

Physical properties, nutritional composition, and antioxidant profiles of five varieties of pumpkin (*Cucurbita moschata*) seeds

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Abstract. Nurrahman, Suyanto A, Astuti R, Dewi YK, Amalia N. 2026. Physical properties, nutritional composition, and antioxidant profiles of five varieties of pumpkin (*Cucurbita moschata*) seeds. *Asian J Agric* 10 (1): g100132. <https://doi.org/10.13057/asianjagric/g100132>. Pumpkin (*Cucurbita moschata*) seeds, in terms of their chemical and nutritional components, have potential as a functional food. The bioactive components contained in pumpkin seeds include carotenoids, tocopherols, antioxidants, and sterols. Pumpkin seed is also rich in bioactive compounds, such as phytosterols, which have antioxidant activity and potential for pharmacological research. The aim of this research is to determine the physical properties, nutritional composition, and antioxidant profiles of five varieties of pumpkin seeds. The research was conducted on five varieties of pumpkin; the pumpkins were cut in half and the seeds were removed. Then, the weight and volume of the seeds were measured. After that, the tested composition covered levels of proximate, fiber, fatty acids, amino acids, β -carotene, total phenols, antioxidant activity, and vitamins C and E. The data obtained were analyzed using the ANOVA method, and the LSD method was used to see the differences between each variety. Research results showed that the five varieties of pumpkin seeds had physical, compositional, nutritional, and antioxidant characteristics, as well as amino acids, that vary. The most common amino acids from the various varieties were glutamic acid, arginine, and aspartic acid. The seeds of Kabocha pumpkin had a composition of proximate, nutrients, antioxidants, and amino acids that are higher compared to other pumpkin seeds varieties. Meanwhile, the highest fatty acids were in the Ketan variety. Different varieties of pumpkin seeds had different physical and chemical characteristics.

Keywords: Antioxidant, nutrition, physic, pumpkin, seeds

INTRODUCTION

Pumpkin (*Cucurbita moschata*) is rich in various components, including carotene, dietary fiber, total phenolics, vitamin C, vitamin E (Nurrahman and Astuti 2022), and mineral components such as potassium, iron, phosphorus, and magnesium (Gumolung 2018). Pumpkin contains high levels of carotene and phenolic compounds, which can play a role in fighting free radicals. Phenolic compounds, on the other hand, contain phenol groups that can bind free radicals (Dhurhania and Novianto 2018).

Each pumpkin variety not only differs in shape and size but also possesses unique nutritional characteristics and bioactive compounds, particularly in the seeds. Various pumpkin seeds varieties have significant potential as sources of bioactive compounds that act as natural antioxidants. These include β -carotene, vitamin C, vitamin E, and phenolic compounds, which play a vital role in neutralizing free radicals and supporting health (Altaf et al. 2025).

Pumpkin seeds are often considered waste during home processing (Montesano et al. 2018). In the industry, small seeds like these are often processed into snacks similar to sunflower seeds, but they are not yet commonly found in other prepared forms. From the perspective of chemical and nutritional components, pumpkin seeds have their own

potential as a functional food ingredient (Patel 2013). The health effects of pumpkin seeds include being antihypertensive, antidiabetic, and anticancer (Bardaa et al. 2016; Medjakovic et al. 2016). Other research has shown that pumpkin seeds possess natural antibacterial, antioxidant, and anti-inflammatory properties (Gutierrez 2016). Bioactive components contained in pumpkin seeds include, among others, carotenoids, tocopherols, antioxidants, and sterols (Dyshlyuk et al. 2017).

Besides their nutritional content, pumpkin seeds are also rich in bioactive compounds, such as phytosterols, which possess antioxidant activity and potential pharmacological effects (Prommaban et al. 2021; Manshi and Chaturvedi 2023). Research results show that the isopropanol extract of pumpkin seeds has a total phenol content of 41.05 mg GAE/g and total flavonoids of 82.98 mg QE/g. Its antioxidant activity is also classified as high, with a DPPH inhibition percentage of 67.99% and a Total Antioxidant Capacity (TAC) of 30.61 mg AAE/g (Kar et al. 2023). Furthermore, the protein fraction from these seeds exhibits functional properties such as good emulsifying capacity and solubility, thus supporting its application in the formulation of various modern food products (Vinayashree and Vasu 2021).

Kopeng Village, Getasan Sub-district, Semarang District, is an area in Central Java, Indonesia, that produces

various varieties of pumpkin. Observations indicate that there are five varieties of pumpkin in the area: Bokor, Madu, Kenti, Ketan, and Kabocha. These pumpkin seeds are currently only used for plant development; they are not used to develop food products. Although their potential is significant, the utilization of pumpkin seeds as a source of nutrition and antioxidants is still limited, especially in the small-scale food industry.

In addition to functioning as a reproductive organ for plants, pumpkin seeds also serve as a storage site for food reserves needed during germination. These reserves are stored in the endosperm and cotyledon tissues, which provide nutrients for the growth of young pumpkin plants, enabling them to photosynthesize independently (Gade et al. 2022). This nutrient content also gives pumpkin seeds high nutritional value, not only for plant needs but also for human consumption (Dotto and Chacha 2020).

Most previous studies have focused more on the flesh of the pumpkin, while studies on the seeds of various varieties are still seldom conducted. Although numerous studies have been conducted on pumpkin seeds, most of these have focused on the species level, such as *C. moschata*, *C. maxima*, and *C. pepo* (Hussain et al. 2022). To date, there have been few studies that systematically examine the physical and chemical characteristics of various local varieties in greater depth. Therefore, this research is crucial to explore the bioactive content of pumpkin seeds from various varieties to support the development of functional foods based on local resources. The aim of this study is to determine the physical properties, nutritional composition, and antioxidant profiles of five varieties of pumpkin seeds.

MATERIALS AND METHODS

Preparation sample

The samples used consist of five types of pumpkins, namely Bokor, Madu, Kenti, Ketan, and Kabocha. Taking the samples of pumpkin seeds was done by splitting the pumpkin fruit of various varieties and noting the size of the fruit and seeds. Samples of pumpkin seeds were collected and weighed in wet conditions for each variety. Seeds were then sorted while wet to remove dirt and other foreign materials. Any foreign matter still attached was removed by washing and airing the seeds. After that, they were peeled, wrapped in plastic, and stored in the freezer.

Volume and weight measurement: Seeds and seeds peel

The seeds of the five pumpkin types were measured for length, width, and thickness using a caliper (push), and then the volume of each type was calculated. The seeds that were measured were then peeled, and their length, width, and thickness were measured again. Both the whole seeds and the peeled seeds were weighed, and their weights were then compared to the total weight of the pumpkin.

Measurement of compound levels: Proximate, fiber, fatty acids, amino acids and antioxidants

Measurement-level proximate analysis was conducted on the peeled seeds, covering the content of water (AOAC, 925.09), ash (AOAC, 942.05), protein (AOAC, 981.10), and fat (AOAC, 920.39). Other compounds analyzed included levels of crude fiber (AOAC, 962.09), fatty acids (AOAC, 996.06), and amino acids (AOAC, 994.12). For antioxidant activity, the compounds measured included antioxidant activity (Nurrahman and Astuti 2022), levels of β -carotene (Rif'an et al. 2017), vitamin C (Abdullah et al. 2023), vitamin E (Anggreni et al. 2024), total phenols (Anggreni et al. 2024), and total flavonoids (Anggreni et al. 2024).

Analysis of water content

Analysis of the water content of pumpkin seeds was carried out using an oven-drying method. A 2 g sample was weighed accurately using an analytical balance and placed into a dry porcelain dish that had been preheated in an oven at 105°C for 1 hour and cooled in a desiccator until constant weight was achieved. The sample was then reheated in the oven at 105°C for 4-6 hours. After drying, the dish was removed, cooled in a desiccator for 30 minutes, and then weighed. Drying was repeated until constant weight was achieved. Water content is calculated based on the difference in initial and final weight using the formula:

$$\text{Water content (\%)} = ((W_1 - W_2) / (W_1 - W_0)) \times 100\%$$

Where, W_0 as the weight of the empty cup, W_1 the weight of the material, and W_2 the weight of the cup and the material after drying.

Analysis of ash content

Ash content is determined using the dry ashing method. Approximately 2 g of sample is placed in a pre-weighed porcelain ash dish and heated on a hot plate or stovetop to remove any initial smoke. The dish is then transferred to a muffle furnace and heated at 550-600°C for 4-8 hours until all organic material has burned away, leaving only a grayish-white inorganic residue. After the process is complete, the dish is cooled in a desiccator and then weighed. Ash content is calculated using the formula:

$$\text{Ash content (\%)} = ((W_2 - W_0) / W_1) \times 100\%$$

Where, W_0 is the weight of the empty ash cup, W_1 is the weight of the sample, and W_2 is the weight of the cup and ash after burning.

Analysis of protein content

The ground sample was weighed at 0.05 g (50 mg) and placed in a Kjeldahl flask. Next, 2 mL of concentrated H_2SO_4 and a small amount of selenium powder were added as a catalyst. The mixture was heated gradually, from low to high heat, until the solution became clear. Once clear, the solution was left in a fume hood to cool. The next step was distillation. Afterward, 10 mL of 40% NaOH solution and three drops of phenolphthalein indicator were added to the distillation flask, which produced a red color. In the Erlenmeyer flask, 5 mL of 4% H_3BO_3 solution was added and methyl orange indicator was added until a red color

was formed. The final step was titration, in which the distillate was titrated with 0.1 N HCl solution until the color changed back from yellow to red. The volume of HCl solution used was then recorded as the titration result.

Protein content calculation:

$$\% N = ((mL \text{ HCl test material} - mL \text{ HCl blank}) \times N \text{ HCl} \times Fp \times 14,007 / \text{material (mg)}) \times 100\%$$

$$\text{Protein (\%)} = \%N \times FK$$

Where, Fp: dilution factor, 14.007: atomic weight of nitrogen, FK: A common protein conversion factor is 5.8.

Analysis of fat content

To analyze fat content, a 1 gram sample of the test material (W_1) was placed into a thimble and tightly closed. The thimble was then placed in a Soxhlet extractor. The fat flask was then filled with solvent (petroleum ether) according to the flask's capacity. The Soxhlet apparatus was completely assembled, and the apparatus was heated for approximately 1 hour, or approximately 8 extraction cycles. After this process, the thimble was removed, and the remaining solvent was evaporated and collected. The fat flask, which still contained a small amount of solvent, was heated again in an oven at approximately 105°C until all the solvent had evaporated. Once dry, the flask was cooled in a desiccator for 30 minutes and then reweighed to obtain the final weight (W_2). The remaining fat is calculated based on the difference in weight of the flask before and after extraction:

$$\text{Fat content (\%)} = ((W_2 - W_0) / W_1) \times 100\%$$

Where, W_0 is the weight of the empty flask, W_1 is the weight of the sample, and W_2 is the weight of the flask after solvent evaporation.

Analysis of crude fiber

The crude fiber analysis procedure begins by weighing approximately 1 gram of the defatted sample, or the residue from the fat content test, into an Erlenmeyer flask. Next, 100 ml of a 1.25% H_2SO_4 solution is added, a reflux condenser is installed, and the mixture is heated. The sample was boiled with acid for approximately 30 minutes, after which the mixture was immediately filtered, and the residue was washed with hot water. The resulting residue was then returned to the Erlenmeyer flask, 100 ml of 1.25% NaOH solution was added, the reflux condenser was installed, and the reflux was continued for approximately 30 minutes. After the boiling was complete, the solution was filtered, and the residue was washed sequentially with hot water, 10% K_2SO_4 solution, hot water again, and finally with hot alcohol. The next step was to dry the filter paper and residue by oven-drying at approximately 100°C until completely dry, then cooling them in a desiccator. Dietary fiber content is calculated using the formula:

$$\text{Crude Fiber (\%)} = ((W_2 - W_1) / W_0) \times 100\%$$

Where, W_0 is the sample weight, W_1 is the filter paper weight, and W_2 is the filter paper weight + residue after drying.

Analysis of fatty acids

Analysis of fatty acid composition in pumpkin seeds using the $NaOCH_3$ -Methanol method. Weighed as much as

5 g of sample placed into a 20 mL screw vial. Added aquabides, Methyl-Tert-Butyl Ether (MTBE) solution, transesterification solution sequentially, then added hexane. Added neutralization solution, after which centrifuged. The result is a fatty acid methyl ester, then analyzed using gas chromatography. Instrument measurement conditions include Injection mode: split; Capillary column: DB FastFAME; Oven program: Temperature gradient 50-230°C; Detector: FID.

Analysis of amino acids

Weighed as much as 0.5 g of sample placed into a suitable container. Hydrolyzed with HCl solution, then transferred the hydrolysis results into a 50 mL measuring flask. Added aquabides up to the mark, then homogenized. The test solution was filtered with a 0.2 μm syringe filter and collected the filtrate. Added standard internal solution, continued to the derivatization stage. The results were in the form of amino acids, then analyzed using UPLC. Instrument measurement conditions include a C18 column; mobile phase eluent accq. Ultra tag and aquabides; gradient pump system; column temperature 49°C; PDA detector.

Analysis of β -carotene

The β -Carotene analysis test involved weighing 0.5 g of ground pumpkin seeds, adding 2 mL of 95% ethanol and 4 mL of 90% petroleum ether. This sample permeation process produces a thin yellow or orange layer. The β -carotene standard used 20 mg of potassium dichromate ($K_2Cr_2O_7$) dissolved in distilled water to the 100 mL mark. The next step was to pipette 1 mL of the yellow layer from the sample. The sample was diluted with 4 mL of 90% petroleum ether and covered with aluminum foil to avoid direct light exposure. The resulting solution was homogenized using Fortex until thoroughly mixed. Next, the absorbance of the sample and standard was measured using a UV-vis spectrophotometer at 450 nm. The obtained absorbance values were used to calculate the concentration of the analyzed compounds. Calculation formula:

$$\beta - \text{carotene content} \left(\frac{\mu g}{g \text{ sample}} \right) (wb) = \frac{A_{450 \text{ sample}}}{A_{450 \text{ standard}}} \times 5,6 (\mu g) \times 2 \frac{1}{\text{sample weight}} \times FP$$

Analysis of vitamin E

A standard vitamin E curve was prepared by weighing 100 mg of pure vitamin E and dissolving it in n-hexane solvent to the mark of a 100 mL volumetric flask. This resulted in a master standard solution with a concentration of 100 ppm. A calibration curve was prepared by diluting the solution to 10 mL with concentration variations of 12.5; 17.5; 25; and 50 ppm.

The sample absorbance measurement for vitamin E analysis begins with the sample preparation stage. A total of 0.5 g of ground pumpkin seeds from each variety was weighed, then extracted using 10 mL of n-hexane solvent. The maceration process lasted for 24 hours and was covered with aluminum foil and stored in a place protected from light. 1 mL of 1% iodine was added and then homogenized. Absorbance measurements were carried out at a maximum wavelength between 280-328 nm using a UV-vis spectrophotometer.

Analysis of vitamin C

Weigh 100 mg of pure ascorbic acid and then add it to a 1000 mL volumetric flask up to the mark using distilled water to produce a 100 ppm standard solution. A calibration curve was made with concentration variations of 2, 4, 6, 8, and 10 ppm with a final volume of 10 mL. Absorbance was measured using a UV-vis spectrometer with a wavelength of 516 nm.

Vitamin C absorbance was measured by weighing 0.5 grams of ground pumpkin seeds from various varieties and dissolving them in 10 mL of methanol. The samples were homogenized using a vortex and macerated for 24 hours. Absorbance was measured using a UV-vis spectrophotometer at a wavelength of 516 nm.

Analysis of total phenol

Weighing 10 mg of gallic acid was then dissolved in a 100 mL volumetric flask using distilled water, resulting in a master standard solution with a concentration of 100 ppm. The solution was made into master standards with concentrations of 2, 4, 6, 8, and 10 ppm with a final volume of 10 mL. Absorbance was measured using a UV-vis spectrometer with a wavelength of 645 nm.

The prepared samples were weighed at 0.5 g per variety, dissolved in 10 mL of methanol, and macerated for 24 hours under closed conditions. The samples were extracted using ethanol, then macerated for 24 hours. Next, 1 mL of each sample was pipetted, Folin-Ciocalteu reagent was added, and 1.2 mL of Na₂CO₃ solution (7.5%) was added. The sample solution was homogenized using a vortex and incubated for 30 minutes. The blank was measured in the same manner without adding the sample. The absorbance of the sample and blank was measured using a UV-Vis spectrophotometer at a wavelength of 645 nm. Total phenol values were measured in mg Gallic Acid Equivalent, using the formula:

$$\text{Total phenol} = \frac{V \text{ (mL)} \times \text{concentration (mg/L)} \times \text{FP}}{\text{Sample weight}}$$

Analysis of flavonoid content

To analyze the flavonoid content, a 0.15 mg quercetin standard was weighed and dissolved in 150 mL of 80% ethanol, then diluted to concentrations of 20, 40, 60, 80, and 100 ppm. Next, 0.5 mL of the quercetin solution was pipetted and added to 1.5 mL of 80% ethanol, 1 mL of 10% AlCl₃, and 1 mL of 1 M CH₃COOK, adjusted to 50 mL of distilled water, and incubated for 30 minutes. A 0.15 mg sample was dissolved in 5 mL of ethanol and homogenized. Next, 0.5 mL of the sample was pipetted and added to 1.5 mL of 80% ethanol, 1 mL of 10% AlCl₃, and 1 mL of 1 M CH₃COOK, adjusted to 50 mL of distilled water, and incubated for 30 minutes. The blank was prepared by pipetting 1.5 mL of 80% ethanol, 1 mL of 10% AlCl₃, and 1 mL of 1 M CH₃COOK and adding 50 mL of distilled water, then incubated for 30 minutes. Then, the absorbance was measured at a wavelength of 415 nm using a UV-Vis spectrophotometer.

Analysis of antioxidant activity

Pumpkin seeds were ground using a mortar, taken as much as 0.5 g, then extracted using 10 mL of methanol solvent and homogenized using a vortex. After that, they were macerated for 24 hours, covered with aluminum foil, and stored in the dark. A total of 0.2 mL of extractant was added to 3.9 mL of 0.1 mM DPPH solution and then vortexed until homogeneous. Incubated for 30 minutes in a water bath at 37°C in the dark (wrapped in aluminum foil). Afterward, absorbance was measured using a UV-Vis spectrophotometer at a wavelength of 517 nm. Blank absorbance was measured from the free Radical Scavenging Activity (RSA) value and then calculated based on the absorbance difference between the sample solution and the blank.

Experimental design

The design used in the study is a Complete Randomized Design (CRD). The treatment factor used is the variety of pumpkin, consisting of five varieties, which were tested for their physical and chemical characteristics, including levels of proximate, fiber, fatty acids, amino acids, antioxidant activity, β-carotene, total phenols, flavonoids, vitamin C, and vitamin E. For every variety, three repetitions were performed, so that the total experimental units were 5×3=15 units.

Data analysis

The study design used a single-factor CRD (completely randomized design) with five treatments. The differences between treatments were analyzed using One-Way ANOVA; if an effect was found with a p-value <0.05, the analysis continued with the LSD test.

RESULTS AND DISCUSSION

The pumpkins used in the research were obtained from Kopeng, Semarang District, Central Java, Indonesia. The researchers obtained five varieties of pumpkins available for sale, namely Bokor, Madu, Kenti, Ketan, and Kabocha. The names of these five pumpkin varieties were taken from the results of interviews with traders. From observations, the most commonly sold pumpkin is the Bokor variety, and its selling price is also the lowest. According to the sellers, Bokor pumpkin is the most widely grown by farmers and is readily available, while other varieties are in limited supply and are sometimes unavailable.

Different pumpkin species have different components and biological activities. Research results show that the bioactive composition of pumpkin seeds grown in different areas varies (Lestari and Meiyanto 2018). Due to differences between species and/or varieties, the results for morphology, proximate levels, fiber, fatty acids, amino acids, and antioxidant compounds vary.

Morphology pumpkin seed

Pumpkin seeds are located in the fruit cavity and are generally covered by mucus and pericarp tissue fibers.

Morphologically, the seeds are flattened with rounded edges, have a longitudinal direction, and a slightly pointed tip on one side. The seed surface can be smooth or slightly textured, while the seeds coat (hull) varies in characteristics, ranging from thin to relatively hard, requiring a peeling process for certain varieties to obtain the kernel (Patel et al. 2023). The hull color is generally cream to light brown, although in some oil varieties it can be darker and thinner. This morphological variation is useful not only for identifying varieties but also for evaluating seeds quality (Arifin et al. 2024). Figure 1 shows the seeds and peel seeds of the pumpkin varieties Bokor, Madu, Kenti, Ketan and Kabocha.

The morphology of the pumpkin seeds from the five varieties was similar, with differences primarily in length, width, and thickness (volume). Table 1 shows characteristics of morphology various varieties of the pumpkin seeds. In general, the physical dimensions of the five varieties of pumpkin seeds were significantly different ($p < 0.05$). Measurement results showed that the volume of Kabocha seeds was $0.570 \pm 0.031 \text{ cm}^3$, which was larger than the other varieties. Meanwhile, the smallest volume was found in the Bokor variety ($0.372 \pm 0.026 \text{ cm}^3$). The weight percentage of the whole Kabocha seeds relative to the fruit was the largest ($9.40 \pm 0.40\%$), but its seeds kernel percentage was the lowest (4.61%). Therefore, while collecting Kabocha pumpkin seeds yielded a higher quantity of seeds, the actual edible seeds content was the lowest.

The weights of the whole seeds and the peeled seeds (kernels) of the five varieties of pumpkin were significantly different ($p < 0.05$). The whole seeds weight was highest in

the Kabocha variety, at $0.43 \pm 0.01 \text{ g}$, while the peeled seeds weight was highest in the Bokor variety ($0.16 \pm 0.01 \text{ g}$). The lowest percentage of pumpkin seeds weight relative to fruit weight were found in the Madu variety, at $1.09 \pm 0.19\%$. Although the percentage of whole seeds to fruit weight in the Bokor variety were not the highest ($2.32 \pm 0.20\%$), its percentage of peeled seeds relative to the total seeds weight were the highest among the five varieties ($51.23 \pm 1.82\%$).

Proximate and fiber content of pumpkin seeds

The proximate content of a food ingredient needs to be analyzed to determine its chemical composition characteristics. Knowledge of the material's composition can be used to understand other characteristics, such as quality, processing potential, and functionality. In this research, the proximate composition and fiber content of pumpkin seed varieties, Bokor, Madu, Kenti, Ketan, and Kabocha, were analyzed. The samples were analyzed in their fresh seeds condition. Table 2 shows proximate and fiber levels of five varieties of pumpkin seeds. In general, the proximate and fiber levels of the five varieties of pumpkin seeds were significantly different ($p < 0.05$).

The seeds moisture content of the five pumpkin varieties ranged between $22.06 \pm 0.31\%$ and $27.56 \pm 0.15\%$ (wet basis), with the Bokor variety having the lowest and Ketan having the highest moisture content. In comparison, Singh and Kumar (2021) reported that the seeds and kernels of five *C. moschata* cultivars (Kashi Harit, Narendra Upkar, Pusa Vishwas, Narendra Agrim, and Azad Pumpkin 1) had a moisture content of around 4-7% after drying.

Table 1. Characteristics of morphology various varieties of the pumpkin seeds

Parameter	Variety				
	Bokor	Madu	Kenti	Ketan	Kabocha
Seeds Volume (cm^3)	0.37 ± 0.03^a	0.49 ± 0.02^b	0.46 ± 0.06^b	0.36 ± 0.02^a	0.57 ± 0.03^c
Peel Seeds Volume (cm^3)	0.20 ± 0.03^a	0.25 ± 0.02^b	0.20 ± 0.01^a	0.18 ± 0.01^a	0.05 ± 0.01^c
Seeds weight (g)	0.23 ± 0.01^a	0.17 ± 0.01^b	0.22 ± 0.01^c	0.30 ± 0.01^d	0.43 ± 0.01^e
Peel seeds weight (g)	0.16 ± 0.01^a	0.11 ± 0.01^b	0.14 ± 0.01^c	0.13 ± 0.01^c	0.14 ± 0.01^c
Percentage of seeds (%)*	2.32 ± 0.20^a	1.09 ± 0.19^a	3.43 ± 0.35^a	3.83 ± 0.21^a	9.40 ± 0.40^b
Percentage of peel seeds (%)**	51.23 ± 1.82^a	35.52 ± 1.91^b	38.04 ± 2.98^b	35.46 ± 2.39^b	4.61 ± 0.30^c

Note: *: Percentage to fruit weight, **: Percentage to seed weight. Different letters in a row indicate a significant difference ($p < 0.05$)

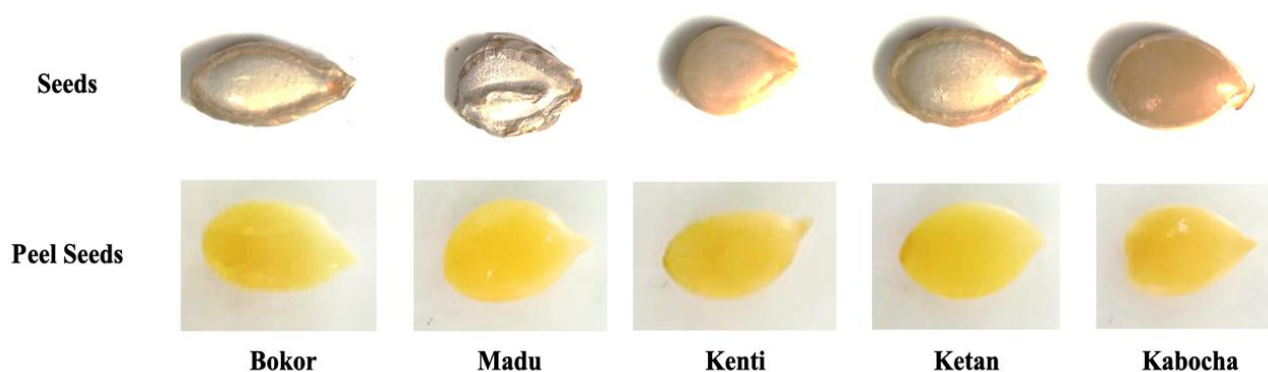


Figure 1. Seed and peel seed from five pumpkin varieties

Table 2. Proximate and fiber levels of five varieties of pumpkin seeds

Parameter	Variety				
	Bokor	Madu	Kenti	Ketan	Kabocha
Water content (%)	22.06±0.31 ^a	25.62±0.29 ^b	23.56±0.17 ^c	27.56±0.15 ^d	22.12±0.56 ^a
Ash Content (%)	4.21±0.19 ^a	4.05±0.04 ^a	3.46±0.11 ^b	4.31±0.22 ^a	5.01±0.01 ^c
Protein (%)	18.68±0.69 ^a	33.30±0.37 ^b	19.74±0.42 ^c	23.79±0.27 ^d	28.14±0.52 ^e
Lipid (%)	28.08±0.18 ^a	24.21±0.12 ^b	39.60±0.26 ^c	31.38±0.06 ^d	32.47±0.17 ^e
Carbohydrates (%)	26.97±1.09 ^a	12.82±0.41 ^{bc}	13.63±0.26 ^c	12.96±0.14 ^{bc}	12.26±0.94 ^b
Crude Fiber (%)	3.53±0.33 ^a	4.13±0.19 ^b	3.83±0.05 ^{ab}	3.55±0.31 ^a	4.55±0.31 ^c

Note: Different letters in a row indicate a significant difference ($p < 0.05$)

The ash content ranged between 3.46% and 5.01% (wet basis), with Kabocha pumpkin seeds having the highest ash level. Ash content reflects the total mineral content of the material. Singh and Kumar (2021) found that the ash content of the seeds and kernels of five *C. moschata* cultivars ranged from 3-5%, with the highest value found in the Kashi Harit cultivar. This ash content correlated with high levels of minerals such as phosphorus, magnesium, manganese, and zinc in those cultivars. Amin et al. (2019) also reported relatively high ash content in seeds compared to the skin and flesh, indicating that the seeds are the part richest in minerals. This consistency is supported by Batool et al. (2022), who stated that pumpkin seeds are an important source of macro and micro minerals that play a role in physiological functions.

Pumpkin seeds have a high protein content, making them a potential source of vegetable protein. Singh and Kumar (2021) noted that *C. moschata* seeds have a protein content of around 25-37%, with kernels showing a higher protein content than whole seeds due to the removal of the husk. In this research, the protein content of the pumpkin seeds ranged between 18.68±0.69% and 33.30±0.37% (wet basis), which is significantly higher than the levels typically found in the flesh of the fruit (Nurrahman and Astuti 2022). The Madu variety was found to have the highest amount of protein, while the Bokor variety had the lowest. Batool et al. (2022) stated that pumpkin seeds protein consist of cucurbitin, albumin, prolamin, and globulin fractions, which possess considerable biological value.

Pumpkin seeds are recognized as a food ingredient with high fat content. According to Singh and Kumar (2021), the fat content in five cultivars of *C. moschata* ranged from 37% to 45% (dry basis), with the Kashi Harit cultivar showing the highest values in both seeds and kernels. In this research, the lipid content of the pumpkin seeds ranged between 24.21±0.12% and 39.60±0.26% (wet basis), which is significantly higher than the levels found in the flesh of the fruit (Nurrahman and Astuti 2022). The Kenti variety was found to have the highest lipid content, while the Madu variety had the lowest. Batool et al. (2022) reinforced these findings, explaining that pumpkin seed oil is rich in unsaturated fatty acids, tocopherols, and phytosterols, giving it great potential as a functional food oil.

The Madu pumpkin variety contains the highest protein content alongside the lowest fat content, whereas the highest fat content was found in the Kenti variety.

According to Devi et al. (2018), pumpkin seeds constitute 3.52-4.27% of the total fruit weight, yet they are often discarded or utilized only as animal feed despite their significant nutritional density. These seeds contain substantial amounts of fat (31.9-58.0%) and protein (14.05-39.75%). Consequently, pumpkin seeds represent a highly viable and sustainable source of vegetable protein and lipids (Mondaca et al. 2019).

The carbohydrate content of pumpkin seeds is generally relatively low compared to that of other grains or legumes. This value is typically determined using the "by-difference" method, which calculates the remaining carbohydrate content after all other proximate components (moisture, ash, fat, and protein) have been summed and subtracted from 100%. Singh and Kumar (2021) observed that the carbohydrate content of *C. moschata* seeds falls within a medium range, once the high levels of fat, protein, ash, and fiber are accounted for. In this study, the Bokor pumpkin seeds were found to have the highest carbohydrate content at 26.97±1.09%. Batool et al. (2022) noted that this carbohydrate fraction includes various polysaccharides, such as pectin.

The pumpkin seeds from the five varieties contained fiber levels ranging between 3.53±0.33% and 4.55±0.31% (wet basis). The Bokor variety had the lowest fiber content, while the Kabocha variety had the highest. These levels are consistent with previous research that reported fiber levels in pumpkin seeds between 3.18% and 4.52% (Singh and Kumar 2021). Generally, the fiber content of pumpkin seeds is moderate and is significantly influenced by the presence of the seeds coat. Singh and Kumar (2021) demonstrated that the intact seeds of five *C. moschata* cultivars had higher fiber content than the kernels due to the presence of the pericarp.

Composition of pumpkin seed fatty acid

Pumpkin seeds are a plant component with high lipid content and the potential to serve as a source of functional vegetable oil. The fatty acid composition of pumpkin seeds has been extensively studied due to its close relationship with nutritional value and physiological health benefits. Analysis using Gas Chromatography (GC) showed that the pumpkin seeds oil was predominantly composed of unsaturated fatty acids, although some saturated fatty acids were also detected in varying concentrations. This finding indicates that pumpkin seeds serve not only as a concentrated energy source but also as a bioactive

component that supports metabolic health (Amin et al. 2019).

As shown in Table 3, the Ketan pumpkin variety possessed the highest levels of both saturated and unsaturated fatty acids. Consequently, the total fatty acid content in the Ketan variety was the highest among all the studied varieties. In general, the levels of individual fatty acid types across the five pumpkin seeds varieties were significantly different ($p < 0.05$).

The primary saturated fatty acids identified in significant quantities were stearic and palmitic acid. In the Ketan variety, the highest values for stearic and palmitic acid were $4.21 \pm 0.01\%$ and $8.68 \pm 0.04\%$, respectively. Regarding unsaturated fatty acids, the highest concentrations were observed for oleic and linoleic acid. In the Ketan seeds, these peaked at $9.75 \pm 0.01\%$ for oleic acid and $22.81 \pm 0.02\%$ for linoleic acid. These findings align with previous reports stating that stearic and palmitic acids are the dominant saturated fats, while oleic and linoleic acids are the primary unsaturated fats in pumpkin seeds (Mondaca et al. 2019; Dowidar et al. 2020). Research by Amin et al. (2019) further identified saturated fatty acids in pumpkin seeds oil including capric (C10:0), lauric (C12:0), myristic (C14:0), palmitic (C16:0), and stearic (C18:0). Unsaturated fatty acids remain the dominant components; oleic acid (C18:1), a Monounsaturated Fatty Acid (MUFA), and linoleic acid (C18:2), a Polyunsaturated Fatty Acid (PUFA), are present in the highest percentages, accompanied by smaller amounts of linolenic acid (C18:3).

Composition of pumpkin seed amino acid

Pumpkin seed protein isolate is reported to have a high protein content, a balanced amino acid composition, and favorable functional properties, making it a promising raw material for high-protein food products (Habib et al. 2025). The amino acid profile of pumpkin seeds is considered complete, as it contains all the Essential Amino Acids (EAAs) required by the human body. Nine amino acids, including histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine, are classified as essential amino acids because they cannot be synthesized by human or other mammalian cells (Lopez and Mohiuddin 2024). This includes tryptophan, lysine, and methionine, which are typically the limiting amino acids in cereal grains (Xie et al. 2025). In this study, 18 of

the 20 naturally occurring amino acids were analyzed within the protein fractions of the seeds. The concentrations of these amino acids varied across the five varieties; in general, the amino acid levels were significantly different ($p < 0.05$). As shown in Table 4, the Kabocha pumpkin seeds possessed the highest content of all measured amino acids.

The amino acids in the largest quantities in pumpkin seeds are glutamic acid, arginine, and aspartic acid. This is found in all seeds of the five varieties, which are sequentially ranked based on their levels of amino acids as follows: Kabocha, Madu, Kenti, Bokor, and Ketan; meanwhile, the levels of other amino acids vary. Other researchers also found that the amino acid composition of pumpkin seeds consists mostly of glutamic acid, arginine, and aspartic acid (Mondaca et al. 2019; Dowidar et al. 2020). This indicates that pumpkin seeds have been investigated across various varieties, with the specific content belonging to each variety. Specifically, the most abundant amino acids are glutamic acid, arginine, and aspartic acid. Meanwhile, certain types of amino acids are present in small amounts, including tryptophan, methionine, and histidine, which are found in all varieties of pumpkin (Mondaca et al. 2019; Dowidar et al. 2020). Of these three amino acids, Kabocha pumpkin seeds contain the highest levels.

Compounds of pumpkin seeds antioxidant

Antioxidants are compounds capable of inhibiting or preventing the oxidation process of a substrate, even at low concentrations. These antioxidants can ward off free radicals or Reactive Oxygen Species (ROS) formed during the body's metabolic processes (Gulcin 2025).

Compounds that act as antioxidants in seeds, such as pumpkin, include β -carotene, vitamin E, vitamin C, phenols, and flavonoids. In general, the levels of antioxidant compounds across the five varieties of pumpkin seeds were significantly different ($p < 0.05$). Among these, the Madu variety contained β -carotene at the lowest level, at 2.28 ± 0.42 mg/100 g (Table 5). In contrast, the highest content was found in Kabocha seeds (6.5 ± 0.38 mg/100 g). Although pumpkin seeds contain β -carotene, they do not exhibit a visible yellow color. This is possible because the amount of β -carotene in the seeds is low enough that it has no impact on the visible color (Qodri 2024).

Table 3. Various fatty acids in the seeds of the pumpkin (the percentages are relative to total dry seeds weight)

Parameter	Variety				
	Bokor	Madu	Kenti	Ketan	Kabocha
Stearic Acid (%)	2.66 ± 0.01^a	1.87 ± 0.01^b	3.58 ± 0.01^c	4.21 ± 0.01^d	2.95 ± 0.01^e
Palmitic Acid (%)	6.84 ± 0.03^a	4.58 ± 0.01^b	5.99 ± 0.01^c	8.68 ± 0.04^d	6.00 ± 0.01^e
Oleic Acid (%)	15.28 ± 0.01^a	9.58 ± 0.01^b	7.01 ± 0.01^c	9.75 ± 0.01^d	15.64 ± 0.01^e
Linoleic Acid (%)	11.29 ± 0.01^a	15.02 ± 0.01^b	21.95 ± 0.01^c	22.81 ± 0.02^d	15.39 ± 0.01^e
Linolenic Acid (%)	0.05 ± 0.01^a	0.07 ± 0.01^b	0.09 ± 0.01^c	0.07 ± 0.01^b	0.05 ± 0.01^d
Saturated Fat (%)	9.89 ± 0.03^a	6.70 ± 0.01^b	9.89 ± 0.01^a	13.23 ± 0.03^c	9.47 ± 0.01^d
Unsaturated Fat (%)	26.71 ± 0.03^a	24.73 ± 0.01^b	29.11 ± 0.01^c	32.69 ± 0.03^d	31.20 ± 0.01^e
Polyunsaturated Fat (%)	11.34 ± 0.01^a	15.09 ± 0.01^b	22.04 ± 0.01^c	22.88 ± 0.02^d	15.44 ± 0.01^e
Monounsaturated Fat (%)	15.37 ± 0.02^a	9.65 ± 0.01^b	7.07 ± 0.01^c	9.81 ± 0.01^d	15.76 ± 0.01^e

Note: Different letters in a row indicate a significant difference ($p < 0.05$)

Table 4. Composition of various amino acids of the pumpkin seeds

Type of amino acids (g/100 g)	Variety				
	Bokor	Madu	Kenti	Ketan	Kobucha
L-Alanine	0.77±0.01 ^a	0.99±0.02 ^b	0.83±0.01 ^c	0.81±0.01 ^d	1.91±0.02 ^e
L-Arginine	2.45±0.02 ^a	3.25±0.01 ^b	2.73±0.01 ^c	2.41±0.01 ^d	6.96±0.02 ^e
L-Aspartic Acid	1.62±0.02 ^a	2.10±0.01 ^b	1.84±0.01 ^c	1.72±0.01 ^d	4.16±0.01 ^e
Glycine	1.02±0.02 ^a	1.24±0.01 ^b	1.06±0.01 ^c	0.95±0.01 ^d	2.46±0.02 ^e
L-Glutamic Acid	3.33±0.04 ^a	4.41±0.01 ^b	3.54±0.01 ^c	3.12±0.01 ^d	8.25±0.02 ^e
L-Histidine	0.39±0.01 ^a	0.45±0.01 ^b	0.42±0.01 ^c	0.35±0.01 ^d	0.97±0.01 ^e
L-Isoleucine	0.59±0.01 ^a	0.63±0.01 ^b	0.70±0.01 ^c	0.49±0.01 ^d	1.50±0.01 ^e
L-Cystine	0.72±0.01 ^a	0.58±0.01 ^b	0.36±0.01 ^c	0.66±0.01 ^d	0.88±0.01 ^e
L-Leucine	1.24±0.02 ^a	1.48±0.01 ^b	1.42±0.01 ^c	1.15±0.01 ^d	2.97±0.01 ^e
L-Lysine	0.52±0.01 ^a	0.57±0.01 ^b	0.53±0.01 ^c	0.50±0.01 ^d	1.33±0.01 ^e
L-Methionine	0.31±0.01 ^a	0.23±0.01 ^b	0.18±0.01 ^c	0.18±0.01 ^d	0.41±0.01 ^e
L-Tryptophan	0.38±0.01 ^a	0.25±0.01 ^b	0.22±0.01 ^c	0.26±0.01 ^d	0.62±0.01 ^e
L-Valine	0.74±0.01 ^a	0.75±0.01 ^b	0.82±0.02 ^c	0.58±0.01 ^d	1.72±0.01 ^e
L-Phenylalanine	1.01±0.01 ^a	0.99±0.01 ^b	0.90±0.01 ^c	1.01±0.01 ^d	2.27±0.01 ^e
L-Proline	0.63±0.01 ^a	0.77±0.01 ^b	0.74±0.01 ^c	0.71±0.01 ^d	1.62±0.02 ^e
L-Serine	0.94±0.02 ^a	1.25±0.01 ^b	0.98±0.01 ^c	1.08±0.01 ^d	2.36±0.02 ^e
L-Threonine	0.39±0.01 ^a	0.43±0.01 ^b	0.40±0.01 ^c	0.52±0.01 ^d	0.91±0.01 ^e
L-Tyrosine	0.57±0.01 ^a	0.64±0.01 ^b	0.75±0.01 ^c	0.53±0.01 ^d	1.65±0.01 ^e

Note: Different letters in a row indicate a significant difference ($p < 0.05$)

Table 5. Compounds of antioxidant of five varieties in the pumpkin seeds

Parameter	Variety				
	Bokor	Madu	Kenti	Ketan	Kabocha
β- Carotene (mg/100 g)	3.59±0.78 ^a	2.28±0.42 ^b	3.59±0.71 ^a	2.34±0.29 ^b	6.51±0.38 ^c
Vitamin E (mg/100 g)	3.75±0.36 ^a	1.51±0.95 ^b	14.51±0.97 ^c	2.18±0.92 ^a	21.70±1.55 ^d
Vitamin C (mg/100 g)	32.90±0.36 ^a	37.25±0.68 ^b	34.87±1.09 ^c	41.39±0.46 ^d	43.81±0.34 ^e
Total Phenol (mg GAE/g)	57.00±1.63 ^a	85.13±2.95 ^b	109.51±2.25 ^c	79.65±3.01 ^d	73.25±1.98 ^e
Total Flavonoid (mg QE/g)	2.14±0.18 ^a	1.43±0.15 ^b	3.44±0.08 ^c	1.00±0.09 ^d	2.55±0.08 ^e
Antioxidant Activity (% RSA)	12.66±0.78 ^a	11.03±0.81 ^a	11.47±1.05 ^a	11.90±1.50 ^a	12.81±0.62 ^a

Note: Different letters in a row indicate a significant difference ($p < 0.05$)

Vitamin E is a group of fat-soluble compounds with high antioxidant activity, with the primary forms being tocopherols and tocotrienols. Of the eight known isoforms of vitamin E (α -, β -, γ -, and δ - for both tocopherols and tocotrienols), α -tocopherol is the most biologically active form in the human body. The primary function of vitamin E is to protect cell membranes against oxidative damage caused by free radicals, particularly in lipid environments such as plasma lipoproteins and phospholipid membranes (Kar et al. 2023). The concentrations of vitamin E and vitamin C in Kabocha seeds are the highest compared to the other varieties, at 21.70±1.55 mg/100 g and 43.81±0.34 mg/100 g, respectively. It is also evident that Kabocha seeds exhibit the highest antioxidant activity among all samples, with a value of 12.81±0.62% RSA. According to research by Kinsman et al. (2024), it is clear that the content of bioactive compounds, especially vitamin E (tocopherol) and vitamin C, is influenced by differences in variety, growing conditions, and pumpkin processing methods.

The total phenolic content is highest in the pumpkin seeds of the Kenti variety (109.51±2.25 mg GAE/g), and the lowest is in the seeds of the Bokor variety (57.00±1.63 mg GAE/g). Similarly, the highest total

flavonoid content is found in the Kenti variety (3.44±0.08 mg QE/g), while the lowest is in the Ketan variety (1.00±0.09 mg QE/g). Phenolic compounds are secondary metabolites naturally found in many plants. These compounds function by donating electrons or hydrogen atoms to free radicals, thereby preventing oxidative damage to body cells and tissues. Pumpkin is a potent source of phenolic compounds, which neutralize free radicals by donating oxygen atoms (Darmakusuma et al. 2025).

Researchers isolated two phenolic glycoside compounds from pumpkin seeds: (2-hydroxy) phenylcarbonyl 5-O-benzoyl-beta-D-apiofuranosyl(1→2)-beta-D-glucopyranoside and 4-beta-D-glucopyranosyl hydroxymethyl phenyl 5-O-benzoyl-beta-D-apiofuranosyl(1→2)-beta-D-glucopyranoside (Li et al. 2009). Furthermore, other studies identified five phenolic glycosides from yellow pumpkin seeds, namely: 2-(4-hydroxy) phenylethanol 4-O-(5-O-benzoyl)-β-D-apiofuranosyl (1→2)-β-D-glucopyranoside, 2-(4-hydroxyphenyl)ethanol 4-O-[5-O-(4-hydroxy)benzoyl]-β-D-apiofuranosyl(1→2)-β-D-glucopyranoside, 4-hydroxybenzyl alcohol 4-O-(5-O-benzoyl)-β-D-apiofuranosyl (1→2)-β-D-glucopyranoside, 4-

hydroxybenzyl alcohol 4-O-[5-O-(4-hydroxy)benzoyl]- β -D-apiofuranosyl(1 \rightarrow 2)- β -D-glucopyranoside and 4-hydroxyphenyl 5-O-benzoyl- β -D-apiofuranosyl (1 \rightarrow 2)- β -D-glucopyranoside (Koike et al. 2005).

Antioxidant activity plays a crucial role in protecting plants from oxidative stress caused by the accumulation of free radicals. Antioxidant compounds can neutralize free radicals and prevent cell damage, thus providing health benefits and potentially reducing the risk of various degenerative diseases (Grajzer et al. 2025). Research by Prommaban et al. (2021) showed that pumpkin seed oil contains various bioactive compounds with high antioxidant properties. These compounds play a role in scavenging free radicals and suppressing lipid oxidation. In this study, the antioxidant activity values of the five types of pumpkin seeds ranged from 11.03 \pm 0.81% to 12.81 \pm 0.62% RSA. The analysis of variance (ANOVA) on the antioxidant activity of the five pumpkin seeds varieties showed no significant differences ($p > 0.05$). Although the five pumpkin seeds varieties possessed different concentrations of antioxidant compounds, their overall antioxidant activity values were similar.

Table 5 shows that the pumpkin seeds of the Kabocha variety have the highest levels of β -carotene, vitamin E, vitamin C, and antioxidant activity compared to the other varieties. As a source of antioxidant compounds, this variety is naturally more beneficial, making it an ideal standard material for processed foods enriched with antioxidants. However, there are practical drawbacks to its use as a primary industrial ingredient, including its higher price, limited market availability, and a very low percentage of seed yield relative to the whole fruit. Conversely, the Bokor variety is highly suitable as a raw material for the food industry because it is the most cost-effective, widely available, and possesses the highest percentage of peeled seeds.

In conclusion, different varieties of pumpkin seeds have different physical and chemical characteristics. Kabocha pumpkin seeds have the largest volume and weight compared to other seeds, but have a lower volume and weight of peeled seeds. Bokor seeds, on the other hand, have the highest percentage of peeled seeds, potential for industrial raw material. In general, Kabocha pumpkin seeds have a relatively higher proximate composition, amino acids, and antioxidants than other varieties, potential for functional ingredients. Ketan variety has the highest fatty acid content, potential for oil extraction.

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REFERENCES

- Abdullah M, Jamil RT, Attia FN. 2023. Vitamin C (Ascorbic Acid). StatPearls Publishing, Treasure Island (FL).
- Altaf A, Sharma H, Dar AH, Dash KK, Pandey VK, Manzoor M. 2025. Phytochemical potential and biological activity of pumpkin: A review. *Food Saf Health* 3 (2): 188-201. <https://doi.org/10.1002/fsh3.70001>.
- Amin MZ, Islam T, Uddin MR, Uddin MJ, Rahman MM, Satter MA. 2019. Comparative study on nutrient contents in the different parts of indigenous and hybrid varieties of pumpkin (*Cucurbita maxima* L.). *Heliyon* 5 (9): e02462. <https://doi.org/10.1016/j.heliyon.2019.e02462>.
- Anggreni N, Mulyaningih S, Bachri MS. 2024. Aktivitas antioksidan serta penetapan kadar β -karoten, flavonoid dan fenol total ekstrak etanol labu kuning (*Cucurbita moschata* (Duch.) Poir.). *Jurnal Insan Farmasi Indonesia* 7 (3): 345-355. <https://doi.org/10.36387/jifi.v7i3.2221>. [Indonesian]
- Arifin AG, Ainurrohman N, Ardianini NR, Sugiharto AN. 2024. Efek xenia dan metaxenia pada persilangan labu kuning (*Cucurbita maxima* Duch.) terhadap buah dan biji. *PLANTROPICA: J Agric Sci* 9 (1): 33-43. <http://dx.doi.org/10.21776/ub.jpt.2024.009.1.4>. [Indonesian]
- Association of Officiating Analytical Chemists (AOAC). 2005. Official Method of Analysis. 18th Edition. AOAC, Washington DC.
- Bardaa S, Halima NB, Aloui F, Mansour RB, Jabeur H, Bouaziz M, Sahnoun Z. 2016. Oil from pumpkin (*Cucurbita pepo* L.) seeds: Evaluation of its functional properties on wound healing in rats. *Lipids Health Dis* 15: 73-84. <https://doi.org/10.1186/s12944-016-0237-0>.
- Batool M, Ranjha MMAN, Roobab U, Manzoor MF, Farooq U, Nadeem HR, Nadeem M, Kanwal R, Abdelgawad H, Al Jaouni SK, Selim S, Ibrahim SA. 2022. Nutritional value, phytochemical potential, and therapeutic benefits of pumpkin (*Cucurbita* sp.). *Plants* 11 (11): 1394. <https://doi.org/10.3390/plants11111394>.
- Darmakusuma D, Boeky GC, Ola ARB, Suwari, Dje YCB, Bekak Y, Neto PD, Mutis A. 2025. Antioxidant activity and total phenol content in steamed pumpkin (*Cucurbita moschata*) flour with skin colour variations. *Int J Sci Res Mod Technol* 4 (1): 32-36. <https://doi.org/10.5281/zenodo.14752649>.
- Devi NM, Prasad R, Sagarika N. 2018. A review on health benefits and nutritional composition of pumpkin seeds. *Intl J Chem Stud* 6 (3): 1154-1157.
- Dhurhanian CE, Novianto A. 2018. Uji kandungan fenolik total dan pengaruhnya terhadap aktivitas antioksidan dari berbagai bentuk sediaan sarang semut (*Myrmecodia pendens*). *Jurnal Farmasi dan Ilmu Kefarmasian Indonesia* 5 (2): 62-68. <https://doi.org/10.20473/jfiki.v5i22018.62-68>. [Indonesian]
- Dotto JM, Chacha JS. 2020. The potential of pumpkin seeds as a functional food ingredient: A review. *Sci Afr* 10: e00575. <https://doi.org/10.1016/j.sciaf.2020.e00575>.
- Dowidar MF, Ahmed AI, Mohamed HR. 2020. The critical nutraceutical role of pumpkin seeds in human and animal health: An updated review. *Zagazig Vet J* 48 (2): 199-212. <https://doi.org/10.21608/zvzj.2020.22530.1097>.
- Dyshlyuk L, Babich O, Prosekov A, Ivanova S, Pavskya V, Yang Y. 2017. In vivo study of medical and biological properties of functional bakery products with the addition of pumpkin flour. *Bioact Carbohydr Diet Fibre* 12: 20-24. <https://doi.org/10.1016/j.bcdf.2017.09.001>
- Gade SR, Meghwal M, Prabhakar PK, Giuffrè AM. 2022. A comparative study on the nutritional, antioxidant, thermal, morphological and diffraction properties of selected cucurbit seeds. *Agronomy* 12 (10): 2242. <https://doi.org/10.3390/agronomy12102242>.
- Grajzer M, Kozłowska W, Zalewski I, Matkowski A, Wiland-Szymańska J, Rękoś M, Prescha A. 2025. Nutraceutical prospects of pumpkin seeds: A study on the lipid fraction composition and oxidative stability across eleven varieties. *Foods* 14 (3): 354. <https://doi.org/10.3390/foods14030354>.
- Gulcin İ. 2025. Antioxidants: A comprehensive review. *Arch Toxicol* 99: 1893-1997. <https://doi.org/10.1007/s00204-025-03997-2>.
- Gumolung D. 2018. Analisis kandungan total fenolik pada jonjot buah labu kuning (*Cucurbita moschata*). *Fullerene J Chem* 3 (1): 1-4. <https://doi.org/10.37033/fjc.v3i1.25>. [Indonesian]
- Gutierrez RMP. 2016. Review of *Cucurbita pepo* (pumpkin) its phytochemistry and pharmacology. *Med Chem* 6 (1): 12-21. <https://doi.org/10.4172/2161-0444.1000316>.

- Habib M, Singh S, Sagar NA, Ahmad S, Qureshi I, Jan S, Jan K, Bashir K. 2025. Physicochemical and functional characterization of pumpkin seed protein isolate. *Sustain Food Technol* 3 (2): 445-455. <https://doi.org/10.1039/d4fb00268g>.
- Hussain A, Kausar T, Jamil MA, Noreen S, Iftikhar K, Rafique A, Iqbal MA, Majeed MA, Quddoos MY, Aslam J, Ali A. 2022. In vitro role of pumpkin parts as pharma-foods: Antihyperglycemic and antihyperlipidemic activities of pumpkin peel, flesh, and seed powders in alloxan-induced diabetic rats. *Intl J Food Sci* 2022: 1-10. <https://doi.org/10.1155/2022/4804408>.
- Kar S, Dutta S, Yasmin R. 2023. A comparative study on phytochemicals and antioxidant activity of different parts of pumpkin (*Cucurbita maxima*). *Food Chem Adv* 3: 100505. <https://doi.org/10.1016/j.focha.2023.100505>.
- Kinsman ME, Serviss MT, Meru G, Chase CA, Sargent SA, Simonne A, MacIntosh AJ. 2024. A greener approach to assess bioactive compounds in tropical pumpkin (*Cucurbita moschata*) using colorimetry. *Front Sustain Food Syst* 8: 1480964. <https://doi.org/10.3389/fsufs.2024.1480964>.
- Koike K, Li W, Liu L, Hata E, Nikaido T. 2005. New phenolic glycosides from the seeds of *Cucurbita moschata*. *Chem Pharm Bull* 53 (2): 225-228. <https://doi.org/10.1248/cpb.53.225>.
- Lestari BE, Meiyanto E. 2018. A review: The emerging nutraceutical potential of pumpkin seeds. *Indones J Cancer Chemoprevent* 9 (2): 92-101. <http://dx.doi.org/10.14499/indonesianjcanchemoprev9iss2pp92-101>.
- Li FS, Xu J, Dou DQ, Chi XF, Kang TG, Kuang HX. 2009. Structures of new phenolic glycosides from the seeds of *Cucurbita moschata*. *Nat Prod Commun* 4 (4): 511-512. <https://doi.org/10.1177/1934578X09000400413>.
- Lopez MJ, Mohiuddin SS. 2024. *Biochemistry, Essential Amino Acids*. StatPearls Publishing, Treasure Island (FL).
- Manshi, Chaturvedi N. 2023. Potential pharmacological activities of pumpkin seeds as a functional food: A comprehensive review. *J Ayurvedic Herb Med* 9 (2): 101-107. <https://doi.org/10.31254/jahm.2023.9209>.
- Medjakovic S, Hobiger S, Ardjomand-Woelkart K, Bucar F, Jungbauer A. 2016. Pumpkin seed extract: Cell growth inhibition of hyperplastic and cancer cells, independent of steroid hormone receptors. *Fitoterapia* 110: 150-156. <https://doi.org/10.1016/j.fitote.2016.03.010>.
- Mondaca RL, Marin J, Rivas J, Sanhueza L, Soto Y, Vera N, Diaz LP. 2019. Pumpkin seeds (*Cucurbita maxima*): A review of functional attributes and by-products. *Rev Chil Nutr* 46 (6): 783-791. <https://doi.org/10.4067/S0717-75182019000600783>.
- Montesano D, Blasi F, Simonetti MS, Santini A, Cossignani L. 2018. Chemical and nutritional characterization of seed oil from *Cucurbita maxima* L. (var. Berrettina) pumpkin. *Foods* 7 (3): 30. <https://doi.org/10.3390/foods7030030>.
- Nurrahman, Astuti R. 2022. Analisis komposisi zat gizi dan antioksidan beberapa varietas labu kuning (*Cucurbita moschata* Duch.). *Agrointek: Jurnal Teknologi Industri Pertanian* 16 (4): 551-559. <https://doi.org/10.21107/agrointek.v16i4.12336>. [Indonesian]
- Patel K, Soni A, Tripathi R. 2023. Pumpkin seed: Nutritional composition, health benefits. *Intl J Home Sci* 9 (3): 93-98.
- Patel S. 2013. Pumpkin (*Cucurbita* sp.) seeds as nutraceutical: A review on status quo and scopes. *Mediterr J Nutr Metab* 6 (3): 183-189. <https://doi.org/10.3233/s12349-013-0131-5>.
- Prommaban A, Kuanchoom R, Seepuan N, Chaiyana W. 2021. Evaluation of fatty acid compositions, antioxidant, and pharmacological activities of pumpkin (*Cucurbita moschata*) seed oil from aqueous enzymatic extraction. *Plants* 10 (8): 1582. <https://doi.org/10.3390/plants10081582>.
- Qodri UL. 2024. Komposisi β -karoten pada biji labu kuning (*Cucurbita moschata* (Duch.) Poir.) menggunakan variasi pelarut. *Jurnal Sains dan Teknologi* 5 (3): 991-994. <https://doi.org/10.55338/saintek.v5i3.2778>. [Indonesian]
- Rif'an, Nurrahman, Aminah S. 2017. Pengaruh jenis alat pengering terhadap karakteristik fisik, kimia dan organoleptik sup labu kuning instan. *Jurnal Pangan dan Gizi* 7 (2): 104-116. <https://doi.org/10.26714/jpg.7.2.2017.104-116>. [Indonesian]
- Singh A, Kumar V. 2021. Nutritional, phytochemical, and antimicrobial attributes of seeds and kernels of different pumpkin cultivars. *Food Front* 3 (1): 182-193. <https://doi.org/10.1002/ff2.117>.
- Vinayashree S, Vasu P. 2021. Biochemical, nutritional and functional properties of protein isolate and fractions from pumpkin (*Cucurbita moschata* var. Kashi Harit) seeds. *Food Chem* 340: 128177. <https://doi.org/10.1016/j.foodchem.2020.128177>.
- Xie Y, Wang Y, Jin X, Zhang X, Yang R. 2025. Pumpkin seed proteins: The potentially alternative protein supplements for food applications. *Foods* 14 (22):3969. <https://doi.org/10.3390/foods14223969>.