

## **Study of the nutritional value of seeds and leaves of some quinoa cultivars *Chenopodium Quinoa Willd***

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### Abstract

The aim of this study is knowing some of the chemical properties of four quinoa plant varieties (white, red, black and V2). Where we focused on the chemical and nutritional compositions of the quinoa plant, and the changes are represented in the elements of nutritional value (compounds of primary metabolism, secondary metabolism and mineral content). In addition to determining electrical conductivity and acidity (pH). The results showed that white quinoa seeds are characterized by a high content of proteins compared to the other three varieties. The fat and carbohydrate content were better in red quinoa followed by black quinoa while V2 variety was the lowest content. Regarding the value of the mineral content, the content was somewhat weak for the four studied varieties, within the range of 3.5%. The results of the study on the leaves show that the mineral content is high in the range of 35%. Whereas the highest protein content was found in black quinoa leaves. The content of carbohydrates and fats was relatively high for the white quinoa, followed by the red quinoa. All of this is due to genetic factors related to the quality of seeds, plant morphology, the extent of their adaptation and tolerance to various stresses and the various influences of climatic factors.

Keywords: Quinoa, nutritional value, seeds, leaves

### **INTRODUCTION**

Global climate change affects agricultural crops and poses a threat to global food security. Demographic growth further worsens the situation by degrading agricultural lands, especially those used for widely consumed crops like wheat.

Therefore, it is crucial to explore alternatives to meet the demand for such crops. Quinoa, a pseudocereal, stands out due to its nutritional properties. It is adaptable to various environments, including marginal and saline soils. The Quinoa genus comprises approximately 250 species. Originally cultivated in the Andes Mountains, it has been a primary food source for the Inca tribes for over 5000 years. Quinoa is suitable for cultivation in diverse environments, even saline soils, and requires less water compared to wheat. It is highly valued for its nutrition, water efficiency, productivity, and its role in improving living standards and reducing poverty. We conducted a study to assess the nutritional value of some quinoa varieties, ( white, black, red, and v2.) grown in the Valley region, Algeria.

### **Plant matter**

The study was carried out on four (04) varieties of quinoa plant, which were obtained from the laboratory of biology, health and environment at the University of elchahid Hamma Lakhdar. The seeds were planted in area El oued to obtain leaves in order to study the nutritional and medicinal value. Figure 1 shows the seeds and leaves powder of the cultivars used.

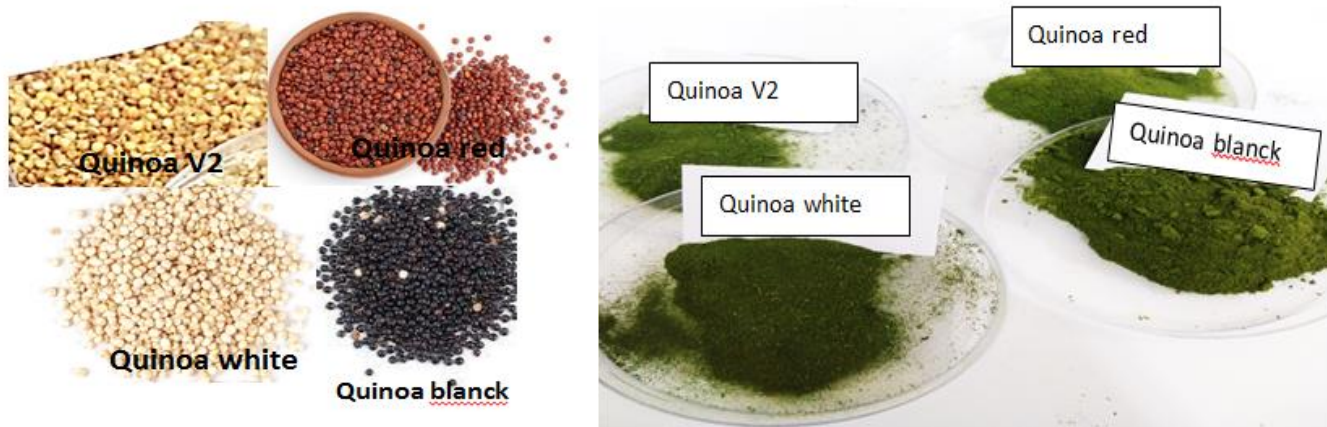


Figure 1 Seeds and leaf powder of the four studied quinoa varieties

### **1- pH and electrical conductivity determine**

The pH and electrical conductivity of the samples were determined using the methods of Marx (1999) and Jones (2001), respectively. The following steps were followed:

5g of each sample was combined with 25ml of distilled water in a 50ml beaker.

The mixture was stirred using a magnetic mixer for 10 minutes.

10ml of the filtered solution was transferred to a graduated glass beaker.

The pH of the extract was measured at 25°C using a pH meter, and the electrical conductivity was measured using a conductivity meter.

### **2 - Content Ash:**

Samples of the four quinoa plant varieties (seeds and leaves) weighing 1g each were placed in numbered glass bottles of known weight. They were then subjected to a temperature of 500 degrees for 6 hours in muffle ovens. Afterward, the ash was weighed to estimate the amount of organic and mineral matter. This process allows us to determine the content of both mineral and organic matter in the studied samples.

### **3- Determination of food content**

#### **1-3 Extracts Preparation**

Extraction of primary metabolic products Primary metabolite products were extracted according to Shibko, (1966) method which is based on 20% TCA use As described Ghamam A. et al. (2017).

#### **2-2 Quantification of Proteins**

The amount of proteins found in the fruits of different Quinoa varieties was estimated by Lowry, (1951), using BSA as a standard protein.(  $y = 0.0001x + 0.0722$ ,  $R^2 = 0.9665$ )

#### **2-3 Quantification of carbohydrates**

The method (Dubois 1956) was used to estimate the total sugar content in Quinoa varieties. As applied by Ghemam A. et al. (2017). This method relies on concentrated sulfuric acid, and glucose served as a standard solution to determine the sugar levels.(  $y = 0.0104x$  ,  $R^2 = 0.9866$ ).

#### **2- 4 total content of fat**

The sinter content in Quinoa varieties was estimated using the method (Goldsworthy et al., 1972). Followed by Amara et al.,(2017) This method involved using the Sulphosphovanilique detector and soybean oil as a standard solution. A standard curve was generated using the soybean oil, and based on that, the sludge content in the Quinoa varieties was estimated.(  $y = 0.0004x + 0.1438$   $R^2 = 0.9684$ ).

## RESULTS AND DISCUSSION

### 1- Results of acidity(pH )

The pH of the samples was measured using Marx's method (1999) as described by Muhammad et al. (2009). The acidity in the previous extract was measured at a temperature of 25°C using a pH meter. The results from Table (1) show that the pH values for the mentioned quinoa varieties (red, black, and white) are close, ranging around 6.77. The V2 quinoa variety has slightly higher acidity with a pH of 6.55.

Referring to Table 1, the pH values are similar between the red and black quinoa varieties, estimated at 6.65 and 6.68, respectively. The white quinoa variety had a pH of 6, while the V2 quinoa variety recorded the highest value of 6.83, indicating the lowest acidity among the studied species.

Table 1: Results of pH in leaf and seeds FOUR variety of Quinoa

Quinoa varieties	Temperature (C°)	pH extracts leaf	pH extracts seeds
Quinoa red	<b>24.6</b>	<b>5.65</b>	<b>6.77</b>
Quinoa black	<b>25</b>	<b>5.68</b>	<b>6.76</b>
Quinoa white	<b>24.3</b>	<b>6</b>	<b>6.78</b>
Quinoa orange V2	<b>25.1</b>	<b>6.83</b>	<b>6.55</b>

## 2- Results of Electrical conductivity (EC)

The electrical conductivity of extracts, leaf powder, and seeds of the studied cultivars was measured following Jones' method (2001). The results from Table (2) indicate similar electrical conductivity values among the four cultivars (red, black, white, V2) at the seed level. The highest value was observed in the V2 variety with 4.40 mmho/cm, while the lowest value was recorded in the black variety with 3.57 mmho/cm.

In terms of the leaves, the electrical conductivity varied across the four varieties. The highest value was found in the V2 quinoa variety at 9.15 mmho/cm, followed by the black variety at 7.83 mmho/cm, and the red quinoa variety at 6.90 mmho/cm. The white quinoa variety had the lowest value at 5.84 mmho/cm.

Table 2 Results of electrical conductivity in FOUR variety of Quinoa

Quinoa varieties	Temperature (C°)	EC extracts leaf	EC extracts seeds
Quinoa red	<b>24.6</b>	<b>6.90</b>	<b>3.57</b>
Quinoa black	<b>25</b>	<b>7.83</b>	<b>3.80</b>

Quinoa white	<b>24.3</b>	<b>5.84</b>	<b>4.10</b>
Quinoa orange V2	<b>25.1</b>	<b>9.15</b>	<b>4.40</b>

### **3- Determination of food content**

#### **1-3 Average Ash ratio in leaf and seeds**

The mineral content was quantitatively estimated by measuring the weight percentage of ash after the burning process, which represents the mineral content in the quinoa seeds. The results FIGURE ( 25) indicate that the mineral content in the seeds of the four quinoa varieties is similar. The red quinoa variety had the highest percentage at 3.83%, followed by V2 quinoa at 3.77%, black quinoa at 3.7%, and white quinoa with the lowest percentage at 3.51%.

In contrast, the mineral content in the leaves was significantly higher compared to the seeds. The mineral content in the quinoa varieties (red, V2, and black) was close, ranging from 30.29% to 29.06%. The white quinoa variety had the lowest mineral content at 27.03%.

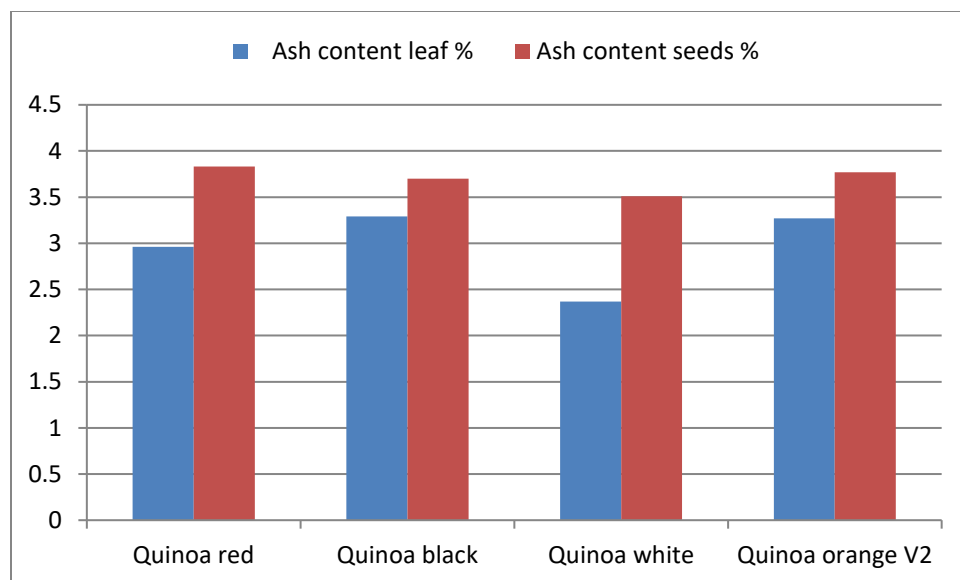


FIGURE 1 Results of Ash ratio in leaf and seeds in FOUR variety of Quinoa.

### 2-3 Total amount of sugars in in leaf and seeds

The total carbohydrate content was estimated using the method of DUBOIS et al. (1956), which provides accurate quantitative measurements using a standard curve of glucose. Figure 2 displays the results obtained. Among the seed varieties, the red quinoa cultivar exhibited the highest carbohydrate percentage at 66%, surpassing the others (white, black, and V2) with percentages of 52.70%, 48%, and 47% respectively, which had similar sugar content. In terms of leaves, the white quinoa variety had the highest carbohydrate percentage at 34.86%, while the red, V2, and black varieties had similar content at rates of 27.69%, 27%, and 24.43% respectively.

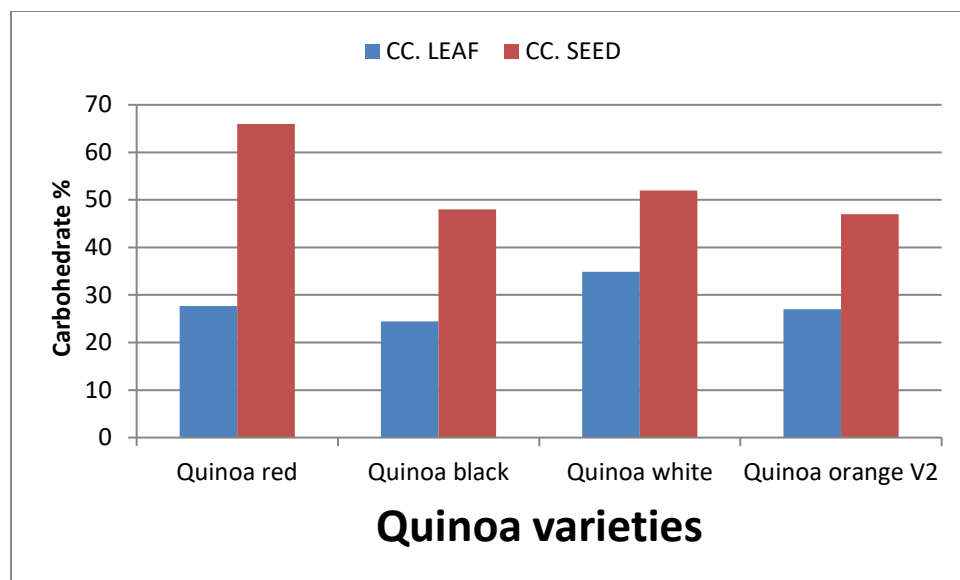


FIGURE 2 Results of sugars in leaf and seeds in FOUR variety of Quinoa

### 3-3 Protein content in leaf and seeds

Protein content was quantitatively estimated using the method of LOWRY et al. (1951), which utilizes a standard curve of bovine serum albumin protein absorption. The results FIGURE (20) indicate variations in protein content among the four quinoa seed varieties. The highest protein content was found in the white quinoa variety at 25.40%, followed by black quinoa at 20.14%, and V2 quinoa at 19.80%. The red quinoa variety exhibited the lowest protein content with an estimated percentage of 18.70%.

Similarly, the protein content in the leaves varied among the four cultivars. The black cultivar had the highest content at 27.41%, followed by red quinoa at 26.15%, and white quinoa at 22.14%. The V2 quinoa cultivar had the lowest percentage of protein content, estimated at 18.70%.

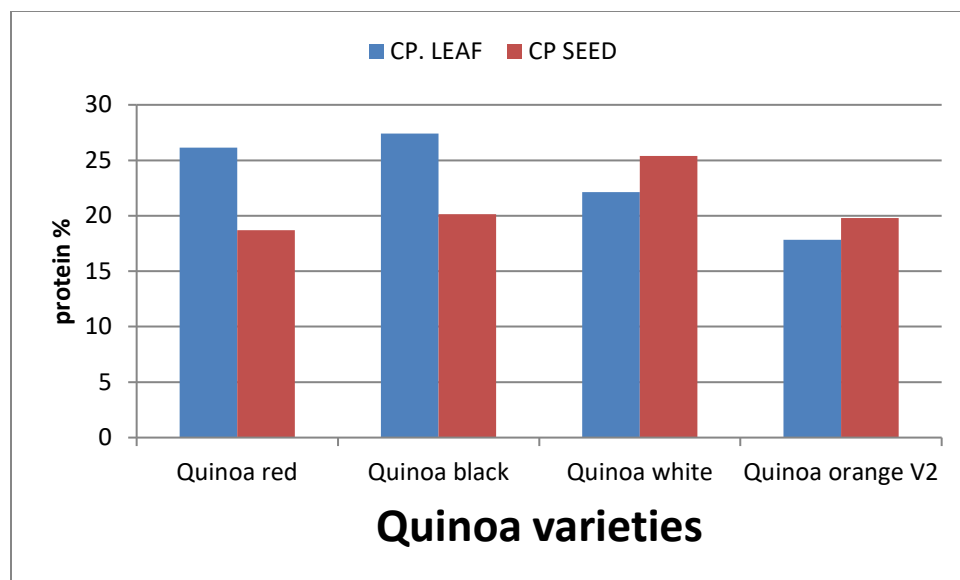


FIGURE 3 Results of Protein in leaf and seeds in FOUR variety of Quinoa

#### 4-3 Quantity of fat in leaf and seeds

The fat content was quantitatively estimated following the method of GOLDSWORTHY et al. (1972), which utilizes a standard curve of soybean oil. The results (document 19) revealed varying percentages of fat content among the four quinoa seed varieties. The highest fat content was observed in the V2 variety at 6.20%, followed by red quinoa at 5.60% and black quinoa at 4.90%. White quinoa seeds had an estimated fat content of 4.50%. At the leaf level, the fat content varied between 3.90% and 4.60%, with black quinoa showing the lowest percentage and the V2 variety exhibiting the highest fat content.

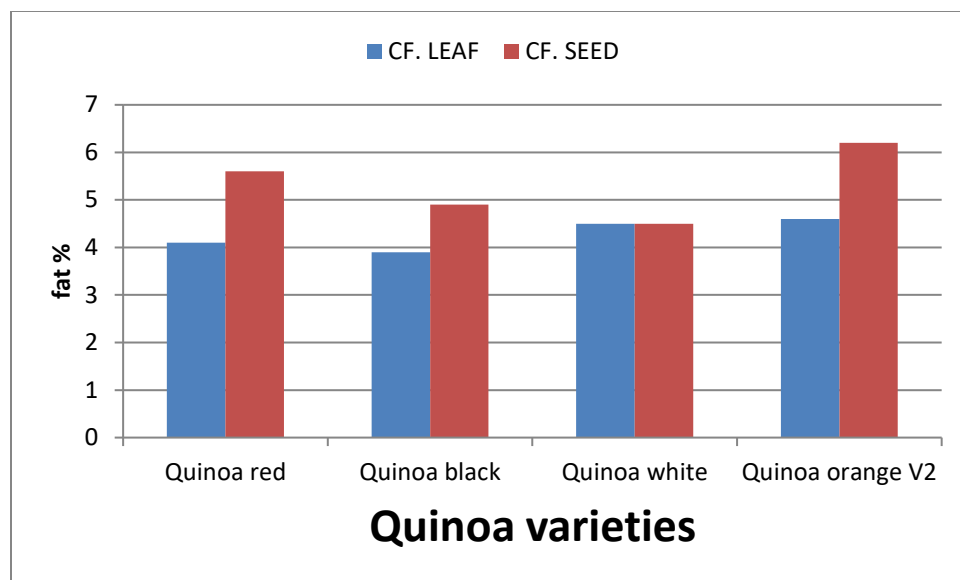


FIGURE 4 Results of Fat in leaf and seeds in FOUR variety of Quinoa

## DISCUSSION

The nutritional value of quinoa seeds was assessed quantitatively for four varieties. The findings indicated no statistical difference in fats and proteins, but a significant difference in carbohydrate percentage. The red quinoa variety had the highest carbohydrate content compared to other varieties. In terms of fats, the V2 quinoa variety had a higher amount than other varieties, while the white quinoa variety had the highest protein percentage.

Regarding the mineral content, the red quinoa variety had the highest percentage, while the white quinoa variety had the lowest.

These results align with previous studies, and the variations may be attributed to genetic differences, resistance to stress, climate changes, and soil characteristics.

Comparing our study with previous ones, the red and white quinoa varieties showed similar carbohydrate content, while the black and V2 varieties had lower percentages compared to other studies. The mineral content in our study was lower

than in previous research. However, the protein content (18% to 25%) was better than one study and similar to another.

These differences can be attributed to genetic variations, plant growth conditions, and different experimental approaches. Climate and cultivation methods also play a role. The dry climate and higher temperature in the el oued region affect the nutritional composition of quinoa.

Considering the nutritional value of the four quinoa varieties, the white variety appears to be the most balanced in terms of primary metabolites and well-adapted to the arid climate of the El oued region.

The nutritional value of the leaves of the quinoa varieties was quantitatively assessed. The findings showed no statistical difference in fats and proteins, but a significant difference in carbohydrate percentage. The leaves of the white quinoa variety had the highest carbohydrate content compared to other varieties, while the V2 variety had a higher fat content and the black quinoa variety had the highest protein percentage.

Regarding the mineral content, the black quinoa variety had the highest percentage in the leaves, while the white quinoa variety had the lowest.

These variations in results can be attributed to genetic differences, resistance to stress, climatic changes, and soil characteristics.

Comparing the results with the seeds of the four varieties, the fat and protein content in both seeds and leaves were similar. The fat content ranged from 4.5% to 6.20% in seeds and from 3.9% to 4.6% in leaves, while the protein content ranged from 18% to 25% in seeds and from 17.84% to 27.41% in leaves.

However, there were differences in carbohydrate and mineral content between the seeds and leaves of the studied varieties. The carbohydrate percentage ranged from 47% to 66% in seeds and from 24.43% to 34.86% in leaves. For the mineral substance, its percentage in seeds ranged from 3.51% to 3.83% and in leaves from 27.03% to 30.29%.

Electrical conductivity and pH measurements were also conducted for the seeds and leaves. The leaves showed higher acidity (5.65 - 6.83) and electrical conductivity (5.84 - 9.15) compared to the seeds, which had acidity between (6.55 - 6.78) and electrical conductivity between (3.57 - 4.40).

The differences in results could be attributed to the plant's exposure to various stresses, which affect its physiology and the production of compounds. The collection, drying, and preservation methods of samples may also contribute to the variations, as external factors like light, heat, and humidity can influence the chemical composition of the plant. Ibrahimi et al. (2008)

### **Conclusion**

Quinoa is valuable for agriculture diversification in regions like el oued Souf due to its ability to produce high-protein grains in harsh environments with high-salinity, sandy, and calcareous soils, and a dry climate.

Quinoa is known for its nutritional properties, making it an interesting food choice. Its proteins are of high quality and nutritional value, with an abundance of lysine, an essential amino acid that contributes to its completeness. It is gluten-free, suitable for individuals with celiac disease or wheat allergies. Moreover, quinoa is a highly nutritious food, rich in natural nutrients, vitamins, dietary fibers, and various minerals.

## REFERENCES

- Ibrahimi, N.S., Hadian, J., Mirjalili, M.H., Sonboli, A., Yousefzadi, M.(2008). Essential Oil Composition And Antibacterial Activity Of *Thymus Caramanicus* At Different Phonological Stages. *Journal Of Food Elsevier Chemistry*, 110, 929
- Amara, D. G., Ferdjani, M., Bokandi, M., Khaled, K., Mohammed, A. M., Ahmed, E., & Mohammad, M. S. (2017). Comparison of the quantitative and chemical characteristics of the three varieties of Peanut (*Arachis hypogaea* L). *Direct Res. J. Agric. Food Sci*, 5, 244-250.
- Ghemam Amara, D., Rebiai, A., Alia, Z., Djihad, S., Kherraz, K., Mesbahi, M. A., ... & Senoussi, M. M. (2019). Effect of some agricultural residues on the characteristics of growth and yield of the onion bulb (*Allium cepa* L).
- Dubois MK, Gilles KA, Hamilton JK, Rebers PA, Smith F (1956). Colorimetric method for determination of sugars and related substances. *Anal.chem.*, 28:350-356.
- Jones J(2001). Laboratory guide for conducting soils test and plant analysis. CRC Press ,Boca Raton Florida,USA.
- Konlan S, Sarkodie AJ, Asare E, Adu-Dapaah H, Kombiok MJ (2013). Groundnut (*Arachis hypogaea* L.) varietal reponse to spacing in the humid forest zone of Ghana. *ARPN Journal of Agricultural and Biological Science*. 8 (9): 642-651.
- Lowry OH, Rosebrough NJ, Farr AL, Randall RJ (1951). Protein measurements with the folin phenol reagent. *J. Biol. Chem.*, 193:265- 275.
- Shibko S, Koivistoinen P, Tratyneck C, New hall A, Freidman L (1966). A method for the sequential quantitative separation and glycogen from a single rat liver homogenate or from a subcellular fraction. *Analyt. Biochem*. 19: 415-428.