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CHARACTERISTICS OF SEED OIL EXTRACTED FROM SEVERAL KENAF (*Hibiscus cannabinus* L.) GENOTYPES FOR MEDICINE AND FOOD TRAITS

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ABSTRACT:

Kenaf plant (*Hibiscus cannabinus* L.) was selected as plant material since it has great value for food and medicine purposes. This current study aims to evaluate the kenaf seed oils extracted (fatty acids) in six genotypes and then to indicate their benefits in cooking and medicinal uses. In the summer season of 2022, seeds of kenaf (FH952, HC95, HC2, 4383, 4202, and V36) were collected after harvesting. Results showed that FH952 is superior on others by having great values of oil, protein, and fatty acids (palmitic, stearic, oleic, linoleic, linolenic) by (29.0, 19.4, 8.8, 2.9, 21.9, 57.3, and 0.9 %), respectively, except of 4383 was recorded the same results in cases of palmitic and linolenic fatty acids. Despite that, the highest smoke point value found in HC95 by almost (400 °F). Inversely, V36 had the lowest position for all study characteristic with observed few similarities in some fatty acids. Generally, having these values of omega-3,6,9 fatty acids were extracted of all kenaf seed oils display the impact of this crop and could considered as a natural edible oil.

KEYWORDS: Kenaf seeds, Fatty acids, Omega-3-6-9, Protein, Oil smoke point, Medicinal plants.

1. INTRODUCTION

Kenaf (*Hibiscus cannabinus* L.) is valuable industrial crop from Malvaceae family, and it is so fast in growing. It can be cultivation in a tropical climate and also which resistance to various environmental conditions. Kenaf is acknowledged as a versatile crop with dual functionality, as both its bast and core fibers find applications as a source to textile and biocomposite applications. Recently, *Hibiscus cannabinus* seeds and leaves have been used as a source of pharmaceutical and food industries since of their benefits and chemical composition (Salih *et al.,* 2022a; Ezzadin *et al.,* 2022; Norhisham *et al.,* 2023). Global warming, environmental pollution, and the importance of *Hibiscus cannabinus* encourage researchers to do more research about the kenaf crop (Salih *et al.,* 2022b).

The fatty acid profile of *Hibiscus cannabinus* seed oil closely resembles that of cottonseed oil, characterized by high concentrations of oleic and linoleic acids (omega-9 and omega-6). Due to its relatively elevated oil content and distinctive fatty acid composition, kenaf seeds exhibit potential as a viable source of edible oil (Coetzee *et al.,* 2008). Furthermore, Nyam *et al.* (2009) observed that kenaf seeds possess a high nutritional value, with significant protein and oil contents measuring 21.8% and 20.8%, respectively.

The flour of *H. cannabinus* seeds has been used in food making industry; cakes, bread, noodles and other meals (Zawawi *et al.,* 2014). Wong *et al.* (2014) also reported that extracts from kenaf seeds and kenaf seed oil might serve as potential natural anti-cancer agents.

Dhar *et al.* (2015) stated that the relatively high oil content and favorable fatty acid composition render kenaf seeds a viable source of edible oil. Additionally, kenaf seed oil exhibits anti-hypercholesterolemic properties, antioxidant, anti-cancer, anti-inflammatory, the potential health benefits of kenaf seed oil extend beyond its nutritional value. The presence of bioactive compounds with anti-thrombotic and anti-mutagenic properties suggests its utility in the medicinal field, alongside its established applications in the food industry. This aligns with previous research demonstrating the versatility of kenaf seed oil extraction for various purposes, including food, cosmetics, and pharmaceuticals (Cheong *et al.,* 2016; Lee *et al.,* 2019; Chu *et al.,* 2019; Chew *et al.,* 2020; Chu & Nyam, 2020). Other studies showed that kenaf seed oil can be formulated into a gel-cream to produce a skincare product (Chu and Nyam, 2020; Chu *et al.,* 2021). Hanumegowda *et al.* (2022) concluded that the protein extract of kenaf seed (PEKS) protected the liver, kidney, and small intestine from oxidative damage through its antioxidant properties. Additionally, PEKS showed anticoagulant and antiplatelet activities. Thus, it could be a better therapeutic agent for several oxidative stress-related pathologies and cardiovascular complications.

The promising nutritional profile of *H. cannabinus* plant seeds positions them as potential candidates for food applications. These seeds could be incorporated whole or processed into various forms to leverage their health benefits (Giwa Ibrahim *et al.,* 2019). With all of these, improving the nutritional value of kenaf leaves as its seed was requested due to the potential applications of kenaf extending beyond livestock feed. The seeds themselves hold promise for fresh and cooked human consumption, while the extracted oil offers possibilities in the cosmetics and pharmaceutical industries (Sultan & Salih, 2022). Additionally, kenaf meal can replace soybean and fish meals as protein supplements (Kujoana *et al.,* 2023).

This research was undertaken to investigate and compare the oil, protein, and fatty acid compositions (saturated, mono, and polyunsaturated fatty acids) of the seed of six kenaf genotypes. Additionally, to evaluate its potential in food and pharmaceutical uses.

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2. MATERIALS AND METHODS

2.1 Study Site and Field Preparation

The experimental area was located in Grdarasha Research Station at the Department of Field Crops and Medicinal Plants, College of Agricultural Engineering Sciences, Salahaddin University-Erbil. It is situated in the governorate of Erbil, Kurdistan/Iraq (Latitude 36° 00 16 N and Longitude 44° 01 24 E), at an elevation of 398 meters above sea level.

A field experiment was carried out during the summer of 2022. After ploughing the field, it was divided into the several plots, and then seeds of six kenaf genotypes were sowed on 14 April, which were included (FH952, HC95, HC2, 4383, 4202 and V36). Table 1 shows the country of origin of the kenaf seeds.

Table 1:Kenaf (*Hibiscus cannabinus* L.) seeds country of origin

Name of kenaf genotypes	Country of origin
FH952	Fujian Fuzhou, China
HC95	Bangladesh
HC2	Bangladesh
4383	BJRI (Bangladesh Jute Research Institute) code for origin from Sudan
4202	BJRI (Bangladesh Jute Research Institute) code for the origin from Tanzania
V36	China (Commercial production line of Malaysia)

2.2 Determination of Seed Chemical Components

Two-gram portion of harvested seeds from each treatment group was pulverized using an electric blender. Subsequently, oil extraction was conducted employing a digital Soxhlet apparatus with n-hexane as the chosen solvent (BDH, UK), (Ferreira-Dias *et al.*, 2003).

The oil content was calculated as the following equation (1):

$$\text{Fixed Oil \%} = W2 - W1/S \times 100$$

W1 = weight of empty flask (g)
W2 = weight of flask and the extracted oil (g)
S = weight of the sample

The following procedure was also applied to determine fatty acids of kenaf seed oil extracted.

Following AOAC (1995), the sample was prepared as follows. First, a methanolic potassium hydroxide solution was prepared by dissolving 11.2 g of potassium hydroxide in 100 mL of methanol. One gram of oil was taken and then combined with 8 mL of the methanolic potassium hydroxide solution and 5 mL of hexane. The mixture was vigorously shaken for 30 seconds to facilitate homogenization. After allowing the sample to settle into two distinct layers, the upper hexane layer, containing the esterified fat, was collected for further analysis. The fatty acid compounds were analyzed using a gas chromatography device (GC-2010) (Shimadzu model of Japanese origin), with a flame ionization detector (FID), and a capillary separation column (SE-30) with a length of (30 m × 0.25 mm) was used.

Protein percentage was also determined by applying the following equation (2) (Salih, 2015):

$$\text{Protein percent (\%)} = \text{Nitrogen \%} \times 6.25$$

Additionally, oil smoke point was calculated according to the understanding of smoke point definition: The oil was heated on the special plate and when light blue smoke was noticed, the temperature was recorded as the smoke point. For that purpose, digital thermometer (TOTAL DIGITAL THERMOMETER (THIT015501), INFRARED THERMOMETER "-22 °F ~+1022 °F"), was used.

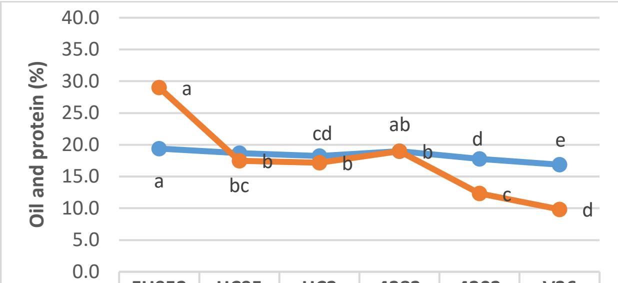
2.3 Statistical Analysis

Oil, protein, fatty acids, and smoke point were repeated thrice. The analysis of variance (ANOVA) of the data was performed using IBM SPSS statistical software program version (20) as well as Duncan's test. Differences were considered statistically significant with a p-value of 0.01.

3. RESULTS AND DISCUSSION

3.1 Kenaf Seed Oil and Protein (%)

Figure 1 shows the oil and protein, which were symbolled (O and P) curves were extracted from kenaf seeds. Both curves showed that FH952 superior on others by having oil and protein (29.0 and 19.4 %), respectively followed by 4383 (19.0 and 19.0 %), which were for O and P. While, the lowest percentage of O and P were noted of V36 (9.8 and 16.9 %), respectively. These results indicated that O and P percentages were significantly changed among kenaf genotypes. These results were supported by a previous study by Mohamed et al. (1995), who reported that the oil % of kenaf seeds was significantly different among varieties; the oil % of Tainung #1 was 21.4 %, while it increased to 26.4 % for Cubano variety. Moreover, a significant difference in crude protein and crude fat of seeds was noted among four kenaf varieties (Victoria *et al.*, 2020).



	FH952	HC95	HC2	4383	4202	V36
P	19.4	18.7	18.2	19.0	17.8	16.9
O	29.0	17.5	17.2	19.0	12.3	9.8

Figure 1:Oil and protein percentages of kenaf seed oil extracted of different genotypes

3.2 Palmitic and Stearic Acids (%)

The fatty acid compositions palmitic and stearic (Pa and St) of kenaf seed oils extracted were statistically different (p-value 0.01) among kenaf genotypes. FH952 was recorded as the highest amount of Pa and St (8.8 and 2.9 %), followed by 4383 (8.8 and 2.8 %), respectively (Figure 2). Despite that, V36 and 4202 were found to have the smallest amount of Pa and St %. These results agree with Mohamed et al. (1995), who reported that wide variations in fatty acid compositions (palmitic and stearic) among kenaf genotypes were found. Similar results were also found by Ryu *et al.* (2013), who stated that palmitic and stearic fatty acids were significantly different among kenaf accessions when they studied 15 kenaf accessions that originated from Russia, India, China, Iran, and Italy. Previous studies indicated the impact of palmitic acid with polyunsaturated fatty acids. Blood lipids and lipoprotein levels will be changed due to dietary fat intake. Additionally, blood cholesterol can be sour by dietary cholesterol and saturated fatty acids such as palmitic acid, and then polyunsaturated fatty acids can diminish it (Freitas & Campos, 2019). While, stearic acid has a crucial role in promoting skin and also protects (Pereira-Leite *et al.*, 2023). However, Kelly *et al.* (2001) stated that dietary stearic acid reduces thrombogenic and atherogenic risk factors, and the food industries should consider adding stearic acid to foods. Generally, we can say that all kenaf seed oils are extracted, which includes a great percentage of both important fatty acids.

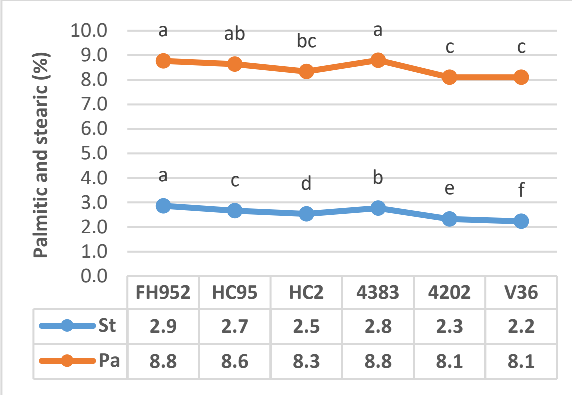


Figure 2: Palmitic and stearic acid percentages of kenaf seed oil extracted of different genotypes

3.3 Oleic and Linoleic Acids (%)

Figure 3 shows the oleic and linoleic (Ol and Li) curves were extracted of kenaf seed oils. The highest amount of Ol and Li were (21. 9 and 57.3 %), respectively which were extracted of FH952 kenaf seeds, again V36 was recorded the smallest amount of both fatty acids (21.4 and 56.4 %), respectively. Similar results were noted by the Coetzee *et al.* (2008) when they researched on the eight commercial kenaf varieties. During their research found that the predominant fatty acids in all eight cultivars were linoleic, oleic and palmitic. Percentages of fatty acids varied significantly among the varieties. Other nine kenaf genotypes were also evaluated to know its seed chemical compositions. Results showed that the monounsaturated fatty acid (oleic), and polyunsaturated fatty acid (linoleic) significantly changed among genotypes (Mohamed *et al.,* 1995).

Great values of each omega-6 and omega-9 fatty acids (linoleic and oleic), which extracted from kenaf FH952 seed oil showed the impact of that oil for cooking purposes. Lowering of cholesterol and preventing inflammation caused to improve heart conditions which is by intake both fatty acids (omega-6 and 9). Previous studies confirmed that facts about benefits of these fatty acids. An optimum omega-6: omega-3 ratio in our meal is reducing the risk of heart disease and is improving brain functions. Omega-3 is anti-inflammatory, while increasing the intake of omega-6 causes to increase body inflammatory, and also it is primarily used for increasing inflammation (Kaur *et al.,* 2014; Silva *et al.,* 2018; DiNicolantonio & Keefe, 2021; Jafari *et al.,* 2022). Again results from this current study is supported by the findings of Coetzee *et al.* (2008), who stated that the potential health benefits of kenaf oil from its favorable fatty acid profile. Kenaf seeds exhibit a relatively high content of monounsaturated and polyunsaturated fatty acids, which are associated with positive health outcomes when consumed in moderation.

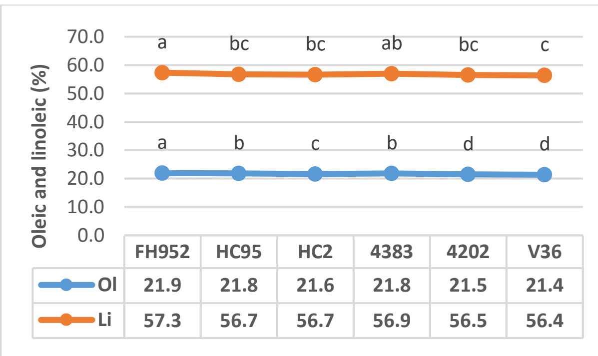


Figure 3: Oleic and linoleic acid percentages extracted of different genotypes of kenaf seed oil

3.4 Linolenic Acid (%)

Slightly differences of linolenic acid (Le), which extracted of kenaf seed oils, were noted among all genotypes. FH952 and 4383 had the highest values of linolenic acid (0.9 %), while others just have (0.8 %) as can be seen in the (Figure 4). Having appropriate rate of linolenic acid (omega-3) in our diet are required for the normal growth and development. From the new study, benefits of omega-3 fatty acids were indicated. Given the known role of omega-3 fatty acids in regulating platelet homeostasis and reducing thrombotic risk, their potential therapeutic application in COVID-19 management warrants investigation (Djuricic & Calder, 2021).

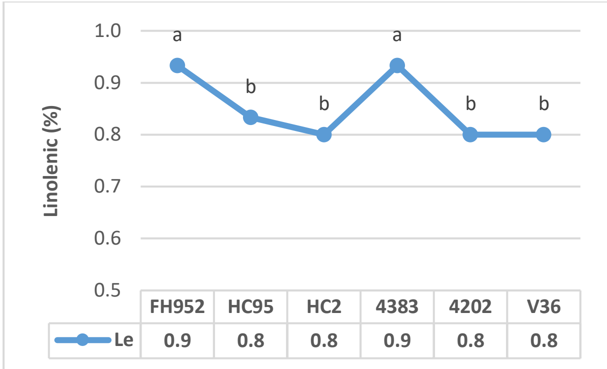


Figure 4: Linolenic acid composition of kenaf seed oil extracted of different genotypes

Generally, FH952 and 4383 found to have the highest total amount of saturated, mono and polyunsaturated fatty acids (91.8 and 91.2 %), respectively compared to other genotypes (Table 2). The ratios of fatty acids fluctuated significantly among the kenaf varieties which display the potential for selecting healthier fatty acid profiles (Ryu *et al.,* 2013).

Table 2: Saturated, mono and polyunsaturated fatty acid compositions of kenaf seed oil

Genotype	**Fatty acids gas-chromatography area (%)**					**Total**
	Palmitic (C16:0)	**Stearic (C18:0)**	**Oleic (C18:1)**	**Linoleic (C18:2)**	**Linolenic (C18:3)**	
FH952	8.8	2.9	21.9	57.3	0.9	91.8
HC95	8.6	2.7	21.8	56.7	0.8	90.6
HC2	8.3	2.5	21.6	56.7	0.8	89.9
4383	8.8	2.8	21.8	56.9	0.9	91.2
4202	8.1	2.3	21.5	56.5	0.8	89.2
V36	8.1	2.2	21.4	56.4	0.8	88.9

3.5 Oil Smoke Point (°F)

Figure 5 shows the oil smoke point curve (Sp). It is really important factor to decide which kind of seed oils extracted possible to use as cooking oil especially for frying purposes. According to the results were found from this current study HC95 had the highest smoke point (394.3 °F), followed by FH952 (366.0 °F). While, comparable results were noted among other genotypes which were ranged between (330 – 339 °F), could say that they were too close. The best type of frying oil is the oil which has the highest smoke point. So in this study, the best oil for that purpose is the oil was extracted from kenaf seeds HC95 followed by FH952. Inhere, the impact argument should be focused on the percentage of fatty acids in each seed oils of kenaf genotypes, since may be that factor caused to create the differences between smoke point of kenaf seed oils. In other words, the smoke point of oil does tend to increase as free fatty acids content decreases (Bharti *et al.,* 2017 and Alvarenga *et al.,* 2018). Additionally, the low the smoke point is inversely related to the amount of protein. Also, with the higher the saturated and monounsaturated fatty acids, the higher the smoke point will be found. Finally, these facts can be noticed with a slight difference if we return to the results in the figures above, and then compared to smoke points from the (Figure 5).

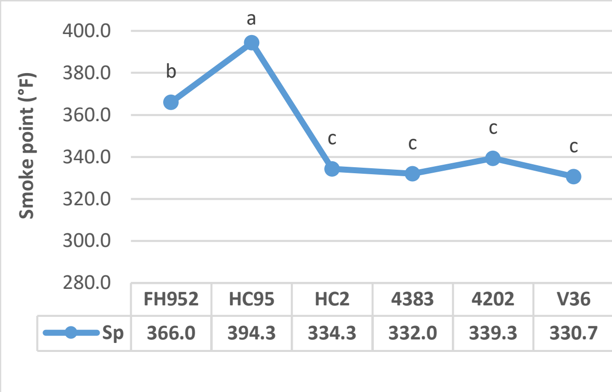


Figure 5: Smoke point of kenaf seed oils

CONCLUSIONS

In this present study six kenaf genotypes used as plant material to extract fatty acids of their seed oils and also to determine the values of each oil and protein percentages. Having appropriate values of each omega-3,6,9 fatty acids with making balance between them in our diet are really important. Based on the results were found in this exist study, the best oil was the oils extracted from the kenaf FH952, HC95 and 4383 seeds, that due to varied of the fatty acid compositions and smoke points. Different among fatty acid compositions may goes to the genetic factors. Also, some kenaf plants were produced very weak seeds and not plumpness. Finally, could concluded that having these beneficial fatty acids of the kenaf seed oils extracted cause to use as other vegetable oil sources for medicinal and cooking purposes. Further studies are recommended to focus on the characterization of these fatty acids and trying to increase oil percentage of kenaf seeds.

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