

**Original article**

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**Evaluation of the physical properties  
in three Vietnamese peanut (*Arachis hypogaea* L.) varieties**

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**Abstract**

The physical characteristics of three peanut (*Arachis hypogaea* L.) varieties grown in Vietnam (Lac Do (RP), Lac Van (SP), and Lac Den (BP)) were evaluated. The values of the measured properties differed significantly. The RP seeds had the highest moisture level (3.9 % RP, 2.9 % SP, 3.7 % BP). The SP variety showed the highest mass per 1000 seeds (474 g RP, 599 g SP, and 541 g BP). The bulk and particle densities of all the varieties ranged from 0.633 to 0.664 g/cm<sup>3</sup> and from 1.10 to 1.14 g/cm<sup>3</sup>, respectively. The RP seeds were relatively larger based on their length (18.2 mm), width (9.0 mm), and thickness (8.7 mm). In terms of sphericity (0.62 RP, 0.62 SP, and 0.65 BP), the BP seeds were rounder in shape. The angle of repose was higher in the SP seeds (28° RP, 28.1° SP, 20° BP). The BP seeds had higher static friction coefficient values (0.37 RP, 0.35 SP, 0.40 BP). These findings highlight the need to adapt standard peanut cultivation, processing, storage, and transportation methods to each peanut variety in order to increase the efficiency of local and global peanut-based production and reduce its potential losses.

**Keywords:** *Arachis hypogaea* L., peanut, seeds, physical properties, Vietnam

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**Оригинальная статья**

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<https://doi.org/10.26907/2542-064X.2026.1.161-169>**Исследование физических свойств трех сортов арахиса (*Arachis hypogaea* L.), выращиваемых во Вьетнаме****Л.Ф.Т. Куок✉, Л.Б.Б. Фыонг***Институт биотехнологий и пищевых технологий, Промышленный университет Хошимина,  
г. Хошимин, Вьетнам*✉ [lephamtanquoc@iuh.edu.vn](mailto:lephamtanquoc@iuh.edu.vn)**Аннотация**

В статье проанализированы физические свойства трех сортов арахиса (*Arachis hypogaea* L.), культивируемых на территории Вьетнама (Lac Do (RP), Lac Van (SP) и Lac Den (BP)). Все три сорта существенно различались по изученным показателям. Семена сорта RP характеризовались максимальным содержанием влаги (3.9 % – RP, 2.9 % – SP, 3.7 % – BP). Наибольшая масса 1000 семян наблюдалась у сорта SP (474 г – RP, 599 г – SP, 541 г – BP). Значения насыпной и истинной плотности варьировались в диапазонах 0.633–0.664 г/см<sup>3</sup> и 1.10–1.14 г/см<sup>3</sup>, соответственно. Семена сорта RP отличались самыми большими размерами (длина – 18.2 мм, ширина – 9.0 мм, толщина – 8.7 мм). Семена сорта BP имели выраженную сферическую форму (0.62 – RP, 0.62 – SP, 0.65 – BP). Наибольший угол естественного откоса отмечен у семян сорта SP (28° – RP, 28.1° – SP, 20° – BP). Семена сорта BP имели наибольший коэффициент статического трения (0.37 – RP, 0.35 – SP, 0.40 – BP). Полученные результаты свидетельствуют о необходимости учитывать сортовые особенности при разработке и оптимизации методов возделывания, переработки, хранения и транспортировки арахиса для того, чтобы повысить эффективность его использования в производственных целях и снизить риски технологических потерь.

**Ключевые слова:** *Arachis hypogaea* L., арахис, семена, физические свойства, Вьетнам.

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## Introduction

Due to its high yield, superior nutritional value, affordability, and diverse applications [1], peanut (*Arachis hypogaea* L.), a herbaceous plant of the legume family (Fabaceae), plays an important role in global agriculture and economy as a valuable oil and food source [2]. As of today, more than one-third of peanut varieties grown worldwide are used for direct consumption and two-thirds are crushed for oil [3, 4]. The primary edible part of peanut is its seeds, which are rich in high-quality proteins, storage lipids dominated by mono- and polyunsaturated fatty acids, complex carbohydrates, digestible fiber, vitamins (such as E and B), and essential minerals (magnesium, potassium, and phosphorus) [5]. The above nutritional benefits have been confirmed by numerous studies. Particularly, Akcali et al. revealed that peanut seeds contain high amounts of edible oil (43–55 %) and proteins (25–28 %) [4]. Consequently, peanut holds promise as a raw material that can be utilized in many ways [6].

In Vietnam, peanut, also known locally as Lac, is a very popular crop, with three major varieties, Lac Do (RP), Lac Van (SP), and Lac Den (BP), on the market [7]. Due to its high nutritional quality and pleasant flavor, it has become integrated into Vietnamese cuisine, where it is consumed directly (roasted or boiled), added in many traditional and modern dishes, used to make confectionery products, and processed to extract oil. Like all legumes, peanut plants are able to improve soil fertility and quality, and therefore they are actively applied to promote sustainable agriculture in Vietnam [8]. Here, it is essential that the handling of peanut, from growing, harvesting, and storage to processing and application, and its value is largely determined by the chemical and physical properties [9]. However, despite the agricultural and economic importance, few research studies have examined the physical properties of the native Vietnamese peanut varieties. Many in the field have converged on cereals instead of oilseeds like peanuts [10]. Yet, a better understanding of such properties is a vital link in the optimization of existing post-harvest handling, storage, and processing techniques, as well as for a more proper design of machinery and equipment used in the agricultural and industrial production, enhancement of the final product quality, and development of new products and applications [4].

This study examines selected physical properties of the Lac Do (RP), Lac Van (SP), and Lac Den (BP) varieties cultivated in Vietnam in order to provide relevant scientific data aiming to support industrial processes and maximize the value of this crop and various commercial products based on it.

## 1. Material and Methods

**1.1. Material.** The following three Vietnamese peanut varieties were studied: Lac Do (RP) from Dien Bien (Vietnam); Lac Van (SP) and Lac Den (BP) from Lao Cai (Vietnam). The seed samples were carefully selected to ensure that they were undamaged and had no impurities, and stored under controlled conditions for subsequent experiments to determine their physical properties.

**1.2. Determination of the moisture content.** The moisture content of all peanut samples (RP, SP, and BP) was determined using a moisture analyzer (Sartorius, Germany). Before the measurements, the seeds were finely ground, and approximately 2 g of each ground sample was accurately weighed, placed in the device, and dried at 105 °C until it reached a constant mass [11]. The measurements were performed in three replicates and then averaged.

**1.3. Determination of the mass of 1000 seeds.** The mass of 1000 seeds was calculated as described by Giczewska and Borowska [12] with minor modifications. In brief, 200 representative

seeds were randomly chosen and weighed, and the mass of 1000 seeds was determined from this value using equation 1:

$$m_{1000} = \frac{m_{\text{sample}}}{n} \times 1000, \quad (1)$$

where  $m_{1000}$  is the mass of 1000 seeds (g),  $m_{\text{sample}}$  is the mass of the representative sample (g), and  $n$  is the number of seeds in it.

**1.4. Determination of the bulk density.** The bulk density was determined using a standardized particle pouring method according to Quoc [13]. The seeds were poured into a cylindrical container with a known volume. After the container was filled, the excess material was leveled off with a ruler. The mass of the seeds in the container was measured. The bulk density ( $\rho_b$ , g/cm<sup>3</sup>) was then calculated as a ratio of the mass of the seeds in the container ( $m$ , g) to its volume ( $V$ , cm<sup>3</sup>).

**1.5. Determination of the particle density.** A 100 g sample of seed particles was placed in a 250 mL graduated cylinder filled with 100 mL toluene. The subsequent increase in toluene volume was recorded. The particle density ( $\rho_p$ , g/cm<sup>3</sup>) was measured as a ratio of the particle mass in the cylinder ( $m$ , g) to the increase in toluene volume ( $V$ , cm<sup>3</sup>) [14].

**1.6. Determination of the seed size.** The length ( $L$ ), width ( $W$ ), and thickness ( $T$ ) of peanut seeds were measured with electronic Vernier calipers to an accuracy of 0.05 mm.

**1.7. Determination of the seed sphericity.** The seed sphericity, ranging from 0 to 1, is a dimensionless parameter which indicates to what extent a seed is round, with 1 being the value of a perfect sphere [15]. This parameter is defined by the equivalent diameter and can be determined from equations 2 and 3:

$$ED = \sqrt[3]{L \times W \times T}, \quad (2)$$

$$S = \frac{ED}{L} \times 100\%, \quad (3)$$

where  $ED$  is the equivalent diameter (mm),  $S$  is the seed sphericity,  $W$  is the seed width (mm),  $L$  is the seed length (mm), and  $T$  is the seed thickness (mm).

**1.8. Determination of the angle of repose (AOR).** A hollow cylindrical tube with both ends vertical was placed on a flat surface and filled with peanut seeds. The tube was then gently lifted, and the seeds were allowed to flow outwards until a stable pile structure was formed with a natural AOR. The AOR (equation 4) was measured as in [16]:

$$\theta = \tan^{-1} \left( \frac{h}{r} \right), \quad (4)$$

where  $\theta$  is the angle of repose,  $h$  is the height of the pile, and  $r$  is the radius of the pile.

**1.9. Determination of the static friction coefficient.** The frictional properties of peanut seeds were analyzed based on the method described by Palilo et al. [17] with minor modifications. The measurements were carried out by moving the seeds on a steel surface: 10 seeds of each studied variety (RP, SP, and BP) were placed on the surface of a steel platform, which was gradually adjusted until they started to slide. For all varieties, the angles of the plane sufficient for the seeds to start sliding were recorded. The tests continued until the remaining seeds slid down along the surface. The static friction coefficient was determined using equation 5:

$$\mu = \tan \alpha, \quad (5)$$

where  $\mu$  is the static friction coefficient and  $\alpha$  is the sliding angle.

**1.10. Statistical data analysis.** ANOVA and mean comparisons were performed using Statistics 20 software, with a 95 % confidence level ( $p \leq 0.05$ ) determined by the least significant difference (HSD) method. The results were presented as the mean  $\pm$  standard deviation (SD).

## 2. Results and Discussion

**2.1. External morphology of the RP, SP, and BP seeds.** As shown in Fig. 1, the studied peanut varieties differ significantly in their external characteristics, such as color and pattern. The RP seeds have smooth coats with a uniform red-brown color. The SP seeds are light beige and have dark stripes due to a patterned pigment distribution during the coat formation. The BP seeds are uniformly dark because of the high concentration of pigment compounds.

The differences observed in the coat colors and patterns are useful morphological metrics to prevent misidentifications, and they may be associated with some variety-specific biological processes, which should be the subject of further research.



**Fig. 1.** External characteristics of the studied Vietnamese peanut varieties: *a)* Lac Do (RP), *b)* Lac Van (SP), and *c)* Lac Den (BP)

**2.2. Moisture content of the RP, SP, and BP seeds.** The experiments yielded low moisture contents (3.9 % RP, 2.9 % SP, and 3.7 % BP) for all the three Vietnamese varieties (see Table 1), which were significantly below the levels reported for the US peanuts (6.8–16.5 %) [18] but comparable to the values obtained by Aydın [19] for the Turkish varieties (4.86 %).

**Table 1.** Moisture content of the Lac Do (RP), Lac Van (SP), and Lac Den (BP) seeds

| No. | Peanut variety | Moisture content, % |
|-----|----------------|---------------------|
| 1   | RP             | $3.9 \pm 0.2^b$     |
| 2   | SP             | $2.9 \pm 0.4^a$     |
| 3   | BP             | $3.7 \pm 0.1^b$     |

Within the column, the letters <sup>a-b</sup> indicate significant differences ( $p \leq 0.05$ ).

According to Angelović et al. [20], the moisture level of stored seeds should be around 13.6 % to prevent mold growth, which, however, can not be treated as a standard, particularly for the substantially lower moisture levels observed in this study and attributed to a complex interaction between the environmental conditions of the tropical region (high temperatures combined with lower humidity at harvest), the genetic characteristics of each variety, and the post-harvest handling such as drying and storage.

**2.3. Physical properties of the RP, SP, and BP seeds.** The data obtained on the bulk density, particle density, and the mass of 1000 seeds in the RP, SP, and BP varieties are summarized in Table 2.

**Table 2.** Bulk density, particle density, mass of 1000 seeds for the Lac Do (RP), Lac Van (SP), and Lac Den (BP) varieties

| Property                            | RP                         | SP                         | BP                         |
|-------------------------------------|----------------------------|----------------------------|----------------------------|
| Bulk density, g/cm <sup>3</sup>     | 0.652 ± 0.006 <sup>b</sup> | 0.633 ± 0.002 <sup>a</sup> | 0.664 ± 0.005 <sup>c</sup> |
| Particle density, g/cm <sup>3</sup> | 1.14 ± 0.04                | 1.12 ± 0.05                | 1.10 ± 0.03                |
| Mass of 1000 seeds, g               | 474 ± 2 <sup>a</sup>       | 599 ± 2 <sup>c</sup>       | 541 ± 1 <sup>b</sup>       |

Within the rows, the letters <sup>a-c</sup> indicate significant differences ( $p \leq 0.05$ ).

The bulk density of the analyzed varieties ranged from 0.633 to 0.664 g/cm<sup>3</sup>, which is similar to the values recorded in the USA (0.558–0.674 g/cm<sup>3</sup>) [18] and India (0.606–0.670 g/cm<sup>3</sup>) [21]. The particle density of the Vietnamese peanuts (1.10–1.14 g/cm<sup>3</sup>) was also comparable to the one documented for the Indian varieties (1.003–1.170 g/cm<sup>3</sup>) [21]. Overall, these findings indicate that the basic physical properties of many peanuts are relatively stable, regardless of geographical and climatic conditions.

The mass of 1000 seeds calculated for the Vietnamese varieties fell in the range of 474–599 g. The SP variety (599 g) significantly outperformed the RP and BP varieties and the peanut variety cultivated in Uzbekistan (501.1 g, by as much as 20 %) [22]. This shows that the genetic background, soil conditions, cultivation techniques, harvest time, and post-harvest storage greatly influence the mass of seeds. Interestingly, the mass values of the studied varieties were also significantly higher than those for some other oilseeds, such as the Serbian sunflower seeds (28.03–52.43 g) [23] and the Iranian safflower seeds (33.4–48.4 g) [24]. The significant differences (by approximately 10–20-fold) between the peanut, sunflower, and safflower seeds reflect their inherent biological distinctions and underscore the high yield and commercial value of peanuts, especially the SP variety. Therefore, peanut seeds are generally more suited for making whole-grain types of food products, whereas smaller seeds like sunflowers are more beneficial for oil extraction. In order to improve the seed quality in agricultural production, careful selection of appropriate varieties and optimal cultivation techniques are needed.

The results on the seed size (length, width, thickness), seed sphericity (along with the equivalent diameter), the angle of repose, and the static friction coefficient (including the sliding angle) in the RP, SP, and BP varieties are presented in Table 3.

The Vietnamese seeds appeared to be significantly different from the Indian seeds in size: they were longer (17–18 mm vs. 11.4–14.5 mm), thicker (8.2–8.7 mm vs. 7.2–7.9 mm), and wider (8.9–9.2 mm vs. 7.9–8.7 mm) [21].

In terms of the seed shape, the Vietnamese varieties had lower sphericity values (0.62–0.65) than the Indian varieties (0.72–0.78), meaning that they were less round [21].

The angle of repose was lower in the BP variety (20°) compared to the RP (28°) and SP (28.1°) varieties and the Indian varieties (22–26°) [21]. This indicates that the BP seeds flow more easily, which can be useful in their handling and processing.

The static friction coefficient was higher in the Vietnamese varieties (0.35–0.40) than in the Indian varieties (0.30–0.36 against wood and 0.26–0.32 against glass) [21], which should be considered during their transportation, handling, and processing. The friction measurements depend heavily on the surface used. The static friction coefficient and sliding angle of the Vietnamese varieties were relatively low when measured on a steel surface ( $\mu_{RP}$  0.37,  $\alpha_{RP}$  20.3°;  $\mu_{SP}$  0.35,

$\alpha_{SP}$  19.3°; and  $\mu_{BP}$  0.4,  $\alpha_{BP}$  21.80°), leading to the conclusion that they slide easily. In an earlier study, Palilo et al. [17] reported higher friction values for bean seeds when tested on plywood ( $\mu$  0.58–0.74,  $\alpha$  30–36°) and steel surfaces ( $\mu$  0.53–0.65,  $\alpha$  28–33°). Since different materials are used to measure friction, it is difficult to compare the results of available studies.

**Table 3.** Seed size, sphericity, angle of repose, and static friction coefficient for the Lac Do (RP), Lac Van (SP), and Lac Den (BP) varieties

| Property                    | RP                      | SP                      | BP                      |
|-----------------------------|-------------------------|-------------------------|-------------------------|
| Length, mm                  | 18 ± 1                  | 18 ± 2                  | 17 ± 1                  |
| Width, mm                   | 9.0 ± 0.2               | 8.9 ± 0.5               | 9.2 ± 0.2               |
| Thickness, mm               | 8.7 ± 0.1 <sup>b</sup>  | 8.2 ± 0.2 <sup>a</sup>  | 8.3 ± 0.2 <sup>a</sup>  |
| Equivalent diameter, mm     | 11.2 ± 0.3              | 10.9 ± 0.2              | 10.9 ± 0.4              |
| Sphericity                  | 0.62 ± 0.02             | 0.62 ± 0.05             | 0.65 ± 0.03             |
| Angle of repose, °          | 28 ± 1 <sup>b</sup>     | 28.1 ± 0.3 <sup>b</sup> | 20 ± 2 <sup>a</sup>     |
| Sliding angle, °            | 20.3 ± 0.3 <sup>b</sup> | 19.3 ± 0.3 <sup>a</sup> | 21.8 ± 0.5 <sup>c</sup> |
| Static friction coefficient | 0.37 ± 0.05             | 0.35 ± 0.02             | 0.40 ± 0.09             |

Within the rows, the letters <sup>a-c</sup> indicate significant differences ( $p \leq 0.05$ ).

The observed differences can be due to the genetic makeup of the peanut varieties, as well as owing to the specific growing and climatic conditions. The larger seed size of the Vietnamese varieties may be advantageous for certain industrial applications, and the friction characteristics and the angle of repose should be taken into account when designing storage and processing systems.

## Conclusions

The physical and morphological characteristics of the Lac Van (SP), Lac Den (BP), and Lac Do (RP) peanut seeds vary widely, depending on their genetic profiles, growing conditions, and cultivation methods. They are in many cases significantly different from those observed in peanut varieties from other regions, such as India and the USA, or even other oilseeds, like sunflower and safflower.

The obtained results are important to identify peanut varieties best suited for specific applications (oil, food, and animal feed production) at the local and international levels. They can also be used to support the development of new peanut varieties with higher yield, enhanced resistance to pests and diseases, and improved nutritional value.

**Conflicts of Interest.** The authors declare no conflicts of interest.

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