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Evaluation of Morphological Characteristics and Fatty Acid Compositions of Some Local Varieties of Oil Flax

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ABSTRACT

Oil flax (*Linum usitatissimum* L.) is a valuable agricultural crop with potential uses in industries including oil production, nutrition, and **medicine. It has a good reputation in Afghanistan as an oil crop. The objective of the current research was to compare the most significant morphological parameters and fatty acid compositions of some local oilflax. The study used a randomized complete block design and was conducted on the research and experimental farm of Parwan University's (REFPU) Faculty of Agriculture in Parwan, Afghanistan, during the 2022 growing season. In this experiment, four seed samples from various regions of Afghanistan [Parwan (V1), Badakhshan (V2), Baghlan (V3), and Kunduz (V4)] were used. The results showed no significant difference between the local varieties on all growth parameters except for the number of seeds per capsule (NSC) and the weight of a thousand seeds (WTS). The maximum NSC was significantly observed in the V1 (10.8), followed by the V3 (7.13) and the V4 (7.33), and the lowest was recorded in the V2 (6.7). The heaviest WTS were significantly produced by V1 (9 gr) compared to V2 (4.67 gr), V3 (5.67 gr), and V4 (4.67 gr). Also, there was not a noticeable difference in the concentration of linoleic acid (LA) and linolenic acid (LLA) between the varieties. Each of the studied local varieties can be used because of their similar performance.**

Keywords- Morphological characteristic, Fatty acid, Variety, Oil flax.

I. INTRODUCTION

The preparation of vegetable oils from oilseeds, that their byproducts are utilized for various industrial, nutrition, and medicine purposes, is one of the basic requirements of society's growth process in the field of agricultural products. Oil flax can make an important contribution in this respect as an industrial crop (Pali and Mehta, 2014). About 1% of the world's oilseed supply comes from flax (Smith and Jimmerson, 2005). Several Investigations on oil flax have found various amounts of oil, ranging from 23.28 to 53%, and 20–25% protein, and additionally, it contains the majority of the vitamins and minerals, depending on the cultivars and climatic regions (Choo et al., 2007; Iran-Nejad and Poshtkoohi, 2009; Janakinath, Bhima, and Uma, 2017). Flaxseed is rich in essential omega-3 fatty acids, especially LLA. Omega-3 fatty acids are beneficial in managing and avoiding long-term illnesses such as type 2 diabetes, kidney illness, high blood pressure, heart disease, Alzheimer's disease, and some types of cancer (Katare et al. 2012).

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Flax is widely cultivated in different regions of Afghanistan using traditional methods. This crop is cultivated extensively in this country, on an area of approximately 38,323 hectares. But according to reports, productivity is only 1.43 tons per hectare on average (Department of Statistics, 2020), which is quite low when compared to other countries. The findings of Sileshi et al. (2019) indicate that the yield and development of flax are significantly influenced by the selection of varieties that are appropriate for the region's climatic conditions. In a research study, Sarkees and Mahmood (2018) discovered that the Thorshansity-72 variety of flax performed better on all parameters than the local varieties. Moknatjou et al. (2002), in an investigation, used gas chromatography (GC) to determine the kinds and concentrations of fatty acids in flax oil. They have found significant differences in the levels of each fatty acid between varieties.

Unfortunately, despite the importance of oil flax, no feasible or effective research has been done on it, and yet, there is still no information obtainable about the flax seed's quality in Afghanistan, especially in the Parwan province. On the other hand, the main cause of the loss in yield could be the lack of varieties suitable for the climate of the area. Therefore, any research in this area seems to be beneficial. It was important to do this research even though there were fewer sources of information about flax. On this note, finding a high-yielding variety with higher quality is the objective of the current research that has been conducted.

II. MATERIALS AND METHODS

The current investigation was conducted on the research and experimental farm of Parwan University's (REFPU) in Parwan, Afghanistan, in a randomized complete block design (RCBD), in 12 plots (2x3 m) with 3 replications, during the growing season of 2022 (March–June). The objective of the current study was to compare the varieties yield performance using the most significant morphological parameters and fatty acid compositions of some oil flax (*Linum usitatissimum* L.). In the current investigation, four seed samples from various regions of Afghanistan [Parwan (V1), Badakhshan (V2), Baghlan (V3), and Kunduz (V4)] are used. The Ministry of Agriculture, Irrigation, and Livestock's (MAIL) Gene Bank was the source of all the seeds. V1 was the only seeds sample with a dark brown color, whereas the others were all light brown in color.

Table 1: Description of the experimental site (2022)

Criteria	Indicators
Climate type	Subtropical (Simi-arid)
Altitude above sea level	2252.05 m
Mean annual precipitation	100-150 mm
Soil texture	Sandy loam
Soil type	Calcareous mountain soil
Soil pH	7.69
OM	2.3 %
EC	0.12 Mmhos/cm
$CaCO_3$	5.5 %

Source: Laboratory of Soil Analysis, Directorate of Soil Science, MAIL.

The seeds were sown at a depth of 2-3 cm, and then the field was lightly covered with soil. The spacing used was 25 cm between rows and 15 cm within rows. Likewise, 100 kg of urea per hectare was applied in two equal doses: half during sowing and the other half at the flowering stage. (Sarkees & Mahmood, 2018). In addition, 80 kg of phosphorus (P) per hectare were utilized during cultivation in the form of di-ammonium phosphate (45% P2O5), and all agricultural practices were carried out in accordance with the requirements of the plant. When the seed capsules had begun to turn brown, the oil flax plants were harvested. Ten plants were randomly selected from the four central rows to collect data. At 67 days after sowing (DAS), the main stem length was measured from the soil's surface to the top of the plants using ruler measurement. For eight consecutive weeks, the number of branches on the selected plants was periodically counted. The number of capsules on selected plants was counted to determine how many capsules existed per plant. The seeds were then manually pulled from the capsules, and the weight of each thousand seeds was recorded. At the end, gas chromatography (GC) was used to determine the fatty acid concentrations. (Andruszczak et al. 2015; Zhang et al. 2011; Ranjzad et al. 2008; Iran-Nejad et al. 2009; Pali and Mehta 2014; Choo et al. 2007). The obtained results were statistically analyzed using SPSS 2016 in accordance with the ANOVA technique, and mean separations were calculated using the Least Significant Difference (LSD) at the 5% probability level.

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III. RESULT AND DISCUSSION

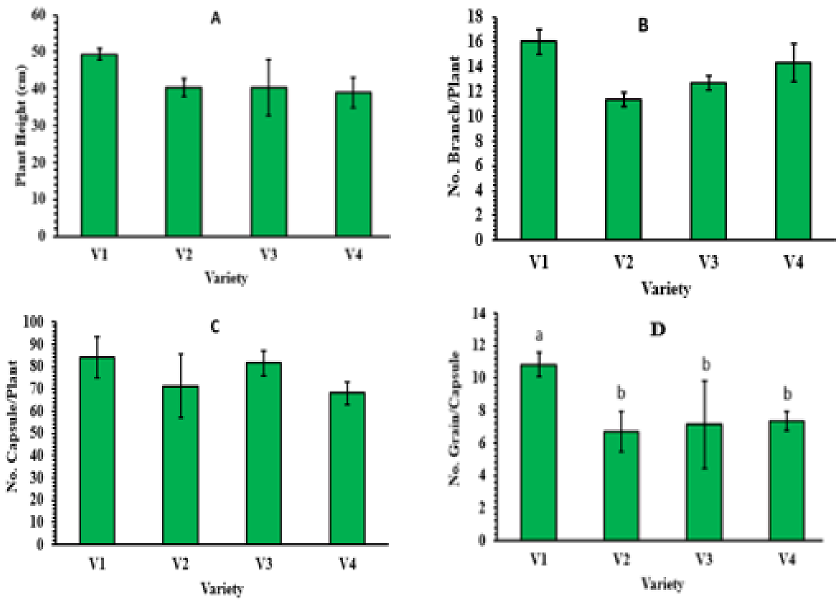
In accordance with Parwan's climate, this research was conducted to determine the high yielding and suitable local variety. The findings showed that there is no significant difference between the local varieties on all parameters except for the NSC and the WTS. Table 2 shows the mean square of several sources of variance, including all of the variables under investigation and experimental error.

There were no significant variations ($p < 0.05$) in plant height (PH). V1 and V4 were the tallest and shortest, respectively. A more detailed description of the results is in Figure 1. The results of the current study are consistent with the findings of Sileshi et al. (2019) who showed that the varieties under consideration aren't significantly different from each other in terms of PH. The number of branches per plant (NBP) produced by each sample was equal (Figure 1). The research conducted by Ranjzad et al. (2017) produced the same results.

The results of this study indicate that there is no significant variation ($p < 0.05$) in the number of capsules per plant (NCP) produced by each plant, as shown in figure 1. Andruszczak et al. (2015) reported similar results. The PH, NBP, and NCP may vary insignificantly due to genetic factors and similar environmental conditions where the samples were taken. Statistical analysis shows that there is a significant variation ($p \geq 0.05$) between varieties in the NSC. The highest NSC was observed in V1 (10.8), followed by V3 (7.13) and V4 (7.33), and the lowest was recorded in V2 (6.7). Additional details are provided in Figure 1. Equivalent results were obtained by Al-Doori (2012). He reported that among all studied samples, the Strain and Belinka genotypes significantly increased the NSC. Figure 1 illustrates that V1 (9 gr) varied significantly more in WTS results than V2 (4.67 gr), V3 (5.67 gr), and V4. The results of our study are in agreement with the results obtained by Ranjzad et al. (2008). He discovered during his study that the Oromia cultivar produced the heaviest WTS. The reason for the significantly increased NSC and WTS can be attributed to the further penetration of the roots.

A fairly steady percentage of polyunsaturated fatty acids is what makes flax oil unique (Andruszczak et al., 2015). The genetics, growing conditions, seed processing, and method of analysis can all affect the chemical composition of flaxseed (Daun et al., 2003). The amount of fatty acids such as linolenic acid (LLA) and linoleic acid (LA) was measured in this study. However, there is not a significant difference ($p < 0.05$) in the amount of LLA (Omega3) between the varieties (table 1). But, according to the statistical analysis, V2 (54.8%) and V4 (48.3%), respectively, had the highest and lowest amounts of LLA. Details are in Figure 1. While the findings of a study by Pali and Mehta (2014), which was conducted on 48 varieties of flax to determine the amount of fatty acids, indicate that, with the exception of the variety RLC-92, all other varieties have a lower amount of LLA compared to the results of the present research, due to their high LLA content, all of the local varieties under this study have good medicinal and food values. LLA is still widely used in industry. Therefore, it can be said that all of the varieties under investigation are desirable for both industrial and medicinal purposes.

In addition, vegetable oils contain large quantities of another group of fatty acids known as Omega-6 or LA. In this research we found the highest LA in V2 (16.3%), while V1 (14.4%) has the lowest (Figure 1 contains more information). But these variations aren't significant (Table 1). Compared to the findings of several researchers, such as Pali and Metah (2014) and Ranjzad et al. (2008), our study's results show a lower concentration of LA. These results demonstrate that the local varieties tested in the current study had similar amounts of fatty acids. Lower percentages of LA were seen in all varieties due to higher production of LLA.



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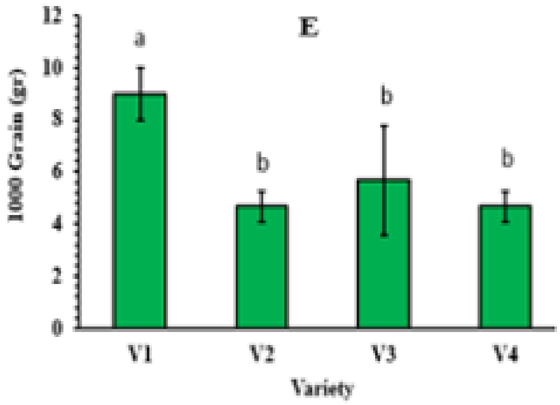

Fig. 1: Morphological characteristics such as Plant height (A), number of brunches (B), number of capsules per plant (C), number of grains per capsule (D), and weight of a thousand grains (E) that were evaluated by cultivation of different local varieties of Parwam (V1), Badakhshan (V2), Baghlan (V3), and Kunduz (V4).

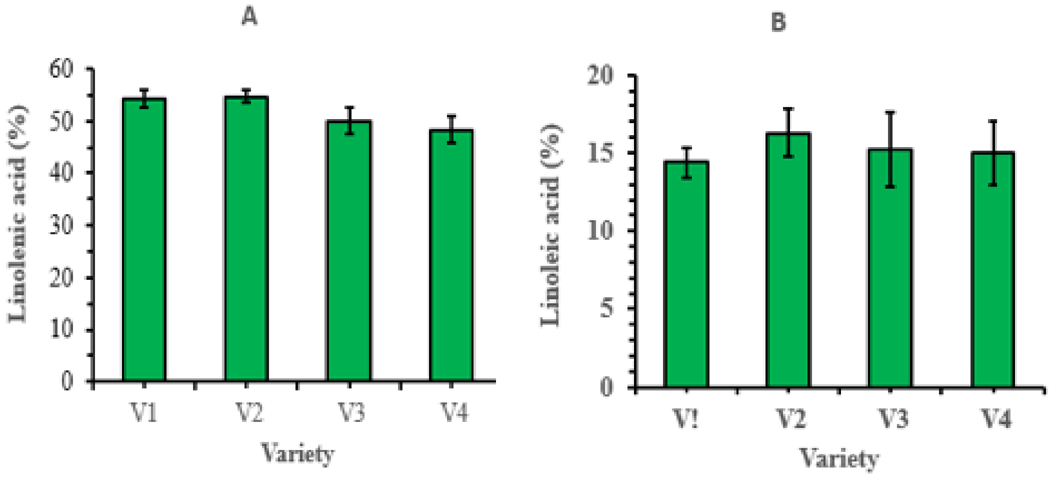

Fig. 2: Linolenic acid (A) and linoleic acid (B), compositions of oil flax that were evaluated by cultivation of different local varieties of Parwam (V1), Badakhshan (V2), Baghlan (V3), and Kunduz (V4).

Additionally, the data analysis's findings indicated that the PH was positively and significantly correlated at 1% with the NSC (r = 0.968*) and the WTS (r = 0.980*). Further information about the correlation between these characteristics is in Table 3. Similar findings to our work were also reported by Ranjzad et al. (2008). This indicates that fewer branches emerge as a plant grows taller. More seeds are produced in the capsules when fewer branches are created. In addition, if fewer branches grow, it's probable that the WTS will rise.

A significant and positive correlation has also been observed between the NSC and the WTS (r = 0.971*) (Table 3). It has been established that LLA and LA have a negative relationship (r = 0.563*) at a level of 1%. More details can be seen in Table 3. The negative relationship between LLA and LA demonstrates that as one of these acids' concentrations rises, the amount of the other one decreases. Iran-Nejad et al. (2009) also found a negative relationship between LLA and LA percentage

Table 2: Mean square for oil flax varieties adaptation trial.

Source of variations	Degree of freedom	PH (cm)	NBP	NCP	NSC	WTS	LLA	LA
Variety	3	68.1	37	2628.1	11*	12.7*	30.367	2.121
Block	2	27.3	4.4	5643.1*	3	0.8	3.498	1.551
Error	6	18.6	21.6	726.1	2.3	1.8	7.358	4.09

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Table 3: Correlation between the examined characteristics of oil flax

Parameters	Plant height (cm)	Number of branch/plant	Number of capsule/ plant	Number of grain/capsule	Weight of 1000 grain (g)	Linolenic acid (%)	Linoleic acid (%)
Plant height (cm)	1						
Number of branch/plant	0.754	1					
Number of capsule/ plant	0.861	0.773	1				
Number of grain/capsule	0.968*	0.696	0.76	1			
Weight of 1000 grain (g)	0.980*	0.575	0.893	0.971*	1		
Linolenic acid (%)	0.585	0.319	0.569	0.385	0.445	1	
Linoleic acid (%)	-0.629	-0.83	-0.47	-0.785	-0.736	-0.563*	1

*; **= correlation is statistically significant at the $p < 0.05$ level or $p < 0.01$ *level*, respectively.

IV. CONCLUSION

In conclusion, the current research was done with the intention of finding the best variety of oil flax in terms of quality and quantity, which shows that the performance of most of the characteristics of all local varieties was insignificant; only the number of seeds per capsule and the weight of 1,000 seeds were significantly different. But the percentage of linolenic acid in all varieties, when compared to the findings of the majority of researchers, has performed well. The genetic similarities, along with similar environmental conditions in the parts of the country where the cultivated samples originated, may be the primary causes of the varieties' similar performance. Therefore, due to the similarity in quantitative and qualitative performance of the local varieties under investigation, each one of them can be applied. Nevertheless, for more assurance, further research is needed to identify suitable local varieties and improve the quality of flax seed production in Afghanistan.

AUTHOR CONTRIBUTIONS

Abdul Alim Osmani and Wakil Ahmad Sarhadi designed the study, conducted the experiments, and analyzed the data. Abdul Alim Osmani and Abdul Musawir Aasim wrote the manuscript. Mohammad Wasif Amin provided critical feedback and contributed to the manuscript revision. Eeraj Danishyar, Zabihullah Farid, Khalid Joya and Hakimullah Amini assisted with data visualization and provided technical support. All authors contributed to the interpretation of the results and approved the final version of the manuscript.

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