

February 28, 2025



<https://ijoabs.com/>  
[DOI: 10.5281/zenodo.](https://doi.org/10.5281/zenodo.105281)

## A Comparative Study on Nutritional Values of Lotus Seeds from Three Vietnamese Provinces

### Author's Details:

Son L. Hoang<sup>1</sup>, Thanh N.K. Le<sup>1\*</sup>, Anh N.P. Ngo<sup>1</sup>

<sup>1</sup> Department of Applied Biochemistry, Faculty of Biotechnology, Ho Chi Minh City International University, Vietnam National University, Ho Chi Minh City, 70000, Vietnam

\*Corresponding author- email: lnkthanh1996@gmail.com

Received Date: 05-Aug-2024

Accepted Date: 28-Sep-2024

Published Date: 28-Feb-2025

### Abstract:

These findings scientifically contribute to the food database system and can be exploited for diet planning, or further research sampling decisions. The study aimed to evaluate the nutritional values of lotus seeds (*Nelumbo nucifera*) from three geographical regions in Vietnam (Dong Thap, Khanh Hoa, and Quang Nam). The analyses were conducted as per standard test methods AOAC. There were generally significant differences in overall sizes, weights, and energy-yielding nutrients among the three studied samples. These lotus seeds possessed moderate concentrations of carbohydrates and proteins but low fat content. The analysis revealed the presence of vitamin C and group B (B1, B3, and B6) in all samples, remarkably vitamin B12 in QNLS and DTLS (1.57 and 0.16 µg/100 g, respectively). In this study, macro-minerals (Ca, K, Mg, Na, P, and S) and microminerals (Fe and Zn) were also detected in all samples. Khanh Hoa lotus seeds were found to be significantly greater in size and predominant in most of the studied nutrients. Further research on specific nutrients (including protein and fatty acid/lipid profiles) and phytochemicals, especially nuciferine should be conducted to complete the investigation of lotus seed nutrition cultivated in Vietnam

**Keywords:** lotus seeds, minerals, nutrients, size, variations, vitamins.

### Introduction

*Nelumbo nucifera* (*N. nucifera*), commonly known as lotus or water lily, is a perennial aquatic plant belonging to the Nelumbonaceae family (Schoch CL, et al, 2020). Lotus is mainly cultivated in marshes and shallows exposed directly to sunlight (Johnson A., 2022). Vietnam, well-known as a tropical nation, possesses appropriate conditions for growing lotus since the weather is almost hot and sunny the whole year with the terrain having many plains and lakes distributed throughout the country. However, lotus is extensively cultivated in the south of Vietnam where there are many vast plains and a temperate climate.

Lotus is supposed to be a miracle plant owing to the utilization of all parts in various fields such as food, medicine, and beauty therapy. Lotus rhizome extract can be utilized as an antidiabetic and anti-inflammatory agent thanks to the actions of steroidal triterpenoid substances present in the roots (Paudel & Panth, 2015). As reported from previous research, the lotus leaves are effective in lowering blood lipids (Punia Bangar, Dunno, Kumar, Mostafa, & Maqsood, 2022), (Zhang et al., 2015) and inducing weight loss thanks to the presence of alkaloids and flavonoids, typically nuciferine. Lotus seeds (LS), on the other hand, have long been traditionally used in combination with other ingredients such as herbs, meat, and bird's nests to make healthy dishes. Contemporary data indicated that LS contain high percentages of energy-yielding

nutrients (carbohydrate, fat, and protein). In addition to supplying macronutrients (Shahzad et al., 2021a), LS are also rich in minerals, and vitamins, particularly vitamin C (Arooj et al., 2021).

It should be noted, however, that the weather truly affects not only nutrients but also morphology. LS harvested from the south have larger sizes compared to the central of Vietnam, where it features harsh conditions, especially during the dry and rainy seasons. In this regard, this study focused on investigating the nutritional values of LS cultivated in three different geographic regions of Vietnam (Dong Thap, Khanh Hoa, and Quang Nam), aiming to provide well-informed options for planning diet and further development toward nutraceuticals and cosmeceuticals.

Dong Thap Province (  $10^{\circ}40'N$   $105^{\circ}40'E$  )- currently has about 1,000 hectares of lotus growing with two crops per year, bringing major profits to the economy. In recent years, many businesses have participated in processing, consuming, and deep processing, so the value of lotus has also increased (Vo, Van Halsema, Hellegers, Wyatt, & Nguyen, 2021). The Mekong Delta province of Dong Thap exported the first batch of 15 tons of frozen lotus in various forms of products worth nearly 1 billion VND (nearly 39,360 USD) to the Japanese market on May 7, 2024 ( recorded by the Ministry of Information and Communications). Khanh Hoa ( $12^{\circ}15'N$   $109^{\circ}12'E$  ) is a southern coastal province in the South-Central Coast region, Central of Vietnam with the longest sea coastlines. Yearly, the changes in water resources and rainfalls are the reasons for converting the cultivation of rice to other annual crops. Farmers in KH are now investing in growing lotus seeds on abandoned or ineffective rice fields, thereby taking these advantages to improve their income (Khanh Hoa Agriculture, 2023). Quang Nam ( $15.55^{\circ}N$   $108.05^{\circ}E$ ) is also a southern coastal province in the South-Central of Vietnam with a natural area of 10 574.74 km<sup>2</sup>, formed from nine different types of soil including dunes and coastal sand, river alluvial soil, marine alluvial soil, etc. In recent years, lotus has grown widely in QN, well-adapting to all climate and soil conditions, and is less affected by pests and diseases. At the average rate, planting two hectares of lotus cultivar yields more than three tons of fresh lotus seeds, providing huge benefits to farmers.

## Material and Methods

### *Chemicals and Reagents*

All chemicals and reagents were provided by the Pharmaceutical Chemistry Laboratory and Applied Biochemistry Laboratory of the Applied Biochemistry Department of International University HCMC. Potassium sulfate; copper sulfate; sodium hydroxide; boric acid and sulfuric acid were purchased from Sigma-Aldrich.

### *Lotus Seed preparation*

LS were collected from various farms located in three different regions in Vietnam (**Figure 1**). The fresh LS were observed in terms of size and weight prior to being processed for further investigation. The samples were dried at 40°C for 3 days and then ground into fine powder for further analysis.



**Figure 1.** Geographical regions for sampling: (A): Quang Nam; (B): Khanh Hoa; (C): Dong Thap

### *Total Carbohydrate Content*

The determination of the total carbohydrate content of three LS samples from different provinces was carried out using colorimetric methods (Nielsen, 2010),(AOAC 988.12, 1990). The assay was prepared by mixing 5 g of LS sample with 45 mL of 80% ethanol in a beaker covered with glass and then incubated for 15 minutes. Once the system had been cooled down, the mixture was transferred to a 50-mL volumetric flask, filling up the volume with 80% ethanol. Thereafter, the mixture was filtered to obtain 10 mL of filtrate. The analysis was conducted by mixing 1 mL of diluted filtrate with 1 mL of 5% phenol and 5 mL of concentrated sulfuric acid, followed by incubation in a water bath for 10 minutes, and then allowed to cool down for 5 minutes. The absorbance was measured against the blank at 490 nm using a spectrophotometer. The 100 µg/mL of glucose solution was used as standard for the calibration curve. The total carbohydrate content was reported as glucose equivalent (GE) per gram of sample (mg GE/g) and as a percentage of the sample.

#### ***Determination of Crude fat content***

The fat content of the samples was determined using Soxhlet method (AOAC 948.22, 2012). 1 g of the sample was accurately weighed into a Soxhlet thimble. The thimble was then placed in the Soxhlet extractor, followed by the addition of 50 mL of hexane to the Soxhlet extractor (Extraction System Operation Manual). The Soxhlet extractor was then heated, and the petroleum ether was refluxed through the sample. Once the extraction process had been completed (approximately 6 hours), the heating was discontinued, and the hexane was allowed to cool. The flask holding the fat was removed from the Soxhlet extractor, dried, and cooled in a desiccator before being weighed.

#### ***Determination of Protein content***

The protein content of the LS sample was determined using Kjeldahl method (AOAC 2001.11, 2005), (AOAC 991.20, 2005). 1 g of sample was accurately weighed into a Kjeldahl flask, followed by adding 10 mL of concentrated sulfuric acid, and 1 g catalyst consisting of potassium sulfate and copper sulfate at a ratio of 9:1. The flask was then heated until it turned to a clear color. The digested sample was then diluted with distilled water in a 100 mL volumetric flask. After adding 25 mL of 45% sodium hydroxide solution to the distillation apparatus, the mixture was distilled until 100 mL of distillate was collected. The distillate was then transferred to a conical flask containing 10 mL of 4% boric acid solution with the addition of a few drops of bromocresol green indicator and then titrated against 0.1N hydrochloric acid until the color turned from green to pink. The protein content of the sample was calculated using the following formula:

$$\% \text{ Protein} = \frac{\text{volumn HDT used (mL)} \times \text{concentration HDT (N)} \times 1.007}{\text{weight of sample (in g)}}$$

#### ***Determination of Moisture content***

The moisture content of the sample was determined using gravimetric method (AOAC 931.04, 2000). 1 g of LS sample was weighed and placed in a glass petri dish. The petri dish was then placed in a food dehydrator and dried at 105°C for 3 hours. Once removed from the oven, and allowed to cool in a desiccator, the sample was weighed again. The moisture content was expressed as a percentage.

#### ***Determination of Vitamins and Minerals***

##### ***Vitamin contents***

The vitamin contents in three LS samples were analyzed primarily based on various AOAC methods. Vitamins A, C, D, and vitamins group B including B1, B3, B6, and B12 were determined by the high-performance liquid chromatography (HPLC) method (AOAC 2001.13, 2011), (European Standard, EN 12821, 2009), (European Standard, EN 15652, 2009), (European Standard, EN 14663, 2005), (AOAC 2011.10, 2011), (AOAC 2012.21, 2013), (European Standard, EN 14122, 2014). The vitamin contents were expressed per 100 grams of sample.

##### ***Mineral contents***

Sodium (Na) and potassium (K) were determined by the flame photometric method (AOAC 969.23, 2005). The analysis of calcium (Ca), magnesium (Mg), zinc (Zn), copper (Cu), and iron (Fe) was conducted

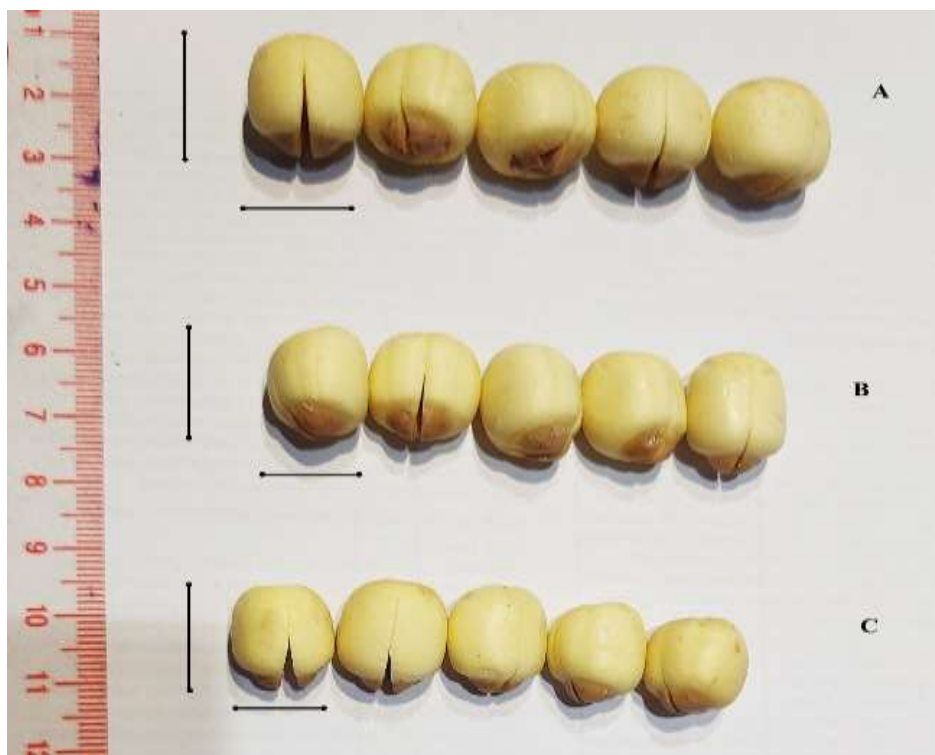
by the atomic absorption spectrophotometric method (AOAC 968.08, 2000), (AOAC 999.11, 2005). Sulfur (S) was analyzed by the inductively coupled plasma-mass spectrometry method (AOAC 2015.01, 2015), (European Standard, EN 15111, 2007). Phosphorus (P) was assessed by the spectrophotometric method (AOAC 995.11, 2000), (Pulliainen & Wallin, 1996). The mineral contents were expressed per 100 grams of sample.

### Statistical analysis

Experiments were triplicated for statistical analysis. The results were expressed as Mean  $\pm$  SD (standard deviation). The results were analyzed by the one-way analysis of variance (ANOVA) and Tukey's multiple comparison test ( $p < 0.05$ ).

## Result and Discussions

### Morphology assessment



**Figure 2.** Lotus seeds cultivated in different regions: (A)- Khanh Hoa; (B)- Quang Nam; (C)- Dong Thap

A preliminary assessment of three fresh LS samples was evaluated in size and weight. **Figure 2** and **Table 1** illustrate that KHLS exhibited the largest size in height and width ( $1.90 \pm 0.10$  and  $1.57 \pm 0.31$  mm, respectively), while DTLS was the smallest overall size (height:  $1.07 \pm 0.15$  mm; width:  $1.07 \pm 0.23$  mm). The weight of 100 seeds from three samples showed significant differences ( $p \leq 0.05$ ), demonstrating the KHLS as the greatest in weight ( $156.68 \pm 5.25$  g), followed by QNLS ( $132.49 \pm 1.72$  g) and DTLS ( $116.51 \pm 4.18$  g).

**Table 1.** Differences in size and weight of three lotus seed samples

|                                  |        | Dong Thap           | Khanh Hoa           | Quang Nam           |
|----------------------------------|--------|---------------------|---------------------|---------------------|
| Size (mm)                        | Height | $1.07 \pm 0.15^a$   | $1.90 \pm 0.10^b$   | $1.07 \pm 0.15^c$   |
|                                  | Width  | $1.07 \pm 0.15^a$   | $1.57 \pm 0.31^b$   | $1.07 \pm 0.23^a$   |
| Average weight (g) per 100 seeds |        | $116.51 \pm 4.18^a$ | $156.68 \pm 5.25^b$ | $132.49 \pm 1.72^c$ |

<sup>a, b, c</sup> Different letters in the same row indicate the significant differences in statistical analysis ( $p < 0.05$ )

### Essential nutrients

**Table 2.** Nutrient contents of three lotus seeds planted in three different provinces.

February 28, 2025

| Parameters   | Quantity (g/100 g)        |                             |                           |
|--------------|---------------------------|-----------------------------|---------------------------|
|              | Dong Thap                 | Khanh Hoa                   | Quang Nam                 |
| Carbohydrate | 6.54 ± 2.08 <sup>a</sup>  | 15.52 ± 0.0004 <sup>b</sup> | 13.28 ± 0.17 <sup>c</sup> |
| Protein      | 10.21 ± 0.89 <sup>a</sup> | 13.61 ± 0.36 <sup>b</sup>   | 12.39 ± 0.37 <sup>c</sup> |
| Crude fat    | 0.97 ± 0.30 <sup>a</sup>  | 0.92 ± 0.21 <sup>a</sup>    | 1.43 ± 0.74 <sup>a</sup>  |
| Moisture     | 12.14 ± 0.21 <sup>a</sup> | 9.63 ± 0.08 <sup>b</sup>    | 8.10 ± 0.94 <sup>c</sup>  |

<sup>a, b, c</sup> Different letters in the same row indicate the significant differences in statistical analysis ( $p < 0.05$ )

**Table 2** shows the presence of all energy-producing nutrients in LS from three different provinces. In general, all these LS samples possessed moderate values of carbohydrates and proteins with significant differences ( $p = 0.0002$ , and  $p = 0.0012$ , respectively), but low-fat content. The carbohydrate in KHLS was recorded to be the highest value which was approximately twice as much as that of DTLS- the lowest. However, these values were extremely lower than those of previous research in which LS from China was composed of 60%- 62% (Punia Bangar et al., 2022), and Italy at 40.87% (Chouaibi et al., 2012), but apparently being consistent with LS from India (16.03%) (Sruthi A, Seeja Thomachan Panjikkaran, Aneena ER, Berin Pathrose, & Deepu Mathew, 2019). The same trend was also documented in protein content as KHLS claimed the highest values while the lowest indices came to DTLS, these differences might be explained by the differences in temperature, atmosphere, and light, which significantly affect carbohydrate production during photosynthetic CO<sub>2</sub> assimilation. Nevertheless, the values of the glycemic index (GI) in all studied LS were dramatically low at 62 which was classified as low GI food ( $< 70$ ) (X. Wu, Wu, Wu, & Weng, 1994), thereby providing well-informed choices for diabetics and controlling body weight.

The proteins contained in three LS samples were significantly lower than the Pakistan LS ( $16.53 \pm 0.12$  g/100 g) (Shahzad et al., 2021b), and Italy LS ( $19.11 \pm 0.03$  g/100 g) (Chouaibi et al., 2012). Notably, the protein synthesis in plants is attributed primarily to the pH in the soil contributing to a reduction in the nitrification rate and thus defining the amount of nitrate in the soil. Several research showed that the pH of the soil in DT was approximately 2.9 to 4.2 (Minh, Vu, Khoa, Tinh, & Dang, 2023) and the pH of alluvial soil in QN ranged from 3.5 to 5.2 (Ha Khuong et al., 2024). It was obvious that the soil in DT was too acidic resulting in the low amount of nitrate in the soil of this location.

The moisture content values were significantly different ( $p = 0.0007$ ) among the three samples. The KHLS and QNLS generally met the LS's ideal moisture ( $< 10\%$ ) which was proven as an appropriate moisture proportion in preventing microbial growth - a key factor in food spoilage as reported in Muhammad A.S.'s (Shahzad et al., 2021b) and Vera Zambrano's research (Vera Zambrano, Dutta, Mercer, MacLean, & Touchie, 2019).

### Vitamins and Minerals

**Table 3.** Vitamin contents in three different lotus seeds.

| Vitamins | Units   | Quantity  |           |           |
|----------|---------|-----------|-----------|-----------|
|          |         | Dong Thap | Khanh Hoa | Quang Nam |
| A        | µg/100g | -         | -         | -         |
| D        | µg/100g | -         | -         | -         |
| B1       | mg/100g | 0.18      | 0.19      | 0.21      |
| B3       | mg/100g | 1.14      | 1.00      | 1.31      |
| B6       | mg/100g | 0.23      | 0.19      | 0.23      |
| B12      | µg/100g | 0.16      | -         | 1.57      |
| C        | mg/100g | 1.58      | 1.60      | 3.31      |

En-dash "-": not detected ( $LOD \leq 0.01$ ).

The analysis revealed the absence of fat-soluble vitamins A and D (**Table 3**), consistent with the record by the Food Data Central of the US Department of Agriculture (USDA) (US. Department of Agriculture, 2019). However, these LS samples possessed a variety of vitamins group B including B1, B3, and B6, and vitamin C, which was generally in agreement with previous research by Mukherjee K.P.'s (Mukherjee, Mukherjee, Maji, Rai, & Heinrich, 2009). Nevertheless, this study remarkably recorded the presence of vitamin B12 in both QNLS and DTLs, but not KHLS. Notably, the amount of B12 in QNLS was ten times greater than that of DTLs. According to the Food and Nutrition Board U.S., 2013, the Recommended Dietary Allowance (RDA) of vitamin B12 is 2.4 µg per day, approximately equal to the daily consumption of 50 g of QNLS. Vitamin B12 plays a crucial role in maintaining healthy nerve cells and preventing megaloblastic anemia. Furthermore, B12 is capable of reducing blood levels of homocysteine, a substance associated with an elevated risk of heart attack and stroke (J. Wu et al., 2007).

**Table 4.** Mineral contents in three different lotus seeds.

| Minerals       | Quantity (mg/100 g) |           |           |
|----------------|---------------------|-----------|-----------|
|                | Dong Thap           | Khanh Hoa | Quang Nam |
| Sodium (Na)    | 4.79                | 2.12      | 7.57      |
| Potassium (K)  | 502                 | 850       | 525       |
| Calcium (Ca)   | 30.20               | 78.50     | 52.90     |
| Magnesium (Mg) | 83.90               | 128.00    | 88.80     |
| Phosphorus (P) | 220                 | 380       | 230       |
| Sulfur (S)     | 190                 | 170       | 160       |
| Zinc (Zn)      | 1.06                | 1.84      | 1.07      |
| Iron (Fe)      | 1.68                | 2.63      | 1.70      |

As can be seen from **Table 4**, all LS samples were relatively rich in minerals, especially macrominerals including Ca, K, Mg, and Na, owing to the fact that lotuses are usually cultivated in alluvial soil primarily containing various minerals (Boettinger, 2005). Remarkably, KHLS was recorded with the highest contents in most of the studied minerals. There were extremely high values of K in KHLS which was approximately 1.5 times greater than that of DTLs and QNLS. This amount was significantly high compared to some well-known cereal sources of potassium such as pistachios, squash, or flax seeds (1007, 919, and 813 mg per 100 g dried seeds, respectively) as powered by the USDA nutrition data.

The three LS samples were generally also rich in Ca and P varying from 30.20 – 78.50 mg/100 g and 220-380 mg/100 g, respectively. Phosphorus and calcium function to build and maintain strong bone and tooth structures. In addition, these two minerals participate in muscle contraction and nerve transmission, helping the kidneys filter waste from the body (Foster et al., 2008). On the other hand, Mg was detected in all three samples ranging from 83.90 to 128.00 mg/100 g, partly meeting the RDA amount of Mg for adults (310- 420 mg per day). Mg is well-known as a cofactor in many enzymes regulating diverse biochemical reactions in the human body (muscle and nerve function, blood glucose control, protein synthesis, and blood pressure regulation). Furthermore, Mg also plays a vital role in the active transport of potassium and calcium ions, important to nerve impulse conduction, and normal heart rhythm.

All three investigated LS were truly not sources of various micronutrients as the analysis recorded the presence of Fe and Zn only. KHLS remarkably provided the highest amount of both Fe and Zn. Zn is essential for enzyme catalytic, enhancing immune function, promoting protein and DNA synthesis, wound healing, and cell signaling. In addition, Zn assists in growth and development, particularly during critical life cycles, and contributes to taste perception. On the other hand, Fe, in conjunction with vitamin B12 present in LS, acts as an essential component of hemoglobin, an erythrocyte protein that transfers oxygen from the lungs to the tissues.

## Conclusion

Three types of LS were generally recorded with moderate concentrations of carbohydrates and proteins but low-fat content. Vitamin C and group B (B1, B3, and B6) were quantified in all samples and remarkably the presence of B12 in QNLS and DTLS. Six macro-minerals (Ca, K, Mg, Na, P, and S) and two microminerals (Fe and Zn) were detected in all samples. However, the size and nutritional values of LS collected from KH were generally greater than those of QN and DT. These findings scientifically provide data on nutrients that would be beneficial to nutritionists/dietitians, food manufacturers as well as consumers.

## Acknowledgement

This study was conducted at the Department of Applied Biochemistry, Faculty of Biotechnology, Ho Chi Minh City International University, Vietnam National University, Ho Chi Minh City, Vietnam.

## References

- AOAC 931.04. (2000). *Official Methods of Analysis of AOAC International- Moisture in Cacao Products*. Gaithersburg, MD, USA: AOAC International.
- AOAC 948.22. (2012). *Fat (crude) in nuts and nut products. Gravimetric methods*. Gaithersburg, MD, USA: Official Methods of Analysis of AOAC International.
- AOAC 968.08. (2000). *Official Methods of Analysis of AOAC International- Minerals in Animal Feed and Pet Food*. Gaithersburg, MD, USA: Official Methods of Analysis of AOAC International.
- AOAC 969.23. (2005). *Official Methods of Analysis of AOAC International- Sodium and Potassium in Seafood*. Gaithersburg, MD, USA: Official Methods of Analysis of AOAC International.
- AOAC 988.12. (1990). *Phenol-Sulfuric Acid Assay for Total Carbohydrate Determination*. AOAC International.
- AOAC 991.20. (2005). *Official Methods of Analysis of AOAC International- Nitrogen (Total) in Milk*. Gaithersburg, MD, USA: Official Methods of Analysis of AOAC International.
- AOAC 995.11. (2000). *Determination of phosphorus content—Spectrophotometric method*. Gaithersburg, MD, USA: AOAC International.
- AOAC 999.11. (2005). *Lead, Cadmium, Copper, Iron, and zinc in foods. Atomic absorption spectrophotometry after dry ashing*. Gaithersburg, MD, USA: Official Methods of Analysis of AOAC International.
- AOAC 2001.11. (2005). *Official Methods of Analysis of AOAC International- Protein (Crude) in Animal Feed, Forage (Plant Tissue), Grain, and Oilseeds*. Gaithersburg, MD, USA.: Official Methods of Analysis of AOAC International.
- AOAC 2001.13. (2011). *Official Methods of Analysis of AOAC International- Vitamin A (Retinol) in Foods*. Gaithersburg, MD, USA: AOAC International.
- AOAC 2011.10. (2011). *Official Methods of Analysis of AOAC International- Vitamin B12 in Infant Formula and Adult Nutritionals*. Gaithersburg, MD, USA: AOAC International.
- AOAC 2012.21. (2013). *Vitamin C in Infant Formula and Adult/Pediatric Nutritional Formula*. Gaithersburg, MD, USA: AOAC International.
- AOAC 2015.01. (2015). *Official Methods of Analysis of AOAC International- Heavy Metals in Food*. Gaithersburg, MD, USA: Official Methods of Analysis of AOAC International.
- Arooj, M., Imran, S., Inam-ur-Raheem, M., Rajoka, M. S. R., Sameen, A., Siddique, R., ... Aadil, R. M. (2021). Lotus seeds ( *Nelumbinis semen* ) as an emerging therapeutic seed: A comprehensive review. *Food Science & Nutrition*, 9(7), 3971–3987. doi: 10.1002/fsn3.2313

- Boettinger, J. L. (2005). Alluvium and Alluvial Soils. *Encyclopedia of Soils in the Environment*, 45–49. doi: 10.1016/B0-12-348530-4/00008-4
- Chouaibi, M., Mahfoudhi, N., Rezig, L., Donsi, F., Ferrari, G., & Hamdi, S. (2012). Nutritional composition of *Zizyphus lotus* L. seeds. *Journal of the Science of Food and Agriculture*, 92(6), 1171–1177. doi: 10.1002/jsfa.4659
- European Standard, EN 12821. (2009). *Determination of vitamin D by high performance liquid chromatography—Measurement of cholecalciferol (D3) or ergocalciferol (D2)*. Brussels: CEN: European Committee for Standardization.
- European Standard, EN 14122. (2014). *Determination of vitamin B1 by high performance liquid chromatography*. Brussels: CEN: European Committee for Standardization.
- European Standard, EN 14663. (2005). *Determination of vitamin B6 (including its glycosylated forms) by HPLC*. Brussels: CEN: European Committee for Standardization.
- European Standard, EN 15111. (2007). *Determination of trace elements—Determination of iodine by ICP-MS (inductively coupled plasma mass spectrometry)*. Brussels: CEN: European Committee for Standardization.
- European Standard, EN 15652. (2009). *Determination of niacin by HPLC*. Brussels: CEN: European Committee for Standardization.
- Food and Nutrition Board U.S. (2013). *Dietary reference intakes (dris): Estimated average requirements*. U.S National Academy of Sciences.
- Foster, B. L., Tompkins, K. A., Rutherford, R. B., Zhang, H., Chu, E. Y., Fong, H., & Somerman, M. J. (2008). Phosphate: Known and potential roles during development and regeneration of teeth and supporting structures. *Birth Defects Research Part C: Embryo Today: Reviews*, 84(4), 281–314. doi: 10.1002/bdrc.20136
- Ha Khuong, M., Phuong Tran, T., Anh Hoang, P., Thuy Doan, T., Son Cao, T., & Hoa Nguyen, X. (2024). Assessment of the current status of soil quality and types of land degradation in Quang Ninh province, Vietnam. *IOP Conference Series: Earth and Environmental Science*, 1345(1), 012020. doi: 10.1088/1755-1315/1345/1/012020
- Johnson A. (2022). *Nelumbo nucifera Gaertn.: U.S. Geological Survey, Nonindigenous Aquatic Species Database, Gainesville, FL. Retrieved from https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=244*
- Khanh Hoa Agriculture. (2023). *Ministry of Agriculture and Rural Development orients agricultural economic development in the South Central Coast region*. Khanh Hoa provincial party committee electronic information portal. Retrieved from https://news.baokhanhhoa.vn/economics/202401/khanh-hoa-provinces-agriculture-makes-steady-progress-1c957af/
- Minh, V. Q., Vu, P. T., Khoa, L. V., Tinh, T. K., & Dang, P. C. (2023). Clustering Analysis of Soil Environmental Quality for Perennial Crops Recommendation in Vinh Long Province, Vietnam. *Journal of Ecological Engineering*, 24(8), 343–352. doi: 10.12911/22998993/166753
- Mukherjee, P. K., Mukherjee, D., Maji, A. K., Rai, S., & Heinrich, M. (2009). The sacred lotus (<I>Nelumbo nucifera</I>—Phytochemical and therapeutic profile. *Journal of Pharmacy and Pharmacology*, 61(4), 407–422. doi: 10.1211/jpp/61.04.0001
- Nielsen, S. S. (2010). *Phenol-Sulfuric Acid Method for Total Carbohydrates* (S. S. Nielsen, Ed.). Springer, Boston, MA: Springer International Publishing. Retrieved from 10.1007/978-1-4419-1463-7\_6
- Paudel, K. R., & Panth, N. (2015). Phytochemical Profile and Biological Activity of *Nelumbo nucifera*. *Evidence-Based Complementary and Alternative Medicine*, 2015, 1–16. doi: 10.1155/2015/789124

- Pulliaainen, T. K., & Wallin, H. C. (1996). Determination of Total Phosphorus in Foods by Colorimetry: Summary of NMKL Collaborative Study. *Journal of AOAC INTERNATIONAL*, 79(6), 1408–1410. doi: 10.1093/jaoac/79.6.1408
- Punia Bangar, S., Dunno, K., Kumar, M., Mostafa, H., & Maqsood, S. (2022). A comprehensive review on lotus seeds (*Nelumbo nucifera* Gaertn.): Nutritional composition, health-related bioactive properties, and industrial applications. *Journal of Functional Foods*, 89, 104937. doi: 10.1016/j.jff.2022.104937
- Schoch CL, et al. (2020). *NCBI Taxonomy: A comprehensive update on curation, resources and tools*. doi: 10.1093/database/baaa062
- Shahzad, M. A., Ahmad, N., Ismail, T., Manzoor, M. F., Ismail, A., Ahmed, N., & Akhtar, S. (2021a). Nutritional composition and quality characterization of lotus (*Nelumbo nucifera* Gaertn.) seed flour supplemented cookies. *Journal of Food Measurement and Characterization*, 15(1), 181–188. doi: 10.1007/s11694-020-00622-x
- Shahzad, M. A., Ahmad, N., Ismail, T., Manzoor, M. F., Ismail, A., Ahmed, N., & Akhtar, S. (2021b). Nutritional composition and quality characterization of lotus (*Nelumbo nucifera* Gaertn.) seed flour supplemented cookies. *Journal of Food Measurement and Characterization*, 15(1), 181–188. doi: 10.1007/s11694-020-00622-x
- Sruthi A, Seeja Thomachan Panjikkaran, Aneena ER, Berin Pathrose, & Deepu Mathew. (2019). Insights into the composition of lotus rhizome. *Journal of Pharmacognosy and Phytochemistry*, 8(3), 3550–3555.
- US. Department of Agriculture. (2019, January 4). Seeds, lotus seeds, dried. [Food Data Central]. Retrieved from U.S Department of Agriculture website: <https://fdc.nal.usda.gov/fdc-app.html#/food-details/170149/nutrients>
- Vera Zambrano, M., Dutta, B., Mercer, D. G., MacLean, H. L., & Touchie, M. F. (2019). Assessment of moisture content measurement methods of dried food products in small-scale operations in developing countries: A review. *Trends in Food Science & Technology*, 88, 484–496. doi: 10.1016/j.tifs.2019.04.006
- Vo, H. T. M., Van Halsema, G., Hellegers, P., Wyatt, A., & Nguyen, Q. H. (2021). The Emergence of Lotus Farming as an Innovation for Adapting to Climate Change in the Upper Vietnamese Mekong Delta. *Land*, 10(4), 350. doi: 10.3390/land10040350
- Wu, J., Zheng, Y., Chen, T., Yi, J., Qin, L., Rahman, K., & Lin, W. (2007). Evaluation of the quality of lotus seed of *Nelumbo nucifera* Gaertn from outer space mutation. *Food Chemistry*, 105(2), 540–547. doi: 10.1016/j.foodchem.2007.04.011
- Wu, X., Wu, Z. C., Wu, B., & Weng, J. (1994). Responses of blood glucose and C-peptide to five Chinese starchy foods. *Asia Pacific Journal of Clinical Nutrition*, 3(4), 207–210.
- Zhang, Y., Lu, X., Zeng, S., Huang, X., Guo, Z., Zheng, Y., ... Zheng, B. (2015). Nutritional composition, physiological functions and processing of lotus (*Nelumbo nucifera* Gaertn.) seeds: A review. *Phytochemistry Reviews*, 14(3), 321–334. doi: 10.1007/s11101-015-9401-9