ABSTRACT

The physico-chemical properties of four popular groundnut (peanut) varieties namely Trombay-Akola Groundnut-24 (TAG-24), Kadiri-6 (K6), Kadiri-9 (K9), and Kadiri-Harithandra (KH) were determined by following the standard measurement methods. The average geometrical mean diameter (GMD) and sphericity values of peanut pods ranged from 14.91 mm (K9) to 16.61 mm (KH) and from 0.56 to 0.63, respectively. The 100 whole pods mass for four different peanut varieties are significantly different from each other. The bulk density of peanut pods ranged from 232.7 kg/m$^3$ (K9) to 289.0 kg/m$^3$ (K6) and these are significantly different from each other. The calculated porosity values for peanut pods varied from 37.89% (KH) to 47.32% (TAG-24). For the kernels, the highest GMD value of 10.57 mm was recorded for the KH variety and the lowest GMD value of 9.33 mm was found for the K6 variety. Sphericity values for peanut kernels ranged from 0.71 (K6) to 0.78 (K9). The average 100 kernels mass ranged from 46.23 g (TAG-24) to 56.34 g...
(for K9). The bulk density of kernels ranged from 583.4 kg/m$^3$ (K9) to 611.9 kg/m$^3$ (K6). However, the bulk density of peanut kernels is not significantly different for the varieties from each other. The true density values of peanut kernels ranged from 1020.4 kg/m$^3$ (K6) to 1052.0 kg/m$^3$ (TAG-24). The porosity values for peanut kernels ranged from 40.06% (K6) to 43.64% (TAG-24) and they are not significantly different for the varieties from each other. Among all the varieties, KH variety had the lowest ash content of 2.18% and also the lowest protein content. The oil content of selected peanut varieties ranged from 45.36% (K9) to 48.22% (KH). The physical properties measured in this study are helpful to design and develop suitable pre and primary processing equipment. Proximate composition gives an idea to decide peanut’s suitability for manufacturing products such as peanut butter.

Keywords: Density; pod size; kernels; composition; protein; oil.

1. INTRODUCTION

Groundnut or peanut (Arachis hypogaea L.) is an important crop in Andhra Pradesh and peanut is also known as earthnut, monkey-nut and ground bean. India is the largest producer of peanuts in the world and ranks second among the countries after China. About 88% of the peanut area and 90% of production in India is concentrated in five states, namely, Gujarat, Andhra Pradesh, Karnataka, Tamil Nadu, and Maharashtra. Some of the peanut varieties prevalent in Andhra Pradesh are Kadiri-2, 3, 6, 7, 9, ICGS-11, Trombay-Akola Groundnut-24 (TAG-24), TG-47, Tirupati-3.4, and Kadiri-Harithandra etc. Peanut is rich source of vegetable protein and plays major role as a food crop besides continuing as an oilseed.

Physical properties of peanuts are needed in design and development of processing machinery such as cleaners, graders, and size separators etc. Chemical compositional properties such as protein content, oil content etc. are needed for deciding their suitability for development of products such as peanut butter, peanut powders, milk analogues, and peanut protein isolates etc. The fundamental physical properties of peanuts are geometrical mean diameter (size) and sphericity (shape), 100 pods or kernels mass, densities etc. Physico-chemical properties for some varieties of groundnut are available [1,2,3]. However, comprehensive evaluation of physical properties of whole pods and kernels, and proximate composition of kernels is needed to better understand the peanut varieties. Keeping this in view, four important peanut varieties for which physico-chemical properties are not widely available were chosen in this study with the objectives: (i) to measure the physical properties of whole pods and kernels, and (ii) to determine the proximate composition of peanut kernels.

2. MATERIALS AND METHODS

2.1 Sample Collection

Samples of four peanut varieties namely TAG-24, Kadiri-6, Kadiri-9, and Kadiri-Harithandra which are commonly grown in Andhra Pradesh were collected directly from the sources. Peanut variety TAG-24 samples were procured from farmers of Kariapalem, Bapatla (both Guntur Dt.) and Chirala (Prakasam Dt.) of Andhra Pradesh, India. Samples of other peanut varieties (Kadiri-6, Kadiri-9 and Kadiri-Harithandra) were procured from the Agricultural Research Station, Kadiri, Anantapur Dt. of Andhra Pradesh.

2.2 Determination of Size and Shape of Pods and Kernels

The major (a), intermediate (b) and minor (c) dimensions of whole peanut pods and kernels were measured with the help of digital Vernier callipers (Make: Aerospace, Model: SR 44 and accuracy: 0.01 mm). Longest dimension along the stem-calyx for whole pod, and along the root cap (embryonic root) to end of the cotyledon for kernel were considered as major dimension (a), intermediate dimension (b) as perpendicular to ‘a’ and minor dimension (c) as perpendicular to ‘a’ and ‘b’ [4]. All the dimensions were measured from randomly selected 150 samples (50 from each source) from the bulk of whole peanuts and kernels. The geometric mean diameter (GMD) for whole peanut pods and kernels were calculated from the measured a, b, and c values as.

$$\text{GMD} = (a \times b \times c)^{1/3}$$

Sphericity, which is the ratio of GMD to the major dimension (a) was calculated by using the following relationship [4,5].

$$\phi = \frac{\text{GMD}}{a}$$
The average of 150 values for GMD and sphericity for each variety were reported.

### 2.3 100 Pods or Kernels Mass

Hundred whole pods or kernels were counted from each sample lot by picking the whole pods or kernels randomly. The mass of 100 whole pods or kernels were measured with the help of digital electronic balance (Make: Essae-Teraoka Pvt. Ltd., Bangalore, Model: HTR-220E, accuracy: ±0.0001g). Triplicate samples were drawn from each sample and the average value of nine measurements for each variety were reported.

### 2.4 Determination of Bulk Density of Peanut Pods and Kernels

Bulk density is defined as the ratio of weight of the sample to volume of the sample. The samples were drawn, filled into the containers of known volume of about 2 L for whole pods and 1 L for kernels above the brim. The samples above the container brim were scraped off with a sharp edge. The weight of the filled samples were taken with an electronic balance. The bulk density value was calculated from the weight and volume of the samples as follows [6].

\[
\text{Bulk density, kg/m}^3 = \frac{\text{weight of the sample}}{\text{volume of the sample}}
\]

Triplicate measurements were carried out for each sample and average values of nine measurements for each variety were reported.

### 2.5 Determination of Apparent Density of Whole Pods and Particle Density of Kernels

The true volume of the whole peanut pods and kernels were measured with the help of a multivolume pycnometer (Make: Micromeritics Instruments Corporation, GA, USA, Model 1305) following the He gas replacement method. As there is a chance of He gas entering inside the whole pods and occupy the air spaces above the kernel and below the hull, the measured volume do not represent true volume of pods. Hence, the density measured in this way is termed as apparent density for whole pods. About 10 g of samples were measured with an electronic balance separately and transferred into a sample cup of 35 cm³. Sample cup with a sample was placed inside the sample chamber of a pycnometer. Sample chamber was closed tightly. And, the pressure in the pycnometer before the expansion was taken as \(P_1\) and the pressure after the expansion was taken as \(P_2\). From values of the sample mass, pressures \(P_1\) and \(P_2\), the true volume and density of the samples was calculated as follows:

\[
\text{True volume} = \frac{V_{\text{cell}} - V_{\text{exp}}}{P_2 - P_1}
\]

\[
V_{\text{cell}} = \text{Empty volume of the sample cell with the empty sample cup in a place}
\]

\[
V_{\text{exp}} = \text{Expansion volume added when the PRE/TEST valve was in the TEST position}
\]

\[
P_1 = \text{Charge pressure before expansion, psig}
\]

\[
P_2 = \text{Pressure after expansion, psig}
\]

Apparent / particle density, kg/m³ = \[
\frac{\text{(mass of sample)}}{\text{True volume of a sample}}
\]

Triplicate measurements were carried out for each sample and average values were reported.

The porosity of peanut pods and kernels were computed from the values of densities using the following relationship [7]:

\[
\text{Porosity, \%} = \frac{\text{Apparent/particle density} - \text{Bulk density}}{\text{Apparent/particle density}} \times 100
\]

### 2.6 Proximate Composition of Peanut Kernels

#### 2.6.1 Moisture content

The moisture content of samples was determined following hot air oven method. About 3-5 g of sample was taken into a moisture box and kept in a convection hot air oven (Make: M. B. Instruments, Delhi) at 105±3°C for 24 h. The weight of empty moisture box and sample were taken with an electronic balance (Model: HTR-220E, Make: Essae-Teraoka Pvt. Ltd., Bangalore, accuracy: ±0.0001g). Weights of the empty box was taken as \(W_1\) g, and moisture box with sample before placed in a hot air oven as \(W_2\) g, and weight of moisture box with sample after placing in hot air oven for 24 h was taken as \(W_3\) [4]. After 24 h at 105±3°C, the moisture boxes were placed in a desiccator to bring the samples to a room temperature. The moisture content of a sample on dry basis (d.b.) was calculated from the following equation.

\[
\text{Moisture content, \% d.b.} = \frac{W_2 - W_3}{W_3 - W_1} \times 100
\]
2.6.2 Ash content

Total ash content in peanut sample was determined with the help of a Muffle furnace (Kadavil Electro Mechanical Industries, KMF-1, Kerala, India) [8]. About 5 g of slightly ground peanut kernels sample was taken into a crucible. After determination of sample weight, the sample crucible was placed into a muffle furnace, then muffle furnace was set at 550°C for 6 hours. Crucible was cooled to room temperature prior to weighing and ash content was calculated as follows.

\[
\text{Ash, } \% = \frac{W_2 - W_1}{W_2 - W_3} \times 100
\]

Where,
- \(W_1\) = Weight of crucible, g
- \(W_2\) = Weight of crucible + sample, g
- \(W_3\) = Weight of crucible + ash, g

2.6.3 Protein content

The principle involved in protein estimation is that the Nitrogen in protein or other organic material is converted to ammonium sulphate \((\text{NH}_2)_2\text{SO}_4\) by \(\text{H}_2\text{SO}_4\) during digestion. On subsequent distillation, liquid ammonia is collected into Boric acid solution and color of this solution changes based on the indicator used. Distilled ammonia solution is titrated against standard acid (0.1 N \(\text{H}_2\text{SO}_4\) or \(\text{HCl}\)) until the change of colour (1 mL of 0.1 N acid is equivalent to 1.041 mg of Nitrogen) [6].

Micro Kjeldahl Nitrogen distillation method uses the mentioned principle and determines the protein content of sample (peanut) by estimating the amount of nitrogen present in the sample material and multiplying the resulted nitrogen value by 5.46.

While estimating the protein content of peanut samples, 0.2 g of ground peanut sample was weighed and transferred into micro Kjeldhal flask to which 3 g of catalyst mixture (5 parts of \(\text{K}_2\text{SO}_4\) + 1 part of \(\text{CuSO}_4\)) and 10 mL conc. \(\text{H}_2\text{SO}_4\) was added and digested at 420°C for 1 h until the mixture turned into dark green colour. Later, the digested mixture was cooled and transferred to a distillation flask and diluted with 40 mL of distilled water. One sample was kept blank. Ammonia was distilled by adding 10 mL of 40% \(\text{NaOH}\) and ammonia liberated was received into a 4% boric acid solution containing methyl red and methyl blue indicator. The amount of ammonia liberated was determined by titrating with 0.1 N HCl. From the titration values and weight of the sample, the \(\text{N}_2\) content and percentage of protein in the sample were calculated as follows.

\[
\text{Nitrogen content, } \% = \frac{(\text{Sample } \text{T.V.} - \text{Blank } \text{T.V.}) \times \text{Normality of HCl} \times 14 \times 100}{\text{Weight of the sample (g)} \times 1000}
\]

Where,
- \(\text{Sample T.V.}\) = Sample titre value, mL
- \(\text{Blank T.V.}\) = Blank titre value, mL
- \(\text{Protein } (\%) = \text{Nitrogen content, } \% \times \text{Protein factor}\)
- \(\text{Protein factor} = 5.46\) for peanuts

2.6.4 Oil content

Oil content of peanut was determined with the help of a Soxhlet apparatus (Socs Plus, SCS 06 DLS; Pelican Equipments, Chennai). The peanut kernel samples were prepared by grinding the kernels into small particles of homogeneous mixture. The ground sample was taken into a thimble which was fitted in a thimble guide of apparatus. Then, about 70 mL of hexane was poured into the beaker and a thimble with sample was placed into a beaker. The instrument was operated for 6 h to extract the oil into \(n\)-hexane which acted as a solvent. After 6 h extraction hexane with oil was distilled off by allowing it to collect in the Soxhlet tube by closing the extractor knob. Further, the obtained oil was dried in a hot air oven at 80°C for a day to eliminate residual hexane. The oil content as percentage was calculated by using the following equation.

\[
\text{Oil content, } \% = \frac{W_2 - W_1}{W_4 - W_3} \times 100
\]

Where,
- \(W_1\) = Weight of empty beaker, g
- \(W_2\) = Weight of beaker + oil, g
- \(W_3\) = Weight of empty thimble, g
- \(W_4\) = Weight of thimble + sample, g

2.7 Data Analysis

Physico-chemical properties of the peanut varieties were determined in triplicate. One-way analysis of variance (ANOVA) for physico-chemical properties data pertaining to four varieties of peanuts was performed with SPSS Software (Tukey HSD method). The least square means test with Tukey grouping was used to determine the significant (\(P < 0.05\)) differences of physico-chemical properties among the peanut varieties.
3. RESULTS AND DISCUSSION

3.1 Physical Properties of Whole Peanut Pods

3.1.1 Size and shape of peanut pods

The average GMD values of peanut pods ranged from 14.94 mm (K9) to 16.61 (KH), respectively as shown in the Table 1. The GMD values of peanut pods of TAG-24 and K9 are similar when compared with that of the other varieties. The average sphericity values of peanut pods in this study ranged from 0.56 to 0.63. The K6 variety has the minimum sphericity value of 0.56, whereas the K9 & KH have the maximum value of 0.63. It indicates that the shape of the whole peanut pods ranges from oblong to close to the spherical shape. Groundnut pods and seeds were neither round nor spherical, but may be of oblong in shape. The sphericity values of peanut pods as reported for ICGV, RMP-9 and RMP-12 were 0.44, 0.54, and 0.52, respectively [4].

3.1.2 100 pods mass

The average 100 pods mass ranged from 98.42 g (K9) to 112.76 g (for K6) as shown in Table 2. The 100 pods mass of whole pods for four different varieties are significantly different. The thousand peanut pods mass ranging from 158 g to 1594 g for various peanut varieties which can be converted for 100 pods as 15.8 g to 159.4 g was reported in the literature [2].

3.1.3 Bulk density and apparent density of whole peanut pods

The average bulk density, apparent density and porosity values for peanut pods are presented in Table 3. The bulk density of peanut pods ranged from 232.7 kg/m$^3$ (K9) to 289.0 kg/m$^3$ (K6). Similarly, the apparent density values of peanut pods ranged from 393.7 kg/m$^3$ (K9) to 492.3 kg/m$^3$ (TAG-24). The apparent density values of TAG-24 and K6 are not significantly different. Generally, the true density values for food materials ranges from 500 kg/m$^3$ to 2000 kg/m$^3$ with an average value of 850 kg/m$^3$[9]. The lower value for whole pods may be attributed to the structural properties of the peanut pod (oblong i.e., vertical diameter greater than the horizontal diameter in shape). The bulk density of ICGV peanut pods was reported as 331.0 kg/m$^3$ [4]. The bulk density of peanut pods at different moisture levels decreased from 243 to 184 kg/m$^3$ whereas the true density of peanut kernels at different moisture levels ranged from 424 to 545 kg/m$^3$[7].

3.1.4 Porosity

From the Table 3 it may be noted that porosity values for peanut pods were varied from 37.89% (KH) to 49.12% [7]. The higher porosity values indicate the easy flow of air through the bed of peanut pods. The inherent oblong nature of the peanut pods do not allow the close packing of peanut pods. The porosity of peanut pods ranged from 37.89% to 49.12% [7].

Table 1. Size and shape properties of whole peanut pods

| Peanut variety | Average Pods | Geometric mean diameter, GMD(mm) | Sphericity, Ø |
|----------------|--------------|----------------------------------|---------------|
|                | Major dimension (mm) | Intermediate dimension (mm) | Minor dimension (mm) |
| TAG-24         | 24.75±2.93c | 11.94±0.87c | 11.34±0.8c | 14.94±1.04c | 0.61±0.05c |
| K6             | 29.90±2.72a | 12.50±0.87b | 11.58±0.93b | 16.13±0.92b | 0.56±0.05c |
| K9             | 23.7±2.52d | 12.2±0.78c | 11.52±0.64c | 14.91±0.78c | 0.63±0.05a |
| KH             | 26.39±2.77c | 13.54±0.86a | 12.90±0.72a | 16.61±0.88a | 0.63±0.05a |

Note: Mean values having same superscript letter are not significantly different at p<.05

Table 2. 100 whole pods mass for four groundnut varieties

| Peanut variety | 100 Pods mass (g) |
|----------------|-------------------|
| TAG-24         | 103.07±1.31c      |
| K6             | 112.76±2.77a      |
| K9             | 98.42±0.91a       |
| KH             | 107.67±0.76b      |

Note: Mean values having same superscript letter are not significantly different at p < 0.05.
Table 3. Average bulk density, apparent density and porosity values of peanut pods

| Peanut variety | Bulk density, kg/m³ | Apparent density, kg/m³ | Porosity, % |
|---------------|---------------------|-------------------------|-------------|
| TAG-24        | 257.9±7.73          | 492.3±50.96             | 47.32±0.51  |
| K6            | 289.0±4.52          | 484.2±10.96             | 40.34±0.59  |
| K9            | 232.7±3.62          | 393.7±8.30              | 40.89±0.18  |
| KH            | 272.7±5.31          | 438.9±16.54             | 37.89±0.32  |

Note: Mean values having same superscript letter are not significantly different at p< 0.05

3.2 Physical Properties of Peanut Kernels

3.2.1 Size and shape of peanut kernels

From the Table 4, the highest GMD value of 10.57±0.85 mm may be found for the KH variety and the lowest GMD value of 9.33±0.62 mm may be found for the K6 variety. The GMD values for peanut kernels of different varieties are significantly different at p<0.05. GMD of 13.57 mm was reported for peanut kernels of NC-V11 variety in the literature [10]. Peanut kernels of K9 variety has higher sphericity value of 0.78±0.05 and K6 has lower sphericity value of 0.71±0.06 among all the four peanut varieties. Sphericity values of TAG-24 and K6 varieties are not significantly different from each other. The sphericity values of 0.63, 0.68, and 0.69 were reported for peanut kernels of ICGV-SM-93523, RMP-9 and RMP-12, respectively [4].

3.2.2 100 kernels mass

The average 100 peanut kernels mass for different varieties are presented in Table 5. The average 100 kernels mass ranged from 46.23 g (TAG-24) to 56.34 g (for K9). 100 peanut kernel mass of 110 g for peanut cv.NC2 was reported in the literature [5].

3.2.3 Bulk and particle density of peanut kernels

The average bulk density, particle density and porosity values for peanut kernels are presented in Table 6. The bulk density of peanut kernels ranged from 583.4 kg/m³ (K9) to 611.9 kg/m³ (K6). The bulk density values of peanut kernels are not significantly different for different varieties. In comparison to the bulk density values of whole pods, the peanut kernels have more than double the value of pods. Further, the lower and higher bulk densities for pods and kernels may be observed for K9 and K6, respectively among the four peanut varieties. The bulk density values of peanut kernels of ICGV variety was reported as 619 kg/m³ [4]. Similarly, the particle density values of peanut kernels ranged from 1020.40 kg/m³ (K6) to 1052.00 kg/m³ (TAG-24). Particle density values of TAG-24 variety was significantly different than that of the values for K6, K9 and KH at p<0.05.

Table 4. Size and shape properties of peanut kernels

| Peanut variety | Major dimension, (a) (mm) | Intermediate dimension, (b) (mm) | Minor dimension, (c) (mm) | Geometric mean diameter, GMD (mm) | Sphericity, Ø |
|---------------|---------------------------|---------------------------------|--------------------------|-------------------------------|-------------|
| TAG-24        | 13.63±1.12               | 8.77±0.68                       | 7.81±0.66                 | 9.76±0.54                     | 0.72±0.05   |
| K6            | 13.17±1.26               | 8.18±0.72                       | 7.58±0.65                 | 9.33±0.60                     | 0.71±0.06   |
| K9            | 12.97±1.16               | 9.66±0.74                       | 8.33±0.71                 | 10.13±0.62                    | 0.78±0.05a  |
| KH            | 14.05±1.55               | 9.7±0.92                        | 8.75±0.85                 | 10.57±0.77                    | 0.76±0.06b  |

Note: Mean values having same superscript letter are not significantly different at p< 0.05

Table 5. 100 kernels mass for four varieties of peanut kernels

| Peanut variety | 100 kernels mass, g |
|---------------|---------------------|
| TAG-24        | 46.23±1.765         |
| K6            | 47.45±2.664         |
| K9            | 56.34±1.386         |
| KH            | 51.92±0.937         |

Note: Mean values having same superscript letter are not significantly different at p< 0.05
The true density of peanut kernels showed an increase from 989 to 1088 kg/m\(^3\) with an increase in moisture content from 4.85% to 32.00% d.b. for some Turkish varieties [1].

### 3.2.4 Porosity

As presented in the Table 6, the porosity values for peanut kernels ranged from 40.06% (K6) to 43.64% (TAG-24). There was no significant differences among the porosity values of peanut kernels belonging to different varieties at p<0.05.

### 3.3 Proximate Composition of Peanut Kernels

#### 3.3.1 Moisture content

TAG-24 had the highest amount of initial moisture content of 8.08% d.b. followed by KH, K6 and K9 peanut varieties as seen in Table 7. The moisture content of TAG-24 was significantly different than that of other varieties. The moisture content values of peanut kernels were used to make the moisture content corrections while determining the other compositional parameters of the kernels such as protein content etc.

#### 3.3.2 Ash content

Among all the varieties, KH had the lowest ash content of 2.18 followed by K9, TAG-24, and K6 varieties as seen in Table 7. However, the ash content values are not significantly different from each other at p<0.05. The ash content of 2.43% for kernels of ICGV-00308 peanut variety was reported by other researchers [11].

#### 3.3.3 Protein content

The protein content of kernels of peanut varieties varied between 15.54% for KH and 22.57% for TAG-24 in Table 7. The lowest protein content was found in KH variety and the highest in TAG-24 among the four peanut varieties. All four peanut varieties had protein content higher than 15%. TAG-24 variety had the highest protein content compared with the other varieties. There is a significant difference in the protein content of peanut kernels belonging to the different varieties. Peanut kernels are the main source of protein and lipids [12].

#### 3.3.4 Oil content

The oil content of selected peanut varieties was varied between 45.36% (K9) to 48.22% (KH) as seen in Table 7. The lowest oil content was found in K9 and the highest in case of KH among the selected peanut varieties. All the four peanut varieties had oil content higher than 40%. KH variety had higher oil content compared with that of the other varieties. There were significant differences among all the varieties with respect to oil content. Oil content was reported as 47.92% for ICGV-00308 peanut variety [11]. The total oil and protein content are important from nutritional and textural quality point of view. The nutritional as well as textural quality of the prepared products plays an important role in the overall acceptability [11].

#### Table 6. Average bulk density, particle density and porosity values for peanut kernels

| Peanut variety | Bulk density, kg/m\(^3\) | Particle density, kg/m\(^3\) | Porosity, % |
|----------------|---------------------------|-----------------------------|------------|
| TAG-24         | 593.2±24.5\(^a\)          | 1052.0±8.5\(^a\)            | 43.64±1.55\(^a\) |
| K6            | 611.9±21.7\(^a\)         | 1020.4±6.4\(^b\)            | 40.06±1.01\(^a\) |
| K9            | 583.4±28.8\(^a\)         | 1027.1±4.1\(^b\)            | 43.23±0.79\(^a\) |
| KH            | 586.8±3.4\(^a\)           | 1035.8±5.2\(^ab\)           | 43.37±1.20\(^a\) |

Note: Mean values having same superscript letter are not significantly different at p< 0.05

#### Table 7. Proximate composition values of peanut kernels

| Peanut variety | Moisture content,% d.b. | Ash content, % | Protein content, % | Oil content,% |
|----------------|-------------------------|---------------|-------------------|---------------|
| TAG-24         | 8.08±1.39\(^a\)        | 2.45±0.04\(^ab\) | 22.57±0.25\(^a\) | 47.50±0.06\(^c\) |
| K6            | 5.04±0.57\(^c\)        | 2.62±0.11\(^a\) | 19.41±0.14\(^b\) | 46.69±0.52\(^c\) |
| K9            | 4.03±0.00\(^d\)        | 2.37±0.01\(^ab\) | 16.50±0.56\(^cd\) | 45.36±0.52\(^d\) |
| KH            | 5.07±0.3\(^d\)         | 2.18±0.12\(^a\) | 15.54±0.31\(^d\) | 48.22±0.18\(^d\) |

Note: Mean values having same superscript letter are not significantly different at p< 0.05
3.3.5 Mass of skins

Peanut skins mass per kg of kernels ranged from 28.22 g (K6) to 34.37 g (KH) for the studied peanut varieties as shown in Table 8. There were significant differences among all the varieties with respect to mass of skins. Peanut skin mass of 35-45 g per kg of shelled peanut kernels were reported in the literature [13]. Peanut skins contains good amount of anti-oxidants which are helpful for good health. The peanut skins are also added in preparation of peanut butter to derive the health benefits. Hence, the values in this study help to estimate the amount of skins that may be in the peanut butter when the peanut butter with skins are prepared.

Table 8. Average mass of skins from four varieties of peanut kernels

| Peanut variety | Mass of skins/kg(g) |
|----------------|---------------------|
| TAG-24         | 30.77±0.19<sup>c</sup> |
| K6             | 28.22±0.42<sup>d</sup> |
| K9             | 32.26±0.68<sup>b</sup> |
| KH             | 34.37±0.12<sup>a</sup> |

Note: Mean values having same superscript letter are not significantly different at p< 0.05

4. CONCLUSION

Physico-chemical properties of four popular peanut varieties namely Trombay-Akola-Groundnut-24 (TAG-24), Kadiri-6 (K6), Kadiri-9 (K9), and Kadiri-Harithandra (KH) were evaluated. The physical properties such as size, shape, bulk density, true density, and 100 pods/kernels mass were determined for whole pods and kernels. Proximate composition of peanut kernels namely moisture content, ash content, protein content, and oil content were determined by following the standard measurement methods. The physical properties measured in this study are helpful in design and development of pre and primary processing equipment. Proximate composition of kernels of chosen peanut varieties give an idea to decide peanut’s suitability for manufacturing various products.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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