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# Evaluation of Physico-chemical properties of selected chilli cultivars

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**Abstract**
The present investigation was carried out to determine the physico-chemical properties of selected dried chilli cultivars i.e. Guntur, Guntur Brown and Byadgi. Varieties differ in axial dimensions, weight, seed and stalk content. The single chilli weight and length of Guntur, Guntur Brown and Byadgi chilli was 0.85g, 1.37g, 1.35 g and 95.90 mm, 113.05 mm, 113.20 mm, respectively. L/B ratio of chilli cultivars was varied from 6.71 to 8.58. Seed and stalk content was highest in Byadgi chilli (51.50% and 10.98%) followed by Guntur Brown (30.80 % and 6.97%) and Guntur (13.95% and 7.07%). The bulk density of Guntur was highest (0.130±3.78 g/cc) compared to Guntur brown (0.089±2.21g/cc) and Byadgi (0.069±2.26 g/cc). Coefficient of static friction was highest in plywood than mild steel and galvanized iron. The quality parameters *viz.* colour, total carotenoids content, ash content, total extractable colour and total phenol content of chilli powder obtained from whole chilli was significantly different from destalked chilli powder. The colour value of destalked Byadgi chilli powder was observed to be 32.31 (L*), 98.47 (a*), 36.12 (b*) and was found much better than whole Byadgi chilli powder 32.28 (L*), 91.70 (a*), 38.65 (b*). Similar trend was found in Guntur and Guntur Brown chilli. Highest carotenoids content and total extractable colour were obtained in Guntur brown chilli followed by Byadgi chilli and Guntur chilli. Results showed that the presence of chilli has deteriorated the quality and its removal is recommended for further industrial applications.

**Keywords:** Chilli, destalking, total carotenoids content, total extractable colour

## Introduction
Chilli is the dried ripe fruit of the species of genus '*Capsicum*' and it is an important commercial crop used as a condiment, culinary supplement or as a vegetable. Among the spices consumed in India, dried chillies contribute a major share. There are more than 400 different varieties of chillies found all over the world. India stands 1st in production, consumption and export of chilli globally. Indian chillies are known for their pungency and colour particularly grown in Guntur district of Andhra Pradesh state. Chilli was grown in an area of 7.92 lakh hectares producing 13.76 lakh tonnes during 2014-15 (Anonymous 2014a). Andhra Pradesh being the largest producer of chilli, contributing to about 53% of the total production, followed by Karnataka (8.23%), West Bengal (7.69%), Madhya Pradesh (7.20%), Odisha (5.38%), Gujarat (5.27%), Maharashtra (3.51%) and Tamil Nadu (1.77%) (Anonymous 2014b).
The dried chillies are sorted out into the form of whole chilli, stem-less chilli and crushed chilli depending upon the market requirement (Satyanarayana and Sukumaran, 2002). Some buyers/exporters prefer stem-less chilli for both domestic and export market. Hence, destalking is carried out at trader's level manually. According to an estimate, it requires 106 lakh labour days to handle the country's total chilli production of 16 lakh metric tonnes (Anonymous 2016). Thus, to improve upon the existing manual destalking practices, mechanical means of removing stalk can be thought off. This will not only enhance the quality of destalked chilli but will also improve the efficiency of the overall process. For designing of mechanical stalk remover, determination of physical properties is very important. Also, adulteration in chilli powder is done by grinding the whole chilli which deteriorates its quality. Hence, differentiation in chilli powder quality made from whole chilli and destalked chilli is also necessary. By keeping above point in view the present study was carried out to determine the physico-chemical properties of commercially available Indian chilli varieties.

## Materials and methods

Representative samples of three dried chilli varieties (Guntur, Guntur Brown and Byadgi) were procured from local market of Karnataka. Foreign matter in the form of broken, discolored chilli was removed. Sundried chillies with the moisture content of 8.32±0.54 (% w.b.) were collected randomly from the composite samples of all the three chilli cultivars.

### Physical properties

Moisture content was determined by keeping the representative samples in hot air oven at 60±2°C for 24 h to constant weight (AOAC, 1990). A randomly selected sample of 30 chillies from each variety was weighed using digital electronic balance (M/S Goldtech, India, ± 0.001g). The spatial dimensions in the form of three linear dimensions specified as length (L), width (W) and thickness (T) were measured using digital vernier callipers (M/S Mitutoyo, Japan, ±0.01 mm). Respective values of axial dimensions were modified to obtain arithmetic mean diameter ($D_a$), geometric mean diameter ($D_p$), sphericity and surface area of the chilli, calculated using the following equations Mohsenin (1970):

$$Arithmetic\ mean\ diameter\ (Da) = \frac{L + W + T}{3} \quad \ldots (1)$$

$$Geometric\ mean\ diameter\ (D_p) = (L \times W \times T)^{1/3} \quad \ldots (2)$$

$$Sphericity\ = \frac{(L + W + T)^{1/3}}{L} \quad \ldots (3)$$

$$Surface\ area = \pi D_p \quad \ldots (4)$$

The seed content was determined by weighing the number of seed present in an individual chilli divided by the whole weight of chilli. For quantification of bulk density, 100 gram of chilli was taken in a volumetric container and volume of the sample was recorded. Further, the bulk density (g/cc) was calculated using equation 5:

$$Bulk\ density\ = \frac{Weight\ of\ sample}{Volume\ occupied} \quad \ldots (5)$$

Static coefficients of friction of chilli against three different surfaces *viz.* plywood, galvanized iron sheet and mild steel were observed. With chilli resting on the surface, the surface was raised gradually until it just started to slide down (Sahoo and Srivastava, 2002). The coefficient of friction was calculated from the following relationship:

$$\mu = \tan \alpha \quad \ldots (6)$$

### Chemical properties

The ordinary practice followed for making of chilli powder is produced by grounding pericarp, seeds, calyx and stalk. The addition of other plant tissue besides the pericarp lowers the colour, but increases the processed yield by as much as 25% (Bosland and Votava, 2000). Hence, in the present section, chemical properties (colour, ash content, total carotenoids content, total extractable colour and total phenol content) of whole chilli and destalked chilli powder were carried out. Destalking of chilli was done manually. Whole chilli and destalked chilli were grounded into powder using mixer (M/S Philips).

Colour measurement was carried out using a Hunter colorimeter D25 optical sensor (Hunter Associates Laboratory, Trestoa, VA, USA) on the basis of three variables (L*, *a**, *b** value). The L* value signifies the lightness (100 for white and 0 for black), the *a** value represents greenness and redness (-80 for green and 80 for red), while the *b** value signifies changes from blueness to yellowness (-80 for blue and 80 for yellow).

In order to quantify ash content, a known amount of sample was taken in weighed crucible. Then, the crucible was kept in a muffle furnace at 650±10°C for 6 hours till the ash turned white. It was then cooled in desiccator and the weight was noted. The ash content was obtained using the following equation:

$$Ash\ content\ (\%)\ = \frac{Weight\ of\ ash}{Weight\ of\ sample} \times 100 \quad \ldots (7)$$

Total Carotenoids were determined by method described by Ranganna, (1986).

ASTA analytical method (Anonymous, 2004b and Chetti *et al*. 2014) were used to determine total extractable colour. For that, 100 mg of ground chilli sample was taken in a 100 ml volumetric flask. Volume was made up to 100 ml with acetone and tightly covered with stopper. Sample was shaken vigorously and allowed to stand for 16 h in dark at room temperature. After 16 h of incubation time, the sample was shaken again and left for sufficient time for particles to settle. The absorbance of sample was observed at 460 nm using spectrophotometer (M/S Labomed Inc., USA). Resultant total extractable colour was calculated using Eq. 8.

$$Total\ extractable\ colour\ (ASTA\ units)\ = \frac{Absorbance\ \times 16.4}{Weight\ of\ sample} \quad \ldots (8)$$

The total phenol content was estimated by Folin-Ciocalteau method (Kaur and Mondal, 2014).

### Data analysis

Results are expressed as mean ± standard error of thirty replications for physical properties and five replications for chemical properties. Statistical Analysis Software (SAS) version 9.3 was used to determine the analysis of variance (ANOVA). Significance was accepted at $p \leq 0.05$.

## Results and discussion

### Physical properties

Generally, dried chillies with bright red colour, thick pericarp, less number of seeds with firm stalk fetch higher price in the market. The physical properties of selected varieties of chilli are presented in Table 1. It can be observed that varieties differ in weight, length, width, seed and stalk content. Average single weight and length of chilli pod varied from 0.849 to 1.368 g and from 95.90 to 113.20 mm, respectively.

L/B ratio of Guntur, Guntur Brown and Byadgi chilli was observed to be 6.97, 6.71 and 8.58, respectively indicating the shape of samples was closer to a round object.

Length of pericarp was highest in Byadgi chilli (83.2 mm) followed by Guntur Brown (81.2 mm) and Guntur (60.45 mm). Whereas, stalk length was highest in Guntur chilli (28.70 mm) followed by Guntur brown (27.05 mm) and Byadgi (26.55 mm). The GMD, AMD and surface area of Guntur brown cultivar were highest followed by the corresponding values for Byadgi and Guntur cultivars. The difference in sphericity values of the selected cultivars was non-significant (Table 1).

Byadgi chilli recorded highest seed content (51.50%) followed by Guntur Brown (30.80%) and Guntur (3.95%). Whereas, the stalk content of Guntur, Guntur Brown and Byadgi chilli was 7.07, 6.97 and 10.98%, respectively.

Hence, variation was observed between the cultivars for weight, L/B ratio, seed content and stalk content which were genetically controlled. The similar findings were reported by Bidari *et al*. (2009), that Guntur (G-3), Guntur (G-4) and Byadgi chilli showed L/B ratio as 7.00, 5.11 and 6.11, respectively. Whereas, corresponding values for stalk and seed content was 43.54% and 7.07%, 45.60% and 6.15%, 42.26% and 6.97%, respectively.

The bulk density of Guntur was highest (0.130±3.78 g/cc) among the three cultivars as the bulk density of Guntur brown and Byadgi were 0.089±2.21g/cc and 0.069±2.26 g/cc, respectively.

**Table 1:** Physical properties of dry chilli varieties

| | Guntur | Guntur Brown | Byadgi | F value |
|---|---|---|---|---|
| Whole chilli weight (g) | 0.849±0.50$^{a}$ | 1.368±0.35$^{b}$ | 1.348±0.98$^{b}$ | 1.945E3$^{S}$ |
| Length of whole chilli (mm) | 95.90±2.21$^{a}$ | 113.05±2.70$^{b}$ | 113.20±3.14$^{b}$ | 969.10$^{S}$ |
| Breadth of chilli (mm) | 13.76±1.31$^{a}$ | 16.84±1.36$^{b}$ | 13.19±1.59$^{a}$ | 28.68$^{S}$ |
| L/B ratio | 6.97±1.76$^{a}$ | 6.71±2.03$^{a}$ | 8.58±2.12$^{b}$ | 11.40$^{S}$ |
| Length of pericarp (mm) | 60.45±2.12$^{a}$ | 81.2±2.10$^{b}$ | 83.2±2.82$^{c}$ | 1.576E3$^{S}$ |
| Length of stalk (mm) | 28.70±1.10$^{b}$ | 27.05±1.22$^{a}$ | 26.55±0.86$^{a}$ | 55.86$^{S}$ |
| Thickness of chilli (mm) | 4.31±0.18$^{a}$ | 4.24±0.23$^{a}$ | 5.01±0.23$^{a}$ | 2.01$^{NS}$ |
| Seed content (%) | 13.95±4.15$^{a}$ | 30.80±4.67$^{b}$ | 51.50±6.12$^{c}$ | 3.930E3$^{S}$ |
| Stalk content (%) | 7.07±0.76$^{a}$ | 6.97±0.89$^{a}$ | 10.98±1.12$^{b}$ | 48.02$^{S}$ |
| Bulk density (g/cc) | 0.130±3.78$^{c}$ | 0.089±2.21$^{b}$ | 0.069±2.26$^{a}$ | 107.44$^{S}$ |
| Arithmetic mean diameter (mm) | 37.98±1.13$^{a}$ | 44.70±1.22$^{b}$ | 43.80±1.61$^{b}$ | 147.85$^{S}$ |
| Geometric mean diameter (mm) | 17.72±2.15$^{a}$ | 19.91±1.34$^{b}$ | 19.57±1.72$^{b}$ | 15.43$^{S}$ |
| Sphericity | 0.18±0.32$^{a}$ | 0.17±0.41$^{a}$ | 0.17±0.45$^{a}$ | 3.00$^{NS}$ |
| Surface area (mm$^{2}$) | 992.4±1.97$^{a}$ | 1258.58±2.53$^{c}$ | 1192.52±2.41$^{b}$ | 1.76E3$^{S}$ |

(Values are mean ± SE; mean in the same rows followed by same superscript letter are not differed significantly at p≤0.05; $^{S}$significant; $^{NS}$non-significant)

**Coefficient of static friction**

It was observed that the roughness of plywood surface gave a higher resistance against flow than that of mild steel and galvanized iron, which were smoother, and thus coefficient of friction is higher (Table 2). The value ranged from 0.515 to 0.726 for plywood, 0.482 to 0.725 for mild steel and 0.423 to 0.509 for galvanised iron.

**Table 2:** Coefficient of static friction of different varieties of chilli

| | Guntur | Guntur Brown | Byadgi | F value |
|---|---|---|---|---|
| Mild steel | 0.5018±0.05$^{b}$ | 0.4823±0.17$^{a}$ | 0.7246±0.19$^{c}$ | 5.44E4$^{S}$ |
| Galvanized iron | 0.4557±0.10$^{b}$ | 0.4234±0.07$^{a}$ | 0.5092±0.21$_{c}$ | 4.23E3$^{S}$ |
| Plywood | 0.5238±0.12$^{b}$ | 0.5150±0.21$^{a}$ | 0.7264±0.09$^{c}$ | 3.22E4$^{S}$ |

(Values are mean ± SE; mean in the same rows followed by same superscript letter are not differed significantly at p≤*0.05*; $^{S}$significant)

**Chemical properties of whole chilli and destalked chilli powder**

The most important and desired quality attribute of chillies is depends upon its colour and pungency. Depending on the variety, powder may vary in colour from dark blackish red to orange yellow (Krithika and Radhai Sri, 2014). Significant difference ($p<0.05$) was observed between whole chilli and destalked chilli powder in terms of colour value (L*, a*, b*). L* value (lightness) and b* value (yellowness) was lower in destalked chilli powder than the whole chilli, whereas, a* value (redness) was high in destalked chilli powder than whole chilli powder. This signifies that grinding of chilli with stalk deteriorates its red colour. Destalked Byadgi chilli powder had highest redness (98.47) followed by Guntur Brown (93.73) and Guntur (85.33). Lowest lightness (32.31) and yellowness (36.12) was observed in destalked Byadgi chilli powder than Guntur Brown (L*: 33.86, b*: 38.81) and Guntur (L*: 42.93 and b*: 45.98). Similarly, powder prepared using Byadgi whole chilli has highest a* value (91.70), lowest L* value (32.28) and b* value (38.65) compared to Guntur Brown (a*: 86.85, L*: 37.61, b*: 41.85) and Guntur (a*: 81.79, L*: 44.82, b*: 48.31), respectively.

Red colour of chillies is mainly due to the carotenoids pigments (Anu and Peter, 2000). The total carotenoids content (mg/100g) was on the higher side for destalked chilli powder than whole chilli powder for all the chilli samples. Table 3 showed that highest carotenoids content were obtained in Guntur brown (whole: 229.61 mg/100g, destalked: 271.72 mg/100g) chilli than Byadgi chilli (whole: 56.68 mg/100g, destalked: 144.77 mg/100g) and Guntur chilli (whole: 85.97 mg/100g, destalked: 90.90 mg/100g).

The presence of stalk in whole chilli has resulted in higher ash content than the respective powder sample of destalked chilli for all the varieties (Table 3). Byadgi chilli had highest ash content (6.47%) followed by Guntur Brown (5.36%) and Guntur (5.13%). Similar findings were reported by Bidari *et al*. (2009) as they reported the ash content in Guntur (G-3), Guntur (G-4) and Byadgi chilli as 5.66%, 5.85% and 6.97%, respectively.

Extractable colour is a measurement of total pigment content and is useful when powder is added as an ingredient or colourant in oil-based foods. Total extractable colour was found to be highest in destalked chilli (773.31) than whole chilli (592.25). Highest total extractable colour was observed in Guntur Brown (whole: 905.15, destalked: 1066.30) followed by Byadgi (whole: 464.15, destalked: 796.12) and Guntur (whole: 407.45, destalked: 457.52) chilli powder, respectively.

Guntur chilli contains highest phenol content (whole: 677.61 mg/100g, destalked: 527.89 mg/100g), followed by Byadgi (whole: 577.12 mg/100g, destalked: 506.38 mg/100g) and Guntur Brown (whole: 478.30 mg/100g, destalked: 458.20 mg/100g).

The existing difference in all the selected chemical properties among the three varieties was attributed to the difference in cultivar, soil, weather conditions, as well as postharvest manipulation and maturity (Krithika and Radhai Sri, 2014).

**Table 3:** Chemical properties of whole chilli and destalked chilli powder

| | Guntur | | Guntur Brown | | Byadgi | | |
|---|---|---|---|---|---|---|---|
| | **Whole chilli** | **Destalked chilli** | **Whole chilli** | **Destalked chilli** | **Whole chilli** | **Destalked chilli** | **F value** |
| L value | $44.82\pm1.87^{f}$ | $42.93\pm2.15^{e}$ | $37.61\pm0.82^{d}$ | $33.86\pm2.51^{c}$ | $32.28\pm2.50^{b}$ | $31.31\pm3.23^{a}$ | $1.450E4^{S}$ |
| a value | $81.79\pm4.16^{a}$ | $85.33\pm4.69^{b}$ | $86.85\pm4.44^{c}$ | $93.73\pm4.94^{e}$ | $91.70\pm1.97^{d}$ | $98.47\pm2.96^{f}$ | $1.051E4^{S}$ |
| b value | $48.31\pm1.35^{e}$ | $45.98\pm1.81^{d}$ | $41.85\pm0.78^{c}$ | $38.81\pm2.08^{b}$ | $38.65\pm1.94^{b}$ | $36.12\pm3.06^{a}$ | $5.539E3^{S}$ |
| Total carotenoids (mg/100g) | $85.97\pm0.35^{b}$ | $90.90\pm1.45^{c}$ | $229.61\pm0.89^{e}$ | $271.72\pm0.30^{f}$ | $56.68\pm1.31^{a}$ | $144.77\pm1.26^{d}$ | $3.367E6^{S}$ |
| Ash content (%) | $5.13\pm0.08^{c}$ | $4.51\pm0.38^{a}$ | $5.36\pm0.02^{d}$ | $5.82\pm0.05^{e}$ | $6.47\pm0.14^{f}$ | $4.94\pm0.02^{b}$ | $225.22^{S}$ |
| Total extractable colour (ASTA units) | $407.45\pm0.08^{a}$ | $457.52\pm0.24^{b}$ | $905.15\pm0.12^{e}$ | $1066.30\pm0.18^{f}$ | $464.15\pm0.21^{c}$ | $796.12\pm0.11^{d}$ | $1.91E7^{S}$ |
| Total phenol content (mg/100g) | $677.61\pm0.10^{f}$ | $527.89\pm0.15^{d}$ | $478.30\pm0.05^{b}$ | $458.20\pm0.10^{a}$ | $577.12\pm0.09^{e}$ | $506.38\pm0.21^{c}$ | $1.80E6^{S}$ |

(Values are mean ± SE; mean in the same rows followed by same superscript letter are not differed significantly at $p\leq0.05$; $^{S}$significant)

## Conclusion

In the present study, the physico-chemical properties of selected chilli cultivars *viz.* Guntur, Guntur Brown and Byadgi were determined. The physical parameters like linear dimensions, weight, seed and stalk content, bulk density, sphericity, coefficient of static friction were found to differ with the cultivar difference. The retention of colour, total carotenoids content and total extractable colour was found to be more in powder made by destalked chilli as compared to whole chilli. The ash content was higher in whole chilli powder sample than the destalked chilli powder sample. Overall, the result showed that the presence of stalk has deteriorated quality of chilli powder and hence destalking can be done to retain the pungent compounds.

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