 | 4.4 | 3.2 | 2.3 | 2.0 |
| Kabuli type | | | | | | |
| KAK 2 | 2.0±0.05 | 1.6±0.13 | 2.4±0.15 | 2.0±0.16 | 1.5±0.08 | 1.3±0.13 |
| JKG 1 | 1.9±0.04 | 1.5±0.21 | 1.8±0.14 | 1.9±0.12 | 1.4±0.07 | 1.0±0.10 |
| BG 1053 | 1.4±0.07 | 1.3±0.17 | 1.5±0.18 | 2.0±0.10 | 1.5±0.08 | 1.2±0.10 |
| L 550 | 1.2±0.05 | 1.2±0.19 | 1.4±0.09 | 2.1±0.06 | 1.6±0.11 | 1.2±0.07 |
| Mean | 1.6 | 1.4 | 1.8 | 2.0 | 1.5 | 1.2 |
| Green type | | | | | | |
| BGD 112 | 5.3±0.09 | 3.8±0.15 | 4.5±0.17 | 3.3±0.57 | 2.1±0.11 | 1.7±0.10 |
| Sadabahar | 5.2±0.09 | 3.9±0.16 | 4.6±0.10 | 3.1±0.10 | 2.1±0.07 | 1.7±0.06 |
| Mean | 5.3 | 3.9 | 4.6 | 3.2 | 2.1 | 1.7 |
| CD($P$<0.05) | 0.1 | 0.3 | 0.3 | 0.4 | 0.2 | 0.2 |

Mean values of three determinations ± standard deviation

on dehusking. The reduction in hemicellulose of *desi*, *kabuli* and green types on dehusking was 28.1 %, 25.0 % and 34.4 %, respectively. This shows a higher reduction in *desi* and green types as compared to *kabuli* types.

Cooking of dehusked grain caused no significant change in hemicellulose content. However, a reduction of 15.8 % in hemicellulose content was observed on cooking of dehusked grain. The average hemicellulose in cooked *desi*, *kabuli* and green type chickpeas was 2.0 %, 1.2 % and 1.7 %, respectively. The cooking caused highest reduction in hemicellulose of *kabuli* types.

*Lignin* The average lignin in dehusked grain of chickpea was 1.7 %. The lignin of seed decreased on dehusking and a

**Table 4** Effect of dehusking and cooking on lignin and pectin content of chickpeas

| Genotypes | Lignin | | | Pectin | | |
|---|---|---|---|---|---|---|
| | Raw Grain | Dehusked | Cooked | Raw Grain | Dehusked | Cooked |
| Desi type | | | | | | |
| BG 256 | 2.1±0.16 | 1.5±0.08 | 1.8±0.08 | 2.5±0.15 | 3.3±0.10 | 3.5±0.05 |
| JG 74 | 2.6±0.17 | 2.1±0.05 | 2.3±0.08 | 2.6±0.08 | 3.2±0.07 | 3.5±0.03 |
| KWR 108 | 2.9±0.06 | 2.2±0.08 | 2.8±0.10 | 2.3±0.07 | 3.3±0.07 | 3.7±0.07 |
| DCP 92-3 | 3.0±0.08 | 2.4±0.09 | 2.8±0.13 | 2.3±0.12 | 3.3±0.11 | 3.6±0.05 |
| Mean | 2.6 | 2.1 | 2.4 | 2.4 | 3.3 | 3.6 |
| Kabuli type | | | | | | |
| KAK 2 | 1.4±0.11 | 1.1±0.10 | 1.4±0.12 | 6.3±0.11 | 7.4±0.11 | 7.8±0.10 |
| JKG 1 | 1.9±0.16 | 1.4±0.06 | 1.7±0.04 | 4.6±0.29 | 5.7±0.09 | 6.4±0.03 |
| BG 1053 | 1.1±0.16 | 0.8±0.15 | 1.1±0.09 | 5.2±0.30 | 6.6±0.13 | 7.0±0.11 |
| L 550 | 1.6±0.16 | 1.2±0.07 | 1.4±0.06 | 4.4±0.15 | 5.4±0.13 | 6.0±0.08 |
| Mean | 1.5 | 1.1 | 1.4 | 5.1 | 6.3 | 6.8 |
| Green type | | | | | | |
| BGD 112 | 2.6±0.15 | 2.2±0.07 | 2.5±0.04 | 5.9±0.07 | 7.1±0.06 | 7.5±0.13 |
| Sadabahar | 2.5±0.09 | 1.9±0.08 | 2.4±0.07 | 6.0±0.16 | 7.1±0.13 | 7.3±0.06 |
| Mean | 2.6 | 2.0 | 2.5 | 5.9 | 7.1 | 7.4 |
| CD($P$<0.05) | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.1 |

Mean values of three determinations ± standard deviation reduction of 27.3 % in lignin content was observed. The reduction, however was not statistically significant. The *desi*, *kabuli* and green type chickpeas had 2.1 %, 1.1 % and 2.1 % lignin respectively in dehusked grain. The *desi* and green type chickpeas were similar in lignin content, whereas kabuli types had relatively low lignin in dehusked grain. The lignin in *desi*, *kabuli* and green types reduced by 19.2 %, 26.7 % and 19.2 %, respectively during dehusking. Hulls mainly consist of cellulose, hemicellulose and lignin (Dalgetty and Baik 2003). Thus the removal of seed hull leads to a decrease in lignin content as well. Dalgetty and Baik (2003) have reported 10.0 % of insoluble dietary fibre (IDF) in raw seed and 6.5 % IDF in chickpea flour (*besan*). The chickpea flour (*besan*) had lower IDF due to removal of hulls and was the powder of dehusked cotyledon, which consists of cellulose, hemicellulose and lignin as components of IDF. Seed coat is composed primarily of insoluble NSP (non soluble polysaccharides) in the form of cellulose, lignin, polyphenolics and minerals (Singh 1984). As *desi* and green type chickpeas had a thicker seed coat, changes in composition due to seed coat removal are more pronounced in *desi* and green types than in *kabuli* types. Removal of seed coat by dehusking produces *dahl* or flour commonly known as *besan* with a lower content of dietary fibre.

Cooking of dehusked grain resulted in an increase in the lignin content, but this increase was non-significant. The average lignin in cooked dehusked grain (*dahl)* was 2.0 % and there was a wide range in lignin content of cooked dehusked grain (1.1 to 2.8 %). There was an increase in lignin content on cooking of the dehusked grain. The lignin in the cooked dehusked grain (*dahl)* of *desi*, *kabuli* and green seed types was 2.4 %, 1.4 % and 2.5 %, respectively. Porres et al. (2002) reported an increase in lignin during autoclaving of lentils. Vidal-Valverde et al. (1992) also reported an increase in lignin of lentil on cooking. Ramulu and Udayasekhararao (1997) also reported an increase in IDF (insoluble dietary fibre) on cooking. Rehinan et al. (2004) reported an increase of 15.2–27.8 % in lignin of different food legumes on cooking.

*Pectin* Pectin in dehusked seed of chickpea was found in the range of 3.2 to 7.4 %. The pectin in dehusked grain of chickpea was 5.3 %. The pectin of seed increased on dehusking, but non-significantly. The average pectin in dehusked grain of *desi*, *kabuli* and green types was 3.3 %, 6.3 % and 7.1 %, respectively. Highest increase of 37.5 % in pectin content was observed in *desi* type on dehusking, followed by *kabuli* and green type chickpeas, which had 23.5 % and 20.3 % increase respectively. Dalgetty and Baik (2003) have also reported an increase in SDF (soluble dietary fibre) content of chickpea on dehusking. The SDF mainly consists of pectin. The increase in pectin on dehusking was due to removal of hull from the seed.

The pectin content in cooked dehusked chickpea grain was 5.6 %. The pectin content of dehusked grain did not change significantly on cooking. However, there was a marginal increase of 5.7 % in pectin content on cooking (Table 1). The average content of pectin in cooked dehusked grain of *desi*, *kabuli* and green type chickpeas was 3.6, 6.8 and 7.4 % respectively. Highest pectin of 7.8 % was observed in KAK 2 variety of *kabuli* type on cooking of dehusked grain. All varieties of *kabuli* and green type chickpeas had highest pectin in cooked dehusked grain, whereas *desi* type had significantly lower pectin in cooked dehusked grain (*dahl*). Cooked *kabuli* and green types had almost double pectin than *desi* type chickpeas.

The softening of legumes during cooking is due to disintegration of the cotyledonous tissue in individual cells. This is caused by the conversion of native protopectin to pectin, which quickly depolymerises on heating. The middle lamella of the cell walls, which consists of pectins and strengthens the tissue disintegrates in the process (Belitz et al. 2009). Remarkable increase in SDF (soluble dietary fibre) has been reported in mungbean on soaking and cooking by Azizah and Zainon (1997). Vidal-Valverde et al. (1992) also reported an increase in pectin content of lentil during cooking.

## Conclusions

Cellulose, hemicellulose, lignin and pectin of seed have changed remarkably in all the genotypes of different type of chickpeas during dehusking and cooking of dehusked grain. These components constitute dietary fibre of chickpea, hence are important from health point of view. The dehusked grain is used as cooked *dahl* as well as for preparation of different type of sweets and snacks. The dehusked grain is also a rich source of dietary fibre and protein, hence useful as a food ingredient. The cooked *dahl* also has high protein and moderate dietary fibres, therefore can be used as health food for longevity.

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