Research Article

Cengiz Yürürdurmaz*

Determination of oil composition of cowpea (Vigna unguiculata L.) seeds under influence of organic fertilizer forms

https://doi.org/10.1515/chem-2022-0218
received September 10, 2022; accepted September 21, 2022

Abstract: This research was carried out to determine the effects of different organic fertilizer forms on important quality elements of cowpea (Vigna unguiculata L.) seeds. The experiment was conducted according to the completely randomized blocks experimental design with three replications. In the experiment, palmitic acid (PALA), stearic acid (SA), and behenic acid (BA) from saturated fatty acids and palmitoleic acid (PLA), oleic acid (OA), linoleic acid (LA), and linolenic acid (LNA) ratios from unsaturated fatty acids were investigated. Besides these, quality factor such as oleic acid/linoleic acid (O/L) ratio, which is one of the oil stability values and iodine value (IV), unsaturated fatty acids/saturated fatty acids (USFA/SFA) ratio, and oil ratio and oil yield were investigated. As a result of these applications, the values of crude oil yield 27.08–40.68 kg ha⁻¹ and some important quality properties of crude oil ratios 0.75–1.09%, PLA 0.250–0.372%, OA 12.00–22.85%, LA 22.97–29.97%, LNA 19.37–26.01%, PALA 19.53–23.53%, SA 5.27–7.04%, BA 1.86–2.37%, O/L acid ratio 0.402–1.043%, IV 113.73–136.76, and USFA/SFA ratio 2.08–2.74 were obtained.

Keywords: cowpea, farm manure, fatty acids, leonardite, macro and micronutrients, vermicompost

1 Introduction

The seeds of legumes, which represent an important component of human nutrition in different parts of the world and are a source of food energy, are used as human and animal food to provide calories and protein. In recent years, legumes have been considered as an interesting and balanced food source. In this sense, although soybeans have received the most attention worldwide, peas, dry beans, broad beans, black-eyed peas, vetch, and lentils are also grown and consumed all over the world [1]. Cowpea (Vigna unguiculata L. Walp), one of the important cultivated legumes, provides various agricultural, environmental, and economic advantages by contributing to further improving the diets and incomes of low-income farmers in Africa, Asia, and South America. Botanically classified as belonging to the Dicotyledonae, Fabaceae family, Faboideae subfamily, and the genus Vigna cowpea seeds provide important vitamins and phytounitantic protein, minerals, carbohydrates, and trace elements as well as antioxidants. In addition, it is a cheap, high-quality protein source [2] in the diet of millions of people in developing countries who cannot afford expensive animal protein for a balanced diet, and its green peels and leaves are used as green vegetables, and the dry parts are used as animal feed [3]. In addition to these nutritional uses, cowpea seeds are used in the treatment of persistent boils [4], common cold [5], treatment of swelling and infection, treatment of insect bites, epilepsy, chest pain, constipation, dysmenorrhea [6], diuretic, to strengthen the stomach, to eliminate worms in the stomach [7], to treat amenorrhea [8], to treat urinary cystomyiasis (bilharzia) [9], to treat blood in the urine, and bilharzia [10]. Although cowpea seed is not defined as an oil-containing seed, it can also be used to obtain edible oil. It is reported that the oil content of cowpea grown in different parts of the world is relatively low on average (2.48–3.03%) [2,11]. The chemical composition (amino acid and fatty acid profile, and mineral content) and nutritional value of cowpea seeds, which have almost the same nutritional value as bean seeds, have been the focus of many scientific studies [2,12,13]. However, little is known about the oil content and composition of cowpea seeds. It has been reported that the unsaturated fatty acids in the oil are 60.0–70.7%, the linoleic acid (LA) ratio is

* Corresponding author: Cengiz Yürürdurmaz, Department of Field Crops, Kahramanmaraş Sütçü İzzet University, Faculty of Agriculture, Kahramanmaraş, Türkiye, e-mail: cengiz.yururdurmaz@gmail.com
35.4–41.0\%, the linolenic acid (LNA) ratio is 10.0–23.2\%, and the oleic acid (OA) ratio is 9.5–16.2\% [12–14]. Although the ratio of unsaturated fatty acids to saturated fatty acids varies between 1.80 and 2.21 [14], it has been reported that the palmitic acid (PALA) ratio, which is dominant among saturated fatty acids in cowpea seed oil, is 24.4.

The importance of cowpea seeds in nutrition contains oil, protein, etc., and depends on the availability of quality characteristics. The most important parameters that determine the presence and amount of these quality characteristics are macro and micronutrients. It is known that plant nutrients have important effects on the yield and quality elements of plants at every stage of plant development. One of the most important factors affecting the yield of plants in the regions where they are grown is the beneficial macro and micronutrients in the soil. In cases where these elements are insufficient, the nutrients needed by the plants are met by external fertilization, and plant production is made sustainable [16]. Due to its high nutrient content and ease of availability, mineral fertilizers play an important role in rapidly increasing soil fertility and crop productivity, but this type of fertilization is not the most effective or sufficient, considering the preservation of soil fertility and the preservation of nutrient-rich crops in terms of sustainable agriculture [17–19]. Therefore, this situation increases the demand for the use of alternative organic fertilizers. However, one of the most important factors here is the selection of the right fertilizer form and dose. With these determinations, it is known that organic materials are of great importance in terms of soil fertility and sustainable agriculture. Success in sustainable agriculture largely depends on the availability of cost-effective and high-quality organic fertilizers. These fertilizers not only increase the yield and quality characteristics by providing plant nutrition but also protect soil resources and increase their values [20–23].

As the commercial interest in legume seed oils increased, it became necessary to carry out studies to elucidate the phytochemical components of these oils. As far as is known, no data have been reported on the characterization and composition of oil obtained from the seeds of cowpea cultivars grown under the influence of different fertilizer forms in Turkey. In this context, this study was carried out to determine the effect of different organic fertilizer forms on the quality of cowpea \( (V.\ unguiculata\ L.) \) seed oil, which has not been extensively investigated until now, and to determine the chemical composition of the isolated oil.

### Table 1: Some chemical properties of organic fertilizer used in the experiment

| Organic fertilizers         | Organic matter (%) | Total nitrogen (%) | Total phosphorus \( P_2O_5 \) (%) | EC (dS m\(^{-1}\)) | pH   |
|-----------------------------|--------------------|--------------------|-----------------------------------|-------------------|------|
| Farmyard manure (FM)        | 61.00              | 0.35               | 0.10                              | 2.10              | 7.70 |
| Leonardite (L)              | 55.00              | 1.40               | 0.17                              | 1.30              | 6.00 |
| Vermicompost (V)            | 56.10              | 2.20               | 0.46                              | 3.60              | 6.50 |
than the long-term average (10.3°C) of the same month. It was determined that the temperature values (25.1 and 25.6°C) in June of both years in which the harvesting process was carried out were higher than the long-term average temperature (24.8°C) of the same month. It was determined that the total precipitation in the months of sowing and harvesting was lower than the long-term average, while the total moisture content of the first year of the experiment was found to be slightly higher than the long-term average, and it was found to be low in the second year.

2.2 Characteristics of the trial site soil

Some physical and chemical properties determined as a result of the analysis of soil samples taken from 0–30, 30–60, and 60–90 cm depths of the trial soils are given in Table 2. In the effective soil depth (0–30 cm), it was determined that the saturation of the experimental soils was 85.80%, very slightly alkaline, slightly salty, slightly calcareous, and medium in organic matter. Additionally, the potassium (266.80 mg kg⁻¹) and phosphorus (10.46 mg kg⁻¹) contents of the soils were found to be very rich (Table 2).

| Depth (cm) | Saturation (%) | pH | Salinity (%) | Lime CaCO₃ (%) | Organic matter (%) | K (mg kg⁻¹) | P (mg kg⁻¹) |
|------------|----------------|----|--------------|----------------|-------------------|------------|------------|
| 0–30       | 85.80          | 7.28| 0.30         | 1.00           | 2.08              | 266.80     | 10.46      |
| 30–60      | 86.35          | 7.31| 0.26         | 1.10           | 1.79              | 291.70     | 4.92       |
| 60–90      | 83.60          | 7.30| 0.23         | 2.90           | 123.00            | 293.90     | 3.65       |

(*) Soil analyses were carried out at the Soil Analysis Laboratory of the Eastern Mediterranean Transition Zone Agricultural Research Institute.
2.3 The observed properties

In the study, besides crude oil ratio (COR) and oil yield (OY), unsaturated fatty acids like palmitoleic acid (PLA), OA, LA, and LNA; saturated fatty acids like PALA, SA, and behenic acid (BA); in addition, properties such as oleic/linoleic ratio (O/L), iodine value (IV), and unsaturated fatty acids/saturated fatty acids (USFA/SFA) ratio were studied. The analyses of the fatty acids discussed in the study were carried out according to the methods specified in Anonymous [24].

2.4 Extraction of seed oil

The seeds were ground into flour with a mill and passed through a sieve. The resulting seed sample was extracted with a mixture of n-hexane/2-propanol (3:1, V/V) in a Soxhlet apparatus for 6 h [2].

2.5 O/L acid ratio

It was calculated by dividing the OA ratio by the LA ratio. The ratio obtained as a result of the calculation is expressed as “%” [25].

2.6 IV

It was determined by calculating with the formula below [25]:

\[
IV = (\text{Palmitoleic acid} \times 1.001) + (\text{Oleic acid} \times 0.899) + (\text{Linoleic acid} \times 1.814) + (\text{Linolenic acid} \times 2.737).
\]

2.7 USFA/SFA

It was obtained by dividing the total of unsaturated fatty acids by the sum of saturated fatty acids [26].

2.8 Statistical analysis of data

The seeds obtained as a result of agronomic studies in the field were subjected to laboratory analyses, and a data set was created with the findings obtained from these analyses. In order to reveal the effectiveness of the factors, variance analysis was performed with the Costat (v. 6.03) statistical package program, and the difference between the factors was determined by applying the LSD test at the level of \( \alpha = 0.05 \), which is the least significant difference test. The correlation analysis was performed with the SPSS (v. 23.0) statistical program to reveal the relationship between the examined features.

3 Results and discussion

Scientific evidence has largely shown that apart from the “amount” of fat, the “quality” of fat has a strong impact on consumer health [27]. Therefore, the fatty acid composition plays an important role in evaluating the nutritional quality of oils. The most important factor affecting the fatty acid composition of plants is undoubtedly the environmental and climatic conditions and agricultural practices, apart from the genetic structure. In this context, external supplementation is very important in the presence and deficiency of useful nutrients in the soil. As a result of the variance analysis of some quality parameters observed in cowpea grown in 2020 and 2021, no statistical difference was found between the years. Therefore, the data of the 2 years were combined and subjected to variance analysis again, and the differences between the applications were tried to be revealed. The mean values and LSD groups of COR, OY, and unsaturated fatty acids such as PLA, OA, LA, and LNA are presented in Table 3. The mean values and LSD groups of saturated fatty acids such as PALA, SA, and BA, as well as O/L ratio, IV, and USFA/SFAs ratio are presented in Table 4.

In the analysis of variance, in terms of all the features examined, the differences between the applications were found to be statistically significant at 1 and 5% level. Although the organic fertilizer forms applied in the study were different on the basis of the examined properties, it was seen that they were effective in determining higher values compared to the plots where the chemical fertilizer was applied and the control plots.

3.1 COR

As seen in Table 3, CORs obtained as a result of different fertilizer applications varied between 0.75 and 1.09%. The highest CORs were obtained from L1 and FM4, while the lowest COR was obtained from chemical fertilization treatment. The CORs obtained as a result of the study were found to be largely consistent with the findings (0.60–1.26%) of Gondwe et al. [28]. When Tables 3 and 4
are examined, it is seen that linoleic, linolenic, oleic, and palmitic fatty acids are the dominant fatty acids in the fatty acid composition of cowpea.

### 3.2 COY

As it is known, the OY is a parameter that depends on the oil content of the seeds and the seed yield. The OY here was calculated based on the seed yield previously determined in the study. COYs obtained as a result of the applications of different fertilizer forms in the study varied between 27.08 and 40.68 kg ha\(^{-1}\). The highest COY was obtained from the FM3 treatment, while the lowest COY was obtained from the V2 treatment (Table 3). Toy and Ünlü [29] reported that farmyard manure significantly increased cowpea seed yield compared to control and chemical fertilizer plots. FM3 application of farmyard manure, in which the highest OY was obtained, caused an increase in both seed yield and seed oil ratios compared to other fertilizer forms.

### 3.3 PLA

As seen in Table 2, the ratio of PLA (C16: 1), which is one of the monounsaturated fatty acids, varied between 0.250 and 0.372%, and the highest PLA ratio was observed in the FM2 treatment, while the lowest ratio was obtained

---

**Table 3:** Effects of different fertilizer forms on oil ratio, OY, and observed fatty acid composition of cowpea

| Treatments             | COR (%)* | Crude oil yield (COY) (kg ha\(^{-1}\)) | PLA (%)* | OA (%)* | LA (%)* | LNA (%)* |
|------------------------|----------|--------------------------------------|----------|----------|----------|----------|
| Control                | 0.91     | B–E                                  | 0.286    | B–D      | 17.19    | 26.98    | D        | 23.27    | A–C      |
| Chemical fertilization | 0.75     | G                                    | 0.309    | BC       | 20.58    | AB       | CD       | 21.12    | CD       |
| Vermicompost (V)       | V1 1.00  | A–C                                  | 0.265    | CD       | 20.89    | AB       | E        | 19.37    | D        |
|                        | V2 0.76  | FG                                   | 0.290    | B–D      | 12.49    | CD       | 29.51    | AB       | 25.67    | A        |
|                        | V3 0.83  | E–G                                  | 0.277    | B–D      | 15.41    | B–D      | 28.19    | A–D      | 23.89    | A–C      |
|                        | V4 0.86  | D–G                                  | 0.250    | D        | 19.59    | A–C      | 27.67    | B–D      | 21.05    | CD       |
| Farmyard manure (FM)   | FM1 0.97 | A–D                                  | 0.318    | B        | 12.69    | CD       | 28.38    | A–D      | 25.47    | A        |
|                        | FM2 0.88 | C–F                                  | 0.372    | A        | 12.19    | D        | 29.90    | A        | 26.01    | A        |
|                        | FM3 1.02 | AB                                   | 0.314    | BC       | 12.00    | D        | 29.97    | A        | 25.01    | AB       |
|                        | FM4 1.07 | A                                    | 0.290    | B–D      | 15.38    | B–D      | 28.95    | A–C      | 24.54    | AB       |
| Leonardite (L)         | L1 1.09  | A                                    | 0.271    | B–D      | 22.85    | A        | 27.78    | B–D      | 21.21    | CD       |
|                        | L2 1.03  | AB                                   | 0.315    | BC       | 18.84    | A–D      | 29.04    | A–C      | 22.07    | B–D      |
| CV                     | 7.987    | 11.657                               | 10.103   | 25.363   | 3.955    | 7.621    |

*There is no statistically (P > 0.05) significant difference between the means shown with the same capital and bold letters in the same column.

---

**Table 4:** Effects of different fertilizer forms on observed oil acid composition of cowpea

| Treatments             | PALA (%)* | SA (%)* | BA (%)* | O/L (%)* | IV (g/100 g)* | USFA/SFA ratio (%)* |
|------------------------|-----------|---------|---------|----------|--------------|---------------------|
| Control                | 23.41     | AB      | 5.74    | BC       | 2.12         | A–C                |
| Chemical fertilization | 21.89     | A–C     | 5.82    | BC       | 1.86         | C                   |
| Vermicompost (V)       | V1 19.94  | DE      | 7.04    | A        | 2.22         | AB                  |
|                        | V2 22.93  | A–C     | 5.70    | BC       | 2.32         | A                   |
|                        | V3 23.27  | AB      | 5.95    | BC       | 2.15         | A–C                |
|                        | V4 22.60  | A–C     | 5.78    | BC       | 1.90         | C                   |
| Farmyard manure (FM)   | FM1 23.53 | A       | 6.19    | B        | 2.37         | A                   |
|                        | FM2 22.18 | A–C     | 6.10    | B        | 2.29         | A                   |
|                        | FM3 23.36 | AB      | 6.06    | B        | 2.12         | A–C                |
|                        | FM4 21.39 | CD      | 5.79    | BC       | 2.35         | A                   |
| Leonardite (L)         | L1 19.53  | E       | 5.27    | C        | 1.92         | BC                  |
|                        | L2 21.58  | B–D     | 5.60    | BC       | 1.91         | BC                  |
| CV                     | 4.953     | 6.478   | 8.687   | 2.477    | 2.509        | 6.075               |

*There is no statistically (P > 0.05) significant difference between the means shown with the same capital and bold letters in the same column.
from the V4 application. In a different previous study, it was determined that the rates of PLA were reported as 0.08% in soybean [30]. In studies on the fatty acid composition of cowpea seed oil, PLA was either not found or ignored because it was in trace amounts.

### 3.4 OA

OA (C18: 1) ratio, which is one of the major unsaturated fatty acids of cowpea seed oil, obtained as a result of the applications of different fertilizer forms varied between 12.00 and 22.85% values (Table 3). The highest OA ratio was obtained from the L1 treatment, while the lowest OA ratio was obtained from the FM3 and FM2 applications (Figure 2). In some previous studies, OA was reported as 16.2 ± 1.7 [12], 4.4–16.2 [1], 6.9–10.6 [3], and 9.5–16.2% [14].

### 3.5 LA

In the study, LA (C18: 2), another major polyunsaturated fatty acid in cowpea oil, was found to vary between 22.97 and 29.97% (Table 3). While the highest LAs were obtained from FM3 and FM2, the lowest was obtained from LA and V1 treatments (Figure 2). It was determined that the results of the study were in agreement with the findings (21.7–30.9%) of Antova et al. [3] studying with different genotypes, partially lower than the findings (20.8–40.3%) of Gonçalves et al. [1], and significantly lower than the findings (35.4 ± 0.8%) of Thangadurai [12].

### 3.6 LNA

As seen in Table 3, as a result of different fertilizer applications, LNA (18:3), another major polyunsaturated fatty acid detected in cowpea seed oil, was found to vary between 19.37 and 26.01%. The highest LNA ratio was obtained from FM2, V2, and FM1 treatments, 26.01, 25.67, and 25.47%, respectively, while the lowest LNA ratio was obtained from V1 treatment. As a result of the study, it was determined that the LNA ratios obtained were 9.6–23.1, partially higher than the findings of Gonçalves et al. [1] and quite higher than the findings (10.0 ± 0.3% and 7.3–16.8%) of Antova et al. [3] and Thangadurai [12].

### 3.7 PALA

In the study, it was determined that the ratio of PALA (C16: 0), one of the saturated fatty acids of cowpea seed oil, varied between 19.53 and 23.53% as a result of the application of different fertilizer forms and doses. Under the influence of these applications, the highest PALA ratio was obtained from the FM1 application, while the lowest PALA ratio was obtained from the L1 treatment (Table 4). The results obtained were found to be slightly lower than the values (24.4 ± 2.2%) reported by Thangadurai [12], significantly lower than the highest PALA value (67.1%) reported by Gonçalves et al. [1], and findings (35.1–47.1%) of Antova et al. [3]. It is thought that this lowness is caused by different cowpea varieties, practical applications, and environmental conditions.

### 3.8 SA

As seen in Table 4, the ratio of SA (C18: 0), which is one of the major saturated fatty acids of the applications, varied between 5.27 and 7.04%, and the highest SA ratio was obtained from V1 treatment, while the lowest SA ratio was obtained from the L1 application. In different previous studies, it was determined that the rates of SA were reported as 14.0 ± 0.1 [12], 2.9–14.0 [1], and 5.0–7.6% [3] in accordance with the results of the study.

### 3.9 BA

As seen in Table 4, the ratio of BA (C22: 0) varied between 1.86 and 2.37% as a result of the treatments. The highest rates of BAs were obtained from the FM1, FM4, V2, and FM2 treatments (2.37, 2.35, 2.32, and 2.29%, respectively).
The lowest BAs were obtained from chemical fertilization with 1.86% and V4 treatments with 1.90%. It was seen that the findings obtained as a result of the study were partially compatible with the BA ratio of 0.1–3.0% previously reported by Gonçalves et al. [1].

3.10 O/L ratio

The O/L ratio is a quality index used to determine the stability and bitterness of oil (such as olive oil) [31]. In fact, a high O/L ratio is associated with high stability and low bitterness of the oil. As seen in Table 4, it was determined that the O/L ratios calculated as a result of the treatments varied between 0.402 and 1.043%. The highest O/L ratio was obtained from the V1 treatment, while the lowest O/L ratio was obtained from the FM3, FM2, and V2 treatments (0.402, 0.409, and 0.424%, respectively).

3.11 IV

The IV, also called the iodine number, is a measure of the degree of unsaturation of oil, fat, or wax. That is, it is the amount of iodine in grams taken by 100 g of oil or fat. In the study, it was observed that the IV determined under the influence of different fertilizer forms and doses varied between 113.73 and 136.76 g/100 g (Table 4). While the highest IV was obtained from the FM2 application, the lowest IV was obtained from the V1 treatment with 113.73 g/100 g. These results clarified that the observed cowpea seed oils have higher oxidative stability and protection during storage and processing. These high values are probably due to the high contents of unsaturated fatty acids such as LA and LNAs. It was determined that the IVs obtained in the experiment were partially higher than the IVs reported by Zia-Ul-Haq et al. [2] and Ashraduzzaman et al. [3], and also quite higher than values reported for different cowpea species by Antova et al. [3]. This may be due to different genotypic structures, environmental conditions, and agricultural practice differences.

3.12 USFA/SFA ratio

As seen in Table 4, the USFA/SFA ratios determined as a result of the effect of different fertilizer forms and doses varied between 2.08 and 2.74. The highest US/S ratio was
obtained from the L1 application, while the lowest US/S ratio was obtained from the FM1 application. Islam et al. [14] reported that the ratio of unsaturated fatty acids to saturated fatty acids varies between 1.80 and 2.21 for different cowpea species. It was seen that the results of the study had higher USFA/SFA values than the findings of Antova et al. [3] study on different cowpea cultivars and the rates (0.98–1.59) reported by Gonçalves et al. [1]. In these two studies, it was determined that it contains more saturated fat than the results of this study. This high ratio of USFA/SFA values is nutritionally desirable [1,33].

### 3.13 The relationships among the observed characteristics

The Pearson correlation matrix of the properties examined in the study is given in Table 5. As a result of the analysis, a significant positive correlation was found between PLA and LNA \((r = 0.376^*\)\), SA \((r = 0.404^*\)\), and USFA/SFA R \((r = 0.340^*\)\). An insignificant negative correlation \((r = −0.053)\) was observed between OA and LAs, while a positive correlation was observed between USFA/SFA R \((r = 0.408^*\)\).

In the study, while there were negative significant correlations between LA and LNA \((r = −0.662^{**}\)\), PALA \((r = −0.915^{**}\)\), SA \((r = −0.595^{**}\)\), BA \((r = −0.371^*\)\), O/L \((r = −0.674^{**}\)\), and USFA/SFA R \((r = −0.653^{**}\)\), it was found to have a positive significant correlation with IV \((r = 0.943^{**}\)\). As seen in Table 5, a significant positive correlation was observed between LNA and PALA \((r = 0.767^{**}\)\), SA \((r = 0.458^{**}\)\), and USFA/SFA R \((r = 0.927^{**}\)\), while a negative and significant relationship was found between IV \((r = −0.795^{**}\)\). Positive significant correlations were observed between PALA and SA \((r = 0.618^{**}\)\), O/L ratio \((r = 0.684^{**}\)\), and USFA/SFA R \((r = 0.866^{**}\)\), while a negative significant relationship was determined between IV \((r = −0.890^*\)\). When Table 5 is examined, there are negative and strong correlations between SA and IV \((r = −0.539^{**}\)\), while a positive and strong correlation is observed between USFA/SFA R \((r = 0.504^{**}\)\). A positive and significant correlation was found between BA and O/L ratio \((r = 0.368^*\)\), while a significant negative correlation was found between USFA/SFA R \((r = −0.409^*\)\). In the study, the O/L ratio had a negative and strong correlation with IV \((r = −0.527^{**}\)\), while it had a positive and significant correlation with USFA/SFA R \((r = 0.399^*\)\). In addition, it was observed that there was a strong negative correlation between IV and USFA/SFA R \((r = −0.741^{**}\)\) (Table 5).

### 4 Conclusion

As a result of different fertilizer applications \((V.\ unguiculata\ L.)\), seed oils exhibited similar chemical compositions. Although the oil content \((0.75–1.09\%\) obtained as a result of these applications is quite low, cowpea seed oils have a relatively high content of biologically active compounds. As a result of the study, it was observed that the applied fertilizer forms and doses had significantly different effects on the fatty acid composition of cowpea seeds and it was determined that palmitic, linoleic, linolenic, and oleic fatty acids were the dominant fatty acids. Compared to other widely consumed legumes (beans, lentils, peas, soybeans, etc.), cowpea seeds are an alternative food source for the Turkish population now and in the future. It is thought that this study will provide a database for this product, which has not been extensively researched until now.

**Acknowledgment:** There is no acknowledgement for this article.

**Funding information:** There is no funding for this article.

**Conflicts of interest:** The author declares no conflict of interest.

**Ethical approval:** Ethical approval is not required, as the study was not performed in vivo.

**Data availability statement:** The processed data necessary to reproduce these findings are available upon request with permission.

### References

[1] Gonçalves A, Goufo P, Barros A, Domínguez-Perles R, Trindade H, Rosa EA, et al. Cowpea \((Vigna unguiculata\ L.\) Walp), a renewed multipurpose crop for a more sustainable agri-food system: nutritional advantages and constraints. J Sci Food Agric. 2016;96(9):2941–51. doi: 10.1002/jfsa.7644.

[2] Zia-ul-Haq M, Ahmad S, Chiavaro E, Ahmed S. Studies of oil from cowpea \((Vigna unguiculata\ L.)\) Walp.) cultivars commonly grown in Pakistan. Pak J Bot. 2010;42(2):1333.

[3] Antova GA, Stoiilova TD, Ivanova MM. Proximate and lipid composition of cowpea \((Vigna unguiculata\ L.)\) cultivated in Bulgaria. J Food Compost Anal. 2014;33(2):146–52. doi: 10.1016/j.jfca.2013.12.005

[4] Duke JA. Introduction to food legumes. In: S.R. Singh, editor.Insect pests of tropical food legumes. Chichester, UK: John Wiley and Sons; 1990.
Oil composition of cowpea seeds under influence of organic fertilizer forms

[5] Siddhuraju P, Becker K. The antioxidant and free radical scavenging activities of processed cowpea (Vigna unguiculata (L.) Walp.) seed extracts. Food Chem. 2007;101(1):10-9. doi: 10.1016/j.foodchem.2006.01.004

[6] Brink M, Belay G. Plant resources of tropical Africa, cereals and pulses. CTA Wageningen, Netherlands: Backhuys Publishers, CTA. Vol. 1; 2006. p. 298.

[7] Chopra RN, Nayar SL, Chopra IC. Glossary of Indian medicinal plants (including the supplement). New Delhi, India: Council of Scientific and Industrial Research; 1986.

[8] Vanwyk BE, Gericke N. People's plants: a guide to useful plants of Southern Africa. Pretoria, South Africa: Briza Publications; 2000. p. 192.

[9] Ndamb A, Nyazema N, Makaza N, Anderson C, Kaondera K. Traditional herbal remedies used for the treatment of urinary schistosomiasis in Zimbabwe. J Ethnopharmacol. 1994;42(2):125-32. doi: 10.1016/0378-8741(94)90106-6

[10] Kritzinger Q, Lall N, Aveling TAS, van Wyk BE. Antimicrobial activity of cowpea (Vigna unguiculata) leaf extracts. S Afr J Bot. 2005;71(1):45-8. doi: 10.1016/S0254-6299(15)30147-2

[11] Onwuliri VA, Obu JA. Lipids and other constituents of Vigna unguiculata and Phaseolus vulgaris grown in northern Nigeria. Food Chem. 2002;78(1):1-7. doi: 10.1016/S0308-8146(00)00293-4

[12] Thangadurai D. Chemical composition and nutritional potential of Vigna unguiculata ssp. cylindrica (Fabaceae). J Food Biochem. 2005;29(1):88-98. doi: 10.1111/j.1745-4514.2005.00014.x

[13] Frota KdMG, Soares RAM, Arêas JAG. Chemical composition of cowpea (Vigna unguiculata L. Walp.). BRS-Milênio cultivar. Food Sci Technol. 2008;28:470-6. doi: 10.1590/S0101-20612008000200031

[14] Islam S, Carmen R, Garner Jr J. Physiological and biochemical variations in seed germination of cowpea (Vigna unguiculata L. Walp) cultivars. Am J Pl Physiol. 2010;5(1):22-30.

[15] Ukhnun MA. Fatty acid composition and oxidation of cowpea (Vigna unguiculata) flour lipid. Food Chem. 1984;14(1);35-43. doi: 10.1016/0308-8146(84)90016-5

[16] Gulshan AB, Saeed HM, Javid S, Meryem T, Atta MI, Amin-Din M. Effects of animal manure on the growth and development of okra (Abelmoschus esculentus L.). J Agric Biol Sci. 2013;8(3):213-9.

[17] Liu X, Zhang Y, Han W, Tang A, Shen J, Cui Z, et al. Enhanced nitrogen deposition over China. Nature. 2013;494(7438):459-62. doi: 10.1038/nature11917

[18] Sánchez-Navarro V, Zornoza R, Faz A, Fernández JA. Cowpea crop response to mineral and organic fertilization in SE Spain. Processes. 2021;9(5):822. doi: 10.3390/pr9050822

[19] Zhang W, Wang X, Xu M, Huang S, Liu H, Peng C. Soil organic carbon dynamics under long-term fertilizations in arable land of northern China. Biogeosciences. 2010;7(2):409-25. doi: 10.5194/bg-7-409-2010

[20] Maduwwe D, Christo I, Onuh M. Effects of organic manure and cowpea (Vigna unguiculata (L.) Walp) varieties on the chemical properties of the soil and root nodulation. Sci World J. 2008;3(1):43-6. doi: 10.4316/swj.v3i1.51772

[21] Kaya A, Coşkun N. Effect of organic fertilizer forms and doses on the seed germination and seedling development of rape-seed (Brassica napus L.). Appl Ecol Environ Res. 2020;18(5):6813-8. doi: 10.15666/aer/1805_68136828

[22] Çirka M, Altunor F, Eryiğit T, Oral E, Bildirici N. Effects of vermicompost applications on some yield and yield properties of wheat. MAS J Appl Sci. 2022;7(1):146-56. doi: 10.52520/masjaps.213

[23] Çirka M, Tunçtürk R, Kulaz H, Tunçtürk M, Eryiğit T, Baran İ. Investigation of the effects of rhizobacteria and algae applications on plant growth in broad bean (Vicia faba L.) plant grown under drought stress. J Inst Sci Tech (JIST). 2022;12(2):1124-33. doi: 10.21597/jist.1076428

[24] Anonymous. Fatty acid composition of vegetable oils determined by gas–liquid chromatography (in Turkish); 2022. https://www.resmigazete.gov.tr/eskiler/2012/04/20120412-7-1.pdf (Access date: 20 May 2022).

[25] Kaya AR. Determination of important quality properties of some soybean (Glycine max. (L.) Merrill) varieties grown as main products KSU. J Agric Nat. 2020;23(4):1012-20. doi: 10.18016/ksutaramdoga.vi.69990

[26] Kaya AR, Eryiğit T. A research on determination of important quality properties of some oilseed sunflower (Helianthus annuus L.) cultivars. J Inst Sci Tech (JIST). 2020;10(3);2143-52. doi: 10.21597/jist.699619

[27] Aranceta J, Pérez C, Mataix J. Ingestas dietéticas de referencia, objetivos nutricionales y guíasalimentarias. Blanco de los Omega. 2013;3:83-103.

[28] Gondwe TM, Alamu EO, Mdziniso P, Maziya-Dixon B. Cowpea (Vigna unguiculata (L.) Walp) for food security: an evaluation of end-user traits of improved varieties in Swaziland. Sci Rep. 2019;9(1):1-6. doi: 10.1038/s41598-019-52360-w

[29] Toy D, Ünlü H. Determination of the effect of farm and green manure utilization on yield and quality in green and dry cowpea. SDU J Nat Appl Sci. 2015;10(2):110-7.

[30] Rueda A, Seiquer I, Ollala M, Giménez R, Lara L, Cabrera-Vique C. Characterization of fatty acid profile of argan oil and other edible vegetable oils by gas chromatography and discriminant analysis. J Chem. 2014;2014:843908. doi: 10.1155/2014/843908

[31] León L, De la Rosa R, Gracia A, Barranco D,Ralio L. Fatty acid composition of advanced olive selections obtained by cross breeding. J Sci Food Agric. 2008;88(11):1921-6. doi: 10.1002/jsfa.3296

[32] Ashraduzzaman M, Alam MA, Khatun S, Bari L, Absar N. Extraction and characterization of cowpea (Vigna unguiculata (L.) Walp) seed oil. J Sci Technol. 2013;3(2):431-8.

[33] Oluwatosin OB. Genetic and environmental variability in starch, fatty acids and mineral nutrients composition in cowpea (Vigna unguiculata (L.) Walp). J Sci Food Agric. 1998;78(1):1-11. doi: 10.1002/(SICI)1097-0010(199809)/78:1<1:AID-JSF447>3.0.CO;2-H