**PHYSICO CHEMICAL PROPERTIES OF GROUNDNUT AND DEFATTED GROUNDNUT CAKE**

**Abstract**

Groundnut (*Arachis hypogaea* L.) is an important oil seed that serves numerous food purposes. After the oil extraction, defatted groundnut cake (DGC) /meal is produced and not used efficiently due to many post processing issues. Utilization of defatted meal/powder in the development of nutritional food products could be an excellent means of addressing malnourishing in developing countries along with customary cattle feed. Groundnut and DGC of Kadiri-Lepakshi 1812 (KL-1812) variety were used in this study to investigate the physico chemical properties and hence possibility of their application in food system. They resulted that the physical properties of groundnut and DGC required *viz*., physical properties like size, projected area, bulk density, true density, porosity, colour, angle of repose, coefficient of internal friction and coefficient of external friction), textural properties (hardness), proximate composition (moisture content, crude protein, crude fat, crude fibre, ash and carbohydrate), microbiological parameters (TPC and *Aspergillus s*p.) were determined by using the standard methods.

**Key words :** Defatted cake, Crushing, Grinding, Value added products, rural employment

**Introduction**

Oilseeds are primarily domesticated for their utility as sources of edible oils and dietary proteins in human diets. Oilseed cakes (OCs) are the by-products of the oil extraction process in edible oil industries, characterized by their richness in protein and fiber content (Kotecka-Majchrzak *et al*., 2020). Interestingly, the solid residues generated in large amounts as OCs during oil extraction are promising source of nutrients and bioactive components that can be used as functional food ingredients (Kaur *et al*., 2021). OCs are generally used as components of feed for livestock and generally underestimated as source of dietary fiber and protein for human consumption (Kotecka-Majchrzak *et al*., 2020). The oilseed by-products can be utilized in the preparation of low-cost healthy foods as they are promising sources of dietary fiber, proteins, minerals, essential amino acids vitamins and antioxidants.

Groundnut or peanut is commonly called the poor man's nut. Groundnut is originated during 3750-3900 BC from Peru, South America. It is generally grown in the tropical, sub-tropical and warm temperate zones. The botanical name for groundnut is *Arachis hypogaea Linn* and derived from two Greek words, *Arachis* means ‘a legume’ and *hypogaea* means ‘below ground’, referring to the formation of pods in the soil. Groundnuts, alongside rapeseed, soybean, sunflower seed and cottonseed, are one of the world’s five major oil crops with widespread cultivation and production globally (Kalpana *et al*., 2013).

Indian groundnuts are available in different varieties: Bold or Runner, Java or Spanish and Red Natal. The main Groundnut varieties produced in India are Kadiri-2, Kadiri-3, BG-1, BG-2, Kuber, GAUG-1, GAUG-10, PG-1, T-28, T-64, Chandra, Chitra, Kaushal, Parkash, Amber, *etc*. (http://apeda.gov.in/) and some of high oil yielding variety is ICGV 03043 which has the highest oil content of 53 % among cultivars grown in India. Normal varieties have about 48 % and farmers get a higher price with every additional 1 % of oil in the produce (http://icrisat.org.in/).

Groundnut kernels contain about 21 to 36 per cent proteins (Purohit and Rajalaksmi, 2011), while fat free seed meal contains about 43 to 63 per cent proteins. Hence, these are the potential source of human food for future. In anticipation of increased worldwide demand for nutritious as well as functional food ingredient, much research is being directed towards the characterization of basic properties of protein materials like a cold pressed cake derived from groundnuts (Cherry *et al*., 1971).

Groundnut involves a number of post-harvest processes, namely harvesting, threshing, drying, cleaning, winnowing, packaging, transportation, storage, processing and marketing. Groundnuts can be processed into a variety of value-added products, namely groundnut oil, peanut butter, roasted groundnuts, masala groundnut, groundnut chocolate, groundnut salad and groundnut chutney (Purohit and Rajalaksmi, 2011).

The groundnut kernels are a major source of commercial edible oil in India. More than 80 per cent of the total produce of the groundnut in the country is crushed to obtain oil. The groundnut oil can be extracted by various methods, including cold pressing, mechanical pressing, solvent extraction and pressing. Cold pressing involves low-temperature mechanical pressing to preserve nutrients, while mechanical pressing uses higher temperatures for greater yield. Solvent extraction employs chemicals like hexane for high efficiency, though it requires extensive refining. Hydraulic pressing uses high pressure with minimal heat, suitable for small-scale production (Kapila, 1982).

Cold pressing process involves mechanically pressing the groundnut at a low temperature to extract oil without the use of heat or chemicals, ensuring that the nutritional integrity of the cake is preserved. The cake typically has a granular and coarse texture, making it suitable for mixing with other feed ingredients or processing into different forms. Groundnut meal is produced by mechanical extraction (expeller) or by mechanical followed by solvent extraction. The partially and completely defatted cake is an important by-product of oil industry which is mostly used as cattle and poultry feed. The defatted meal has been reported to exhibit higher protein efficiency ratio, net protein utilization and digestibility than the full fat ground-nut meal (Kabirullah *et al*., 1977)

Groundnut meal, also known as groundnut deoiled cake, is a significant by-product of the groundnut oil extraction process, with nearly 8 million tonnes being produced worldwide every year. The cake contains 45–60 % protein, 22–30 % carbohydrate, 3.8–7.5 % crude fiber and 4–6 % minerals making it an excellent source of plant-based protein. Its protein content is comparable to that of soybean protein and significantly higher than that of lentils and mug beans (defatted groundnut meal contains 52.2 g of protein per 100 g of raw material, while defatted soy contains 51.5 g, lentils contain 24.6 g and green peas contain 5.4 g). Groundnut meal is also an abundant source of essential amino acids (Desai *et al*., 1999).

Utilization of defatted meal or defatted meal powder into food products could be an excellent vehicle for enhancing the utilization of groundnut protein in the diets of malnourished people in developing countries. Groundnut powder produced from cake blends easily and enhances or enriches the nutritive value of wheat and other flour. It has potential to be used as low fat groundnut concentrate, composite flour, in bakery products, breakfast cereal flakes, snack foods, multipurpose supplement, infant and weaning foods, extruded foods or fabricated food. Central Food Technological Research Institute (CFTRI), Mysore, India has developed some processed foods (paustic atta, composite grain, protein isolate, multipurpose supplement, infant and weaning foods, bal-ahar and miltone) from groundnut meal. Utilization of defatted groundnut meal with mild processing treatment is becoming increasingly popular in other countries (Gopala Krishna, 2007).

**Material and methods**

**Size**

Size is the measure of physical dimension of the object. From practical point of view, measurements of several mutually perpendicular axes are to be taken. However, the measurements along the major, minor and intermediate axes were taken for describing the size of the groundnut kernels and DGC (Mohsenin, 1986). The spatial dimensions of the seed and cake were determined by using vernier calliper. The size of the groundnut kernels and DGC was determined with the help of geometric mean of the three spatial dimensions, *i.e*., length (L), width (W) and thickness (T). The geometric mean diameter (Dg) of sample was determined by using the following formula (Mohsenin, 1986),

Dg (mm) = (L × W × T) 1/3 … (1)

 Where,

L= Length, mm

W= Width, mm

T= Thickness, mm

**Projected area**

The projected area is one of the important physical properties of biological materials. For determining the projected area, groundnut kernels and DGC were placed on the drawing paper and the outline was traced using a pencil. The initial point was marked on the outline of the drawing paper and the digital planimeter was traced along the outline in clockwise direction till it reached the initial point. The projected area of the cake was displayed by the planimeter and it was recorded (Mohsenin, 1986). Similar experiment was replicated thrice for randomly selected different sized groundnut kernels and DGC to minimize error. The average value was considered as a surface area of the groundnut kernels and DGC.

## Bulk Density

It is the ratio of mass per unit volume of the sample. Bulk density is important parameter in design of different processing machineries like separators, handling equipment, dryers, storage and transportation machineries and related systems. The bulk density of groundnut kernels and DGC was used to determine the size crushing cylinder. A rectangular container of known volume was filled with groundnut kernels and DGC to a height of 46.5 cm. After that the weight of the groundnut kernels and DGC was measured using an electronic weighing balance of an accuracy of 0.001 g. The bulk density was calculated as the ratio of the weight of the groundnut kernels and DGC to its volume (Mohsenin, 1986).

… (2)

**True Density**

It is the density of solid material constituting the true volume of the occupied material, excluding any interior pores that are filled with air (blind and through pores). The true density is to be determined by using the toluene displacement method. Totally 10 gram of groundnut kernels and DGC were taken for the experiment and true density of the groundnut kernels and DGC was determined by using following formula (Mohsenin, 1986).

 … (3)

## Porosity

The per cent void of an unconsolidated mass of the materials in terms of volume is called as porosity. It is the measure of void space between the materials. The porosity of samples was determined from the values of bulk density and true density by using the following equation (Sahay and Singh, 1994),

 … (4)

## Colour

Hunter’s lab colorimeter (Colour Flex EZ; Hunter Associates Laboratory; Inc., United States) was used to measure the colour of groundnut kernels and DGC. The colour was measured by using CIELAB scale at 10° observer with D65 illuminate. It works on the principle of focusing the light and measuring the energy reflected from the sample across the entire visible spectrum. It provides reading in terms of *L*\*, *a*\* and *b*\*, where luminance (*L*\**)* indicates whiteness (+) to darkness (-). In the same way, *a*\* indicates redness (+) to greenness (-) and *b*\* indicates yellowness (+) to blueness (-).

The instrument was initially calibrated with a black as well as with standard white plate. Once the instrument was calibrated, it was ready to measure the colour. Measurements were taken for 50 g samples at different spots of each sample and the average of the values for each sample was calculated (Nindo *et al.,* 2003).

## Angle of Repose

Flow ability of material is usually measured using the angle of repose (a measure of the internal friction between groundnut kernels and DGC) that is useful in the design of hoppers. The angle of repose is the angle between base and slope of the cone formed by a free-falling groundnut kernels and DGC on to a horizontal plane (Plate 1). It was determined by the procedure described by Sahay and Singh (1994). From the height and diameter of groundnut kernels and DGC heaped in natural piles, the angle of repose was calculated by using the following formula,

 … (5)

Where,

H= Height of piled material (mm)

D= Diameter of pile formed (mm)

**Coefficient of internal friction**

Coefficient of internal friction is the friction between the sample materials against each other. The coefficient of internal friction was measured by using a table provided with changeable surfaces. A box of size 7.5 cm × 7.5 cm × 9.5 cm was tied by cord passing over pulley is attached to cord. The changeable surface was filled with groundnut kernels and DGC. The weights (W1) were put into pan until the empty box started to slide on groundnut kernels and DGC surface. Later, the empty box filled with known weight of sample (W) and again the weights were put into pan to cause sliding. The weights (W2) required sliding the filled box on the groundnut kernels and DGC surface was recorded (Mohsenin, 1986).

 … (6)

Where;

µi= Coefficient of internal friction

W1 = Weight to cause sliding of empty small box, g

W2= Weight to cause sliding of filled small box, g

W= Weight of the material inside the small box, g

## Coefficient of external friction

Coefficient of external friction is the sliding stress between the groundnut kernels and DGC on the horizontal plane against the wall. The coefficient of external friction was measured by using a table provided with changeable surfaces. The box of the size 7.5 cm × 7.5 cm × 9.5 cm was tied by cord passing over pulley and pan was attached to cord. The weights (W1) were put into pan until the empty box started to slide. Later, the box was filled with known weight of sample (W) and again the weights were put into pan to cause sliding. The weights (W2) required to slide the filled box was recorded (Mohsenin, 1986).

 … (7)

Where;

µe= Coefficient of external friction

W1 = Weight to cause sliding of empty box, g

W2= Weight to cause sliding of box filled with material, g

 W= Weight of the material inside the box, g

## Textural properties of groundnut kernels and DGC

The important textural property such as hardness of groundnut kernels and DGC required for the development of DGC crusher machine were determined by following standard method.

## Hardness

The hardness of the groundnut kernels and DGC were determined using the Texture Analyser (Stable Micro System; Texture Export Version 1.22; UK). The texture analyser is a microprocessor-controlled analysis system which could be interfaced to a wide range of peripherals including PC-type computers.

The maximum force applied to check the hardness of the groundnut kernels and DGC was directly obtained from the data recorder (computer) connected to the Texture Analyser. The selected groundnut kernels and DGC were tested for the force required to puncture in different positions.

The following instrument settings were used during the experiment:

 Type of probe used - 75 mm compression platen

Test module - Measure hardness

Test option - Return to start

Pre-test speed - 3.00 mm s-1

Test speed - 1.00 mm s-1

Post-test speed - 5.00 mm s-1

Distance - 2

Trigger force - 25 g

Load cell - 0.10 N

## Proximate composition of groundnut kernels and DGC

## Moisture content

The moisture content of the groundnut kernels and DGC was determined by hot air oven (Swastik Electric and Scientific works; KOS.6FD; Kemi) method (AOAC, 2016 (Method No. 945.43)). About 5 g of the samples were weighed into a pre-weighed moisture box and dried in an oven at 105 ℃ for 24 hours and cooled in a desiccator. The weight of the dried sample was recorded. The moisture content of the sample on per cent (w. b.) was calculated by using the following formula. Determination of moisture content of samples was carried out thrice and the average value was considered as moisture content of groundnut kernels and DGC.

 … (8)

 Where,

W1 = Initial weight of the sample, g

W2 = Final weight of the sample, g

## Crude protein

The crude protein in groundnut kernels and DGC was determined using micro Kjeldahl (Foss; Kjeltec-2100) method (AOAC, 2016 (Method No. 960.52A)). A finely ground 2 g of samples were transferred to a digestion tube, to this 0.5 g of digestion mixture and 10 mL of concentrated H2SO4 were added. The sample was digested in a digestion unit till it became colourless. Then the tubes were cooled and transferred to the distillation unit. 40 mL of 40 % NaOH solution was allowed into the tube. Liberated ammonium was absorbed in 2 % boric acid solution containing mixed indicator. The pink colour of the boric acid solution was turned to green and this was titrated against 0.01N HCl until the pink colour was obtained. The protein in per cent was obtained by using the following formula. Determination of protein content of samples was carried out thrice and the average value was considered as protein content of groundnut kernels and DGC.

 … (9)

## Crude fat

The crude fat content of the groundnut kernels and DGC was determined by SOCS– PLUS (Pelican Equipment’s; SCS-8) apparatus (AOAC, 2016 (Method No. 920.85)). 3 g of samples were weighed accurately and transferred to thimble. The empty beaker weight was taken and all the beakers were loaded into the system. The petroleum ether was poured into the beaker from the top and boiled for about 80-90 min. at 80 °C. After the completion of process time, the temperature was doubled to 160 ℃ for 15-20 min. to collect the petroleum ether. All the beakers were removed and placed in a desiccator for about 5 min. The final weight of the beaker was noted down. The per cent fat content was calculated by using the following formula. Determination of fat content of samples was carried out thrice and the average value was considered as fat content of groundnut kernels and DGC.

 …. (10)

Where,

W1 = Initial weight of the beaker, g

W2 = Final weight of the beaker, g

W = Weight of the sample, g

## Ash content

The ash content of the groundnut kernels and DGC sample was determined by muffle furnace (MAC; MSW-251) method (AOAC, 2016 (Method No. 925.23). Accurately 5 g of the sample was weighed into a crucible (which was previously heated to about 600 °C and then cooled). The crucible was placed on a clay pipe triangle and heated first over a low flame till all completely charred, followed by heating in a muffle furnace for about 3- 5 h at 600 °C. It was then cooled in desiccators and weighed. The percentage of ash was calculated by using the following expression. Determination of ash content of samples was carried out thrice and the average value was considered as total ash content of groundnut kernels and DGC.

 … (11)

## Crude fibre

The crude fibre content in groundnut kernels and DGC was determined by sequential acid and alkali hydrolysis method using Fibra-Plus (Pelican Equipment’s; FES-08S) apparatus (AOAC, 2016 (Method No. 962.09)). Accurately weighed 2 g of groundnut kernels and DGC sample was taken in a crucible. The sample was boiled in 1.25 % sulphuric acid and subsequently boiled in 1.25 % sodium hydroxide solution. The sample was dried in hot air oven at 100 ℃till all the moisture was evaporated. The weight of the crucible before ashing was noted down. The obtained dried sample was ashed in a muffle furnace at 550 ℃ for 4 h. After ashing, the crucibles were cooled in a desiccator and reweighed. The residue obtained after subtraction of the ash was regarded as fibre. The crude fibre was obtained by using the following equation. Determination of crude fibre content of samples was carried out thrice and the average value was considered as crude fibre content of groundnut kernels and DGC.

 …. (12)

## Carbohydrates

Total carbohydrate content was determined by phenol sulphuric acid method (AOAC, 2016 (Method No. 996.11)). 1 g of the sample was weighed exactly and extracted with 80 % hot ethanol. The sample was centrifuged at 5000 rpm for 10 min. subsequently followed by three extractions and the final volume was made up to 25 mL. The test sample of 0.1 mL and 0.2 mL was pipette out into a test tube followed by the addition of 1 mL of 5 % phenol and 5 mL of 96 % sulphuric acid and the tubes were shaken well for 10 min. The tubes were placed in water bath at 25-30 ℃ for 20 min. and absorbance was read at 490 nm in Spectrophotometer (Make: Systronics; model: PC based double beam spectrophotometer 2200). The total amount of carbohydrate present in the sample was calculated using standard graph. Determination of carbohydrate content of samples was carried out thrice and the average value was considered as carbohydrate content of groundnut kernels and DGC.

 … (13)

Where,

X = Concentration of D-glucose from standard graph

**Microbial analysis of groundnut kernels and DGC**

Microbial analysis and enumeration *of Aspergillus* sp*.* Colonie was carried out for groundnut kernels and DGC samples by following ISO, 2013 (Method No. 4833-1). One gram of sample was taken in sterilized pestle and mortar and diluted with 9 mL (10-1) of 0.1 % peptone salt solution (8.5 g sodium chloride and 1 g peptone in 1000 mL distilled water). From this, 1 mL of the solution was pipetted out using a micropipette into test tube containing 9 mL of sterile peptone water (10-2) and serially diluted upto 10-3 dilution. One mL of aliquot from each dilution was transferred to the Petri plates and poured plate count agar media. The plates were rotated clockwise and anticlockwise directions to have a uniform distribution of colonies for the enumeration of microbial load. After inoculation the plates were inverted and incubated at 30 ℃ for 72±2 h. The colonies were counted after the incubation period and the number of colony forming units per gram (cfu g-1) of sample was calculated by applying the following formula,

 ….. (14)

 Where,

DF = Dilution Factor

**Results and Discussion**

## Size

As represented in Table 3. The average length, width and thickness of whole groundnut kernels were 15.25±2.17, 8.82±1.53 and 8.73±1.38 mm, respectively. Similarly for DGC the average length, width and thickness were 276.95±194.92, 166.34±72.09 and 35.04±5.33 mm, respectively. The average geometric mean diameter for whole groundnut kernel was 10.52±1.49 mm and for DGC was 118.84±49.55 mm. The findings are similar to the results obtained by Malathi *et al*., 2024 that, the average geometric mean was found to be 8.92 mm for groundnut (Kadiri Lepakshi).

## Projected area

The mean projected area of groundnut kernels and DGC were 37.38±3.13 mm2 and 461.90±390.75 mm2, respectively. The similar results were obtained by Aydin, C., 2007 on projected area of groundnut (44.08 mm2).

## Bulk density

The mean bulk density of groundnut kernels and DGC were 598.60±1.75 kg m-3 and 452.68±1.94 kg m-3 respectively. Higher bulk density is desirable since it helps to reduce the paste thickness which is an important factor in convalescent and child feeding (Padmashree *et al*., 1987). The findings are similar to results obtained by Chukwu *et al*., 2018 that, the bulk density was found to be 579.28 kg m-3 for groundnut.

## True density

The mean true density of groundnut kernels and DGC were 984.12±27.51 kg m-3 and 1111.11±0.04 kg m-3, respectively. The similar results were obtained by Fekria *et al*., 2012 on true density of groundnut (852.34 kg m-3). Similar results were obtained by other researchers also for various varieties of groundnut (Balasubramanian, 2001; Akcali *et al*., 2006).

## Porosity

The mean porosity value of groundnut kernels and DGC were 39.17±0.02 % and 59.29±0.04 %, respectively. The reason for higher porosity value might be due to the shape of groundnut. Further, the higher porosity value for groundnut cake might be due to highly irregular shape. It indicates that the pore space occupies 50 % of the total volume. The porosity of the groundnut seeds recorded by Chukwu *et al*., 2018 was observed to be 36.40 %. The porosity of the DGC samples recorded by Susheela *et al*., 2023 was 63.47 %.

## Colour

The average colour values of groundnut kernels *viz.*, *L\*, a\** and *b\** were 43.30±0.91, 14.62±1.94 and 20.83±0.51 respectively, and for DGC were 43.03±0.56, 8.56±0.08 and 17.14±0.24 respectively, indicating pinkish red for groundnut kernels and brownish colour for DGC. Similar values were recorded by Nindo *et al*., 2003 for *L\*, a\** and *b\** with 40.2, 3.1 and 11.7 for fresh *Asparagus officinalis, L*.

## Angle of repose

The average angle of repose for groundnut kernels and DGC were 35.49±2.25° and 37.67±2.52°. Similar results were reported by Chukwu *et al*., 2018 for groundnut of 36.89°.

## Coefficient of internal friction

The average value of coefficient of internal friction for groundnut kernels and DGC was calculated as 0.54±0.26 and 0.60±0.15, respectively as presented in Table 4.

## Coefficient of external friction

The average value of coefficient of external friction against mild steel for groundnut kernels and DGC was calculated as 0.23±0.02 and 0.37±0.26, respectively. Similar results were reported by Gharibzahedi *et al*., 2010 an average coefficient of friction for groundnut using stainless-steel surface (0.44).

## Textural property

The hardness of groundnut kernels and DGC was found to be in the range of 50.49 and 54.80 N with average of 52.83±2.18 N and 539.17 to 541.05 N, with average of 540.09±0.94 N respectively. The finding on hardness is in confirmative with the results of as reported by Ranjan *et al*. (2018) for groundnut kernels (53.197 N). Though the hardness of DGC was not found but the finding on hardness as reported by Krishnappa *et al*. (2017) for DGC 533.19 N.

**Proximate composition of groundnut kernels and DGC**

**Moisture content**

The mean values of moisture content for groundnut kernels and DGC of are presented in Table 5 and the values were found to be 7.52 % for groundnut kernels and 14.11 % for DGC. The increase in moisture content of DGC might be due to the addition of water during oil extraction process. Similar findings were observed by Ranjan *et al*., 2018 for groundnut (7.34 %) and DGC (14.28 %).

**Crude protein**

The mean values of crude protein content for groundnut kernels and DGC were 26.13±1.00 % and 54.57±7.11 %, respectively. The results obtained by Onimawo *et al*., 1998 for protein content (17.5 to 21.1 %) of groundnut were in agreement with the results reported in the investigation and the results obtained by Ranjan *et al*., 2018 for protein content (45 to 60 %) of DGC were in agreement with the results reported in the investigation.

**Crude fat**

From the Table 5, it is observed that the mean values of crude fat for groundnut kernels and DGC were found to be 48.62±1.17 % and 4.15±0.37 %, respectively. Similar results were recorded by Abdullahi *et al*., 2021 for groundnut as 40.20 %. Similar results were recorded by Oko *et al*., 2015 for DGC as 5.40 %.

**Crude fibre**

The data shows that, the mean values of crude fibre content of groundnut kernels and DGC were recorded to be 6.01±0.78 % and 5.57±0.41 %, respectively. The findings are in confirmation with the results reported by Onimawo *et al*., 1998 on crude fibre (5.98±0.15 %) content of groundnut and the findings are in confirmation with the results reported by Ranjan *et al*., 2018 on crude fibre (4-7 %) content of DGC.

**Ash content**

The mean value of on ash content of groundnut kernels and DGC was to be 2.86±0.30 % and 4.30±0.43 %, respectively. The results are slightly different with results reported by Abdullahi *et al*., 2021 on total ash content of 2.40 % for groundnut. This might be due to varietal difference. The results are in agreement with results reported by Ranjan *et al*., 2018 on total ash content of 4 to 6 % for DGC.

**Carbohydrates**

Table 5, reveals that the mean values of carbohydrates of groundnut kernels and DGC were 8.84±3.16 % and 17.56±10.78 %, respectively. Similar results were reported by Abdullahi *et al*., 2021 for carbohydrates of groundnut with 7.45 %. Similar results were reported by Ranjan *et al*., 2018 for carbohydrates of DGC with 12 to 18 %.

* + 1. **Microbial analysis of groundnut kernels and DGC**

**Total plate count (cfu g-1)**

It indicated that, the average values of total plate count for groundnut kernels and DGC as 1.6 ×103 cfu g-1 and 1.9 ×103 cfu g-1, respectively. And also it is observed that the mean values of total fungus count for groundnut kernels and DGC was found to be 0.6 ×103 cfu g-1 and 1.0 ×103 cfu g-1 respectively. The results are well below the results recorded by Madilo *et al*. (2023), for groundnut as 1.93 x 105 cfu g-1. The results are well below the results recorded by Fathima and Saba., 2023 for the formulation of savory cakes as 2.30×103 cfu g-1. Similar results were recorded byFathima and Saba, 2023 for the formulation of savory cakes as 1.30×103 cfu g-1.

**Table 1. Dimensions of groundnut and DGC**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Parameters** | **Groundnut** | **DGC** |
| 01 | Length (mm) | 15.25±2.17 | 276.95±194.92 |
| 02 | Width (mm) | 8.82±1.53 | 166.34±72.09 |
| 03 | Thickness (mm) | 8.73±1.38 | 35.04±5.33 |
| 04 | Geometric mean diameter (mm) | 10.52±1.49 | 118.84±49.55 |

**Table 2. Engineering properties of groundnut and DGC**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Parameter** | **Groundnut** | **DGC** |
| 01 | Projected area (mm2) | 37.38±3.13 | 461.90±390.75 |
| 02 | Bulk density (kg m-3) | 598.60±1.75 | 452.68±1.94 |
| 03 | True density (kg m-3) | 984.12±27.51 | 1111.11±0.04 |
| 04 | Porosity (%) | 39.17±0.02 | 59.29±0.04 |
| 05 | Colour | *L\** value | 43.30±0.91 | 43.03±0.56 |
| *a\** value | 14.62±1.94 | 8.56±0.08 |
| *b\** value | 20.83±0.51 | 17.14±0.24 |
| 06 | Angle of repose (º) | 35.49±2.25 | 37.67±2.52 |
| 07 | Co-efficient of I. F | 0.54±0.26 | 0.60±0.15 |
| 08 | Co-efficient of E. F [MS] | 0.23±0.02 | 0.37±0.26 |
| 09 | Hardness (N) | 52.83±2.18 | 540.09±0.94 |

## Table 3. Biochemical characteristics of groundnut and DGC

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Parameter** | **Groundnut** | **DGC** |
| 01 | Moisture content (%) | 7.52±0.98 | 14.11±2.43 |
| 02 | Crude protein (%) | 26.13±1.00 | 54.57±7.11 |
| 03 | Crude fat (%) | 48.62±1.17 | 4.15±0.37 |
| 04 | Crude fibre (%) | 6.01±0.78 | 5.57±0.41 |
| 05 | Ash (%) | 2.86±0.30 | 4.30±0.43 |
| 06 | Carbohydrates (%) | 8.84±3.16 | 17.56±10.78 |

## Table 4. Microbiological analysis of groundnut and DGC

|  |  |  |  |
| --- | --- | --- | --- |
|  **Sl. No.** | **Parameter** | **Groundnut** | **DGC** |
| 01 |  TPC (cfu g-1) | 1.6 ×103 | 1.9 ×103 |
| 02 |  *Aspergillus s*p. (cfu g-1) | 0.6 ×103 | 1.0×103 |

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