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Original article

Evaluation of the Chemical and Nutritional Composition of Legumes and Their Contribution to Diets

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Abstract

Legumes constitute a food group with significant nutritional and economic value worldwide. A large portion of the world's population depends on them as an important and affordable source of protein. Given this importance, the objective of this study was to evaluate the chemical and nutritional properties of legumes. Eight species commonly consumed in the Albanian diet were analyzed: beans, lentils, chickpeas, soybeans, faba beans, green beans, peas, and okra. The moisture, fat, protein, selected vitamins, and polyphenol contents were determined in the collected samples. The results revealed that dried legumes exhibited higher nutritional values for most parameters compared to fresh ones (peas, okra, and green beans). The vitamin content was satisfactory, especially for vitamins B1, B2, and E. In conclusion, the findings highlight the importance of including legumes in a balanced diet as valuable nutritional sources and underscore the need to promote their consumption in the context of sustainable nutrition.

Keywords: Legumes, Chemical composition, Nutritional Values, Vitamins.

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INTRODUCTION

Legumes are plants belonging to the Leguminosae (or Fabaceae) family, characterized by their ability to produce seeds within a pod. As one of the most diverse and widespread plant families worldwide, they comprise more than 18,000 species, many of which are of ecological, nutritional, agricultural, and industrial importance (Hughes *et al.,* 2025; Maphosa & Jideani, 2017). In addition to their conventional use as food crops, legumes are cultivated as forage plants, green manure, and as a source of bioactive compounds in pharmaceutical and industrial applications. Their unique capacity for biological nitrogen fixation, through symbiotic relationships with Rhizobium bacteria, improves soil fertility and reduces dependence on synthetic fertilizers, positioning them as a key factor for sustainable agriculture (Fadhlullah, 2024).

Despite this diversity, only a limited number of legume species are widely consumed by humans. Common food legumes include lentils (*Lens culinaris*), chickpeas (*Cicer arietinum*), common beans (*Phaseolus vulgaris*), peas (*Pisum sativum*), fava beans (*Vicia faba*), and soybeans (*Glycine max*). These species are integral to traditional diets across various cultures and are increasingly recognized for their potential role in global food and nutrition security (Amoah *et al.,* 2023). In particular, legumes are essential in vegetarian and vegan diets, serving as alternative sources of high-quality protein and essential micronutrients (Mekkara and Bukkan, 2021).

From a nutritional point of view, legumes are rich in plant proteins, complex carbohydrates, unsaturated fatty acids, dietary fiber, essential minerals (e.g., iron, zinc, magnesium), B vitamins, polyphenols, and other antioxidant compounds. Their low glycemic index and high fiber content contribute to better glycemic control, increased satiety, and improved lipid metabolism (Zhang *et al.,* 2010). Numerous epidemiological and clinical studies have shown that regular legume consumption is associated with a lower risk of various chronic diseases, such as cardiovascular disease (Marventano *et al.,* 2017), type 2 diabetes, colorectal cancer (Jin and Je, 2022), non-alcoholic fatty liver disease (Bahrami *et al.,* 2019), and breast cancer (Zargarzadeh *et al.,* 2023).

However, despite these well-documented benefits, global per capita intake of legumes remains insufficient (averaging just 22 grams per person per day), especially in regions such as Central Asia and the Caucasus (Semba *et al.,* 2021). Several barriers contribute to this underconsumption, including cultural dietary preferences, limited awareness of their health benefits, long preparation times, and competition from animal protein sources (Skórska *et al.,* 2021). Furthermore, while soybean is among the most researched pulses due to its industrial applications and unique phytochemical profile, many other legume species remain underutilized and poorly studied, despite offering significant nutritional and agronomic potential.

Legumes have long been a dietary staple in Albania, especially in rural areas where beans, lentils, and chickpeas provided affordable protein. In recent decades, however, diets have shifted toward greater consumption of animal protein and processed foods, reflecting broader Mediterranean and Balkan trends. According to FAOSTAT (2013), Albanians consumed 111.4 g of protein per day, 66.5% from plant sources. Bean intake in 2021 was just 5.05 kg per person per year (Helgi Library, 2021), a notable decline from the past. Despite this, Albania remains a notable producer, harvesting around 24.5 thousand tons of legumes in 2018 (Eurostat). Reviving legume consumption could enhance nutrition, support sustainable agriculture, and preserve traditional food culture, though data on the nutritional and functional properties of local varieties remain limited.

Therefore, this study aims to evaluate the chemical and nutritional composition of selected edible legume species, focusing on their macronutrient and micronutrient profiles, as well as the presence of bioactive compounds with potential health-promoting properties. By comparing the nutritional value and functional properties of different legumes, this research seeks to identify some species with promising dietary potential.

MATERIAL AND METHODS

This study examined eight types of edible legumes: peas (BI), lentils (TH), chickpeas (QA), green beans (MA), soybeans (SO), faba beans (BA), common beans (FA), and okra (BM). For each type, a composite sample (~500 g) was collected from the Tirana Agro-Food Market, selected from different geographical areas of Albania. Samples were transported to the Food Research Center, and prepared according to standard protocols. Each sample was analyzed in triplicate for physicochemical properties, total polyphenol content, and selected vitamins.

Analitic Determination:

Moisture content was determined using the oven-drying method, according to AOAC (1990). A 5 g sample was placed in a thermostat at 105°C. After drying, the sample was transferred to a desiccator, allowed to cool, and then weighed. This process was repeated until a constant weight was achieved.

Total sugar content was determined using the colorimetric method described by DuBois *et al.* (1956). The principle of the method involves dehydration of carbohydrates using concentrated sulfuric acid, resulting in the formation of furfural derivatives. These derivatives react with phenol to produce a distinct color, which is measured using a spectrophotometer at a wavelength of 490 nm. Distilled water was used as the blank.

Fat content was determined using the Soxhlet extraction method, with ether as the solvent. The samples were extracted in the Soxhlet apparatus for 6 to 8 hours, following the procedure according to AOAC (2000).

Protein content was determined using the Kjeldahl method, according to AOAC (1990). A 1.0 g portion of each sample was analyzed. Protein content was calculated using the nitrogen conversion factor: %N × 6.25.

Caloric content of the legume samples was estimated based on the content of protein, carbohydrate, and fat, following the method of Rawat & Darappa (2015).

Determination of Polyphenols

Extraction of Polyphenolic Compounds

The extraction of polyphenolic components from legume samples was performed according to the procedure described by Ivanova *et al.,* (2009). For the preparation of legume extracts, 10 g of each ground sample was extracted twice for 15 minutes using 90 mL of ethanol/water (80:20, v/v) containing HCl (0.1/10, v/v) to prevent polyphenol oxidation. The extraction was carried out in an ultrasonic bath at room temperature, followed by stirring on a magnetic stirrer for 30 minutes. After centrifugation at 3000 rpm for 10 minutes, the supernatants from both extractions were combined and brought to a final volume of 100 mL with distilled water. The extracts were filtered through a 0.45 µm membrane filter before spectrophotometric determination of the polyphenolic components.

Total Polyphenol Content

Total polyphenol content in the legume extracts was determined using the Folin–Ciocalteu reagent, and absorbance was measured at 765 nm using a Biochrom Libra S22 UV/Vis spectrophotometer, following the method described by Ivanov *et al.*, (2014). Results were expressed as mg/100 gr of gallic acid equivalents (GAE), based on a calibration curve constructed with gallic acid standards in the range of 0.02–0.10 mg.

Determination of Vitamins

Vitamins B_1 and B_2

Thiamine (vitamin B_1) and riboflavin (vitamin B_2) contents were determined spectrophotometrically following the method described by Ifediba and Nwafor (2018). The samples were extracted with deionized water and filtered after heating. Absorbance readings were taken at 261 nm for B_1 and 242 nm for B_2. Vitamin concentrations were calculated using the formula:

Concentration = (A × DF) / E,

where *A* = absorbance, *DF* = dilution factor, and *E* = extinction coefficient (25).

Vitamins C and E

Ascorbic acid (vitamin C) and tocopherol (vitamin E) were determined according to the method described by Saeed et al., (2018). Deionized water was used to extract vitamin C, and acetone was used for vitamin E. Standard solutions (100 µg/mL) of both vitamins and reagents—potassium ferricyanide ($K_3Fe(CN)_6$) and ammonium iron(III) sulfate dodecahydrate ($FeNH_4(SO_4)_2 \cdot 12H_2O$)—were prepared. The pH of the reaction mixture was adjusted to 4, and the absorbance was measured at 743 nm against the test blank, which is prepared in the same steps without adding vitamin C or vitamin E.

RESULTS AND DISCUSSION

Legumes (Leguminosae) are a dominant and important source of food crops for humans, offering both nutritional and health benefits (Watson *et al.,* 2017). They are easy to harvest and store, making them a suitable crop for cultivation in various regions (FAO, 2017).

Physicochemical Parameters of Legumes.

The legume samples included in this study were initially analyzed for several physicochemical parameters, including moisture content, total protein, fat, total sugars, and caloric value. The results are presented in Table 1.

Table 1. Moisture, fat, total sugar, total protein content, and caloric values of legume samples

Sample	Moisture (%)	Fat (%)	Total sugars (g/100 g)	Protein (g/100 g)	Calories (kcal)
Ba	11.68 ± 0.3 [a]	0.96 ± 0.03	15.36 ± 0.09	22.8 ± 0.7	161.36 ± 0.5
Fa	11.05 ± 0.1	0.97 ± 0.04	35.32 ± 0.06	19.7 ± 0.1	228.97 ± 0.1
Qa	7.43 ± 0.3	5.11 ± 0.01	24.19 ± 0.12	21.1 ± 0.3	226.96 ± 0.3
So	8.35 ± 0.3	18.00 ± 0.99	24.15 ± 0.05	34.1 ± 0.9	394.92 ± 0.4
Th	4.08 ± 0.2	0.65 ± 0.07	15.30 ± 0.05	24.1 ± 0.2	163.28 ± 0.1
Bi	71.04 ± 0.5	2.14 ± 0.00	31.79 ± 0.07	7.8 ± 0.2	177.45 ± 0.5
Bm	85.55 ± 0.8	0.20 ± 0.00	22.09 ± 0.10	3.6 ± 0.03	104.74 ± 0.8
Ma	88.49 ± 1.9	0.21 ± 0.00	25.04 ± 0.20	2.6 ± 0.01	112.31 ± 0.6

a – Mean ± Stdev

The data in the table show that moisture content among legume samples ranged from 4.08% to 88.49%. Notably, the first five samples (Ba, Fa, Qa, So, and Th) exhibited significantly lower moisture levels compared to the remaining three (Bm, Bi and Ma), which can be attributed to the fact that the first group consists of dry legumes, while okra, peas, and green beans were analyzed in their fresh form. The determination of moisture content is important, as studies by Altuntas & Demirtola (2007) have shown that moisture levels significantly influence other physico-mechanical properties of legumes such as mass, shape, and density.

Fat content among the samples varied from 0.2% to 18%. Samples Ba, Fa, Th, Bm, and Ma showed very low fat levels, below 1%, whereas samples Qa and Bi presented slightly higher fat content. Soybean (So) exhibited the highest fat concentration at 18%, consistent with values reported by Costa *et al.,* (2006).

Regarding total sugars, the highest values were observed in common beans (Fa) and peas (Bi), exceeding 30 g/100 g. These results are somewhat lower than those reported in previous studies by

Munthali *et al.,* (2022) and Rivera *et al.,* (2013). According to Rivera *et al.,* (2013) the sugar composition of beans can be influenced by genotype, soil composition, and cultivation period.

The protein content in legumes generally ranges from 17% to 40%, and is almost at the levels of meat protein content (18-25%) (Genovese & Lajolo, 2001). In this study, the highest protein levels were found in Fa, Ba, Qa, So, and Th samples. In contrast, the fresh legumes (Bi, Ma, and Bm) showed much lower protein content, ranging between 2.6 and 7.8 g/100 g.

Caloric values ranged from 104.74 to 394.92 kcal across the samples. The highest energy value was observed in soybean (So), while the lowest was recorded in fresh okra (Bm) and green beans (Ma).

Total Polyphenol Content

Polyphenols are the dominant bioactive compounds with multiple biological activities found in various legume cultivars. Phenolic acids, flavonoids, and proanthocyanidins are the main types of polyphenols present in common legumes, particularly in those with dark or varied pigmentation, which tend to have higher polyphenol concentrations. Several factors, including genotype, environmental conditions, storage, and processing methods, play a critical role in determining the polyphenol content and composition in legumes (Yang *et al.,* 2018).

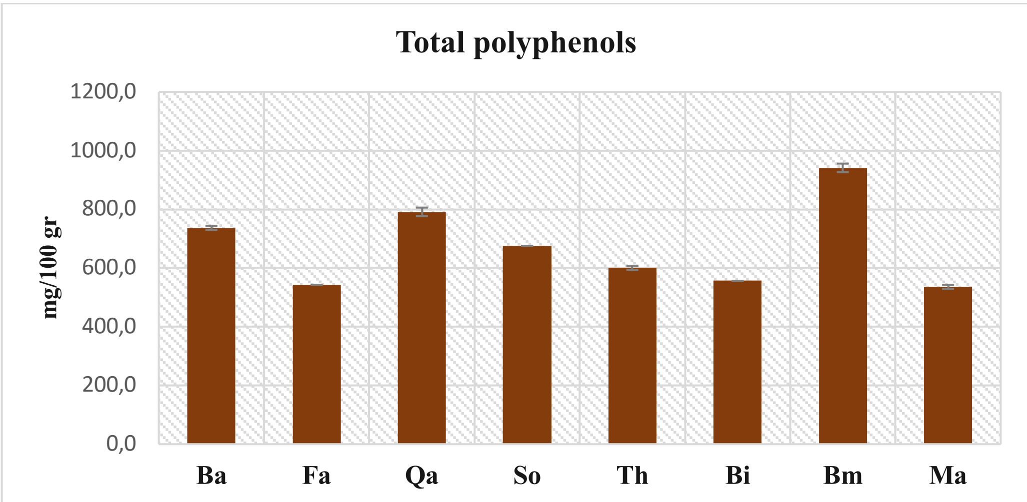

Figure 1. Total polyphenol content in the legume samples analyzed in the study.

As shown in the figure, the highest total polyphenol content (expressed as mg gallic acid equivalents (GAE)/100 g) was observed in the okra sample (Bm), followed by chickpeas (Qa) and faba beans (Ba). The remaining samples exhibited relatively similar polyphenol levels, with no significant differences among them.

Vitamin Content in Legumes

Nutrients such as vitamins and minerals are essential for the proper functioning of the human body. The requirement for these elements depends on metabolic activity as well as the life cycle of an individual (Akram *et al.,* 2020).

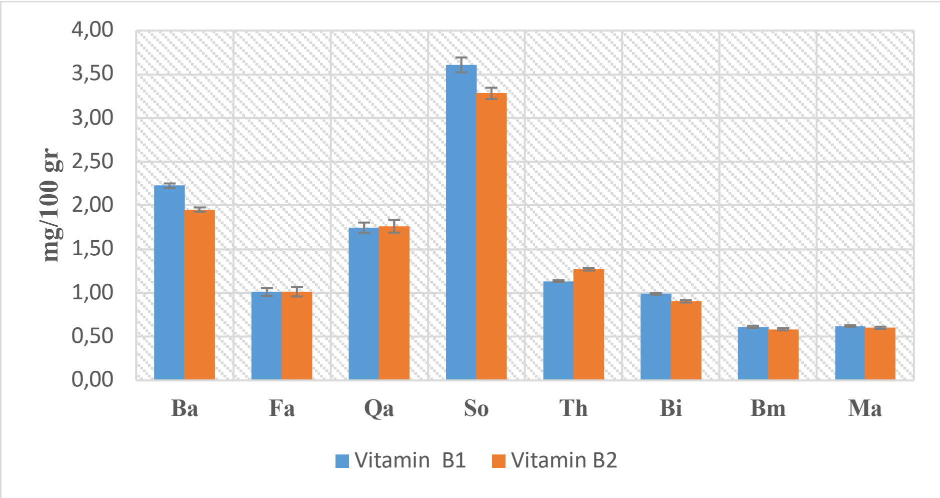

Figure 2. Vitamin B_1 and B_2 content in the legumes analyzed in the study.

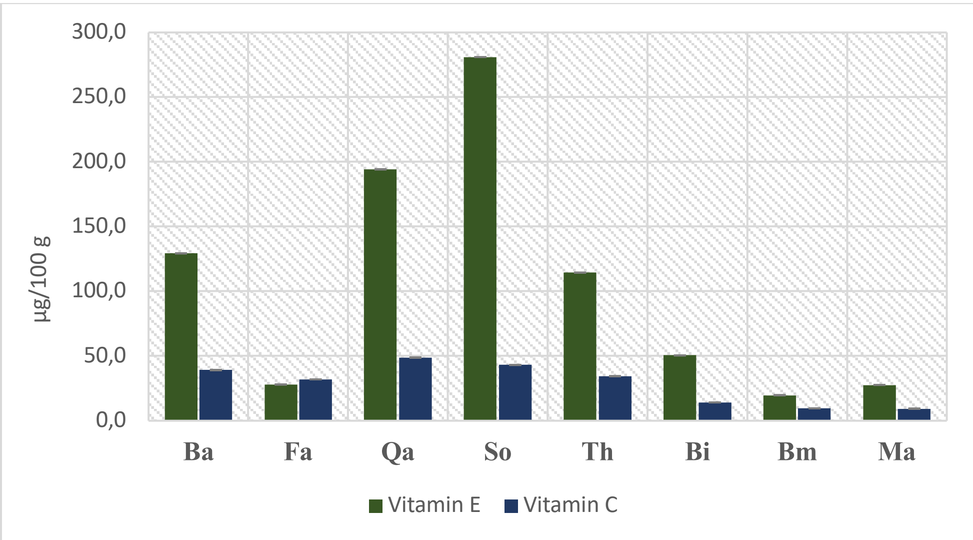

Figure 3. Vitamin E and C content in the legumes analyzed in the study.

As shown in the figures above, the content of vitamin B1 is ranged from 0.61 to 3.61 mg/100 g. The soybean (So) and faba bean (Ba) samples showed the highest levels compared to the other samples analyzed in this study. The content of vitamin B2 ranges from 0.59 to 3.28 mg/100 g, with the soybean (So) sample again standing out for its higher value. Regarding vitamin E, the soybean (So) and chickpea (Qa) samples showed the highest content, expressed in µg/100 g. The content of vitamin C in the analyzed samples ranges from 9.3 to 48.8 µg/100 g, which is slightly lower than the values reported in the study by Moriyama and Oba (2008). This variation can be attributed to several factors, as the vitamin

C content in legumes can naturally vary depending on the cultivar, soil quality, climatic conditions, and the stage of maturity at the time of harvest. Furthermore, vitamin C is a highly unstable compound, with its levels decreasing over time, particularly when exposed to heat, light, or oxygen. Therefore, the time and storage conditions under which the legumes remained on the market prior to analysis may have significantly contributed to the reduced vitamin C content observed in this study.

CONCLUSIONS

This study evaluated the chemical and nutritional composition of eight species of legumes commonly consumed in the Albanian diet. The results showed that dried legumes (beans, lentils, chickpeas, soybeans and kidney beans) presented significantly higher nutritional values in terms of protein, calorie content and bioactive compounds compared to fresh legumes (okra, peas and green beans). Among the species analyzed, soybean stands out for its high protein, fat and vitamin content; chickpeas and beans for their favorable vitamin profile; and okra for its high concentration of polyphenols.

These results confirmed that legumes make a valuable contribution to a balanced diet, especially for those seeking plant-based protein sources. Promoting their consumption could help improve dietary patterns and promote sustainable eating patterns in Albania and other countries. Further studies focusing on variety selection and processing methods to maximize their nutritional and functional potential are recommended.

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