Asian Journal of Advances in Agricultural Research

11(2): 1-10, 2019; Article no.AJAAR.51017
ISSN: 2456-8864

Physicochemical Characteristics and Oil Keeping Quality of Two Cultivars of Sunflower (*Helianthus annuus*) Seeds

A. Kafi[1,2*], S. Gheyasuddin[1] and M. H. Rashid[1]

[1]Department of Biochemistry and Molecular Biology, Bangladesh Agricultural University, Mymensingh-2200, Bangladesh.
[2]Department of Agriculture, Hena Islam College, Challisa, Netrokona Sadar, Netrokona, Bangladesh.

Authors' contributions

This work was carried out in collaboration among all authors. Author AK designed the study, performed the analysis and wrote the manuscript. Authors SG and MHR supervised the study. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAAR/2019/v11i230048
Editor(s):
(1) Prof. Daniele De Wrachien, Department of Agricultural and Environmental Sciences, The State University of Milan, Italy.
Reviewers:
(1) Grace O. Tona, Ladoke Akintola University of Technology, Nigeria.
(2) Ufuoma Bigila Shemishere, Federal University Birnin Kebbi, Nigeria.
Complete Peer review History: http://www.sdiarticle4.com/review-history/51017

Original Research Article

Received 18 June 2019
Accepted 20 August 2019
Published 20 September 2019

ABSTRACT

The work was conducted on sunflower seeds of two cultivars namely 'Kironi' and 'Hysun-46'. Proximate composition of the seeds, chemical characteristics and fatty acid composition of the oils, and its keeping quality at different storage conditions were studied. Moisture content of Kironi seeds was nearly twice than Hysun-46 (8.03 vs 4.46%). Crude fat in Hysun-46 seeds was somewhat higher than Kironi. Kironi had significantly higher crude protein whereas Hysun-46 contained significantly higher percent of starch than Kironi (7.05 vs 3.90%). Physical characteristics of oil such as viscosity, colour and transparency changed with time during storage; specific gravity and smoking temperature, however, remained unchanged. Acid values of the freshly extracted oil from Hysun-46 were unexpectedly high (98.75). Iodine values were found to be higher in Kironi than Hysun-46, so the former had greater proportion of unsaturation. Saponification values of the oils decreased with the time in open vessel, in amber coloured bottle at 4°C and also in boiled oil kept at room temperature. However, these values registered an increase in oils stored in closed vessel and amber coloured bottle at room temperature. Peroxide

**Corresponding author: Email: a.kafi_69@yahoo.com;*

values increased in oils under all conditions except in amber bottle at 4°C. The ratio of linoleic acid to oleic acid in Kironi (2.3:1) was higher than that in Hysun-46 (1.9:1), indicating that Kironi had more semidrying capacity and suitable for edible purpose. The freshly extracted oil had attractive appearance. Between the two oil samples, Kironi seems somewhat superior to Hysun-46.

Keywords: Sunflower seeds; physicochemical characteristics; oil keeping quality.

1. INTRODUCTION

Sunflower (*Helianthus annuus* L.) oil seeds are consumed as food, it is the most concentrated form of energy and carrier of various fat soluble vitamins, and it's margarine is consumed as food. It is used as raw material for many industrial products such as soap, detergents and animal feed due to presence of high quality proteins. Lennerts [1] listed forty different oil seeds, among them sunflower seed is an important source of edible oil. Sunflower ranks second to soybean [2] among annual field crops in the world for edible oil production. The quantity of sunflower oil represents about 14% of the total world production of the nine major vegetable oils. Sunflower oil is of very high quality and sells for markets over soybean, palm and rapeseed oils. The sunflower meal, by-product of the extraction of oil from the seed, has a high protein and is used in food rations for livestock.

Sunflower is grown mainly for oil, although certain cultivars are grown for non-oilseed or confection purposes, in the U.S.A. Other growing countries are Spain, China, Turkey, Russia, Canada and some others with low production. The seed contains 48% to 52% of good quality oil and 40 to 52% protein in meals [3]. The oil is a rich source of Linoleic acid up to 79%, which helps wash out cholesterol deposition in the coronary arteries of heart for heart patients. Sunflower meal is used in confectionary to prepare value-added products [4]. Sunflower oil is premium for its light colour, bland flavour, high smoke point and high level of linoleic acid. The unsaturated fatty acid oleic and linoleic acid comprise about 90% and the remainder consisting the saturated fatty acids (palmitic and stearic acids). The high level of unsaturated fats in sunflower oils as nutrition, increasing the proportion of unsaturated to saturated fatty acids in diet will reduce the level of blood cholesterol. The high level of linoleic acid supplies the high level of α-tocopherol, as Vitamin-E. Fats and oils are used to synthesize phospholipid, which are important component of active tissues, viz. brain, nerve and liver of human beings and other animals. Sunflower oil maintains softness of skin and increase palatability of food. It serves as insulator to the human body and carrier of vitamin-A, D, E and K [5].

Sunflower is a new crop to Bangladesh and this crop can be grown widely all over the country. Bangladesh is not self-sufficient both in edible and industrial oil, but a recent introduction of sunflower to agriculture may be a potential source of high quality edible oil. Nowadays, it is familiar in Bangladesh as oil crop as well as ornamental plant. In 2012, total area under sunflower and other minor oilseed cultivation was 351.82 ha with a production of 373 metric tons [6]. Two crop production cycles are also popular as nutrition requirement of crops is supplemented by each other cultivation like sunflower, chickpea and Khesari after the cultivation of T. Aman in coastal regions of Bangladesh [7]. Furthermore, 1.0 kg of sunflower seeds yields 500 to 600 grams of oil, which is more than that of any other oilseeds [8]. Sunflower oil contributes about 13% of the world edible oil production with high value [9]. Therefore, this work was conducted to determine proximate composition, evaluate nutrients and study the physicochemical properties and keeping quality of the oils extracted from seeds of two sunflower cultivars, namely Kironi (local) and Hysun-46 (hybrid).

2. MATERIALS AND METHODS

2.1 Collection of Sunflower Seeds

Kironi (local) and Hysun-46 (hybrid) samples were collected from BARI and BAU Agronomy farm, respectively to determine physical and chemical properties of freshly extracted oil including fatty acid composition and to study keeping quality of oils under different conditions.

Among the cultivars, Kironi was evolved by the BARI, from the variety "Alkopoliski" collected from Poland and Yugoslavia in 1975 and released by the National Seed Board in 1982. The variety is suitable for cultivation in both Rabi

and Kharif seasons in farmer's field. On the other hand, Hysun-46 is a hybrid variety. It was introduced directly from Australia.

2.2 Proximate Composition Determination

In proximate composition determination, ground samples from both dried sunflower seeds were analyzed for chemical compositions. Fat, ash and carbohydrates were analyzed using the procedures as mentioned by AOAC [10], while crude protein and crude fibre were analyzed using the procedures of AOAC [11].

2.3 Measurement of Moisture and Ash Content

About 10-20 g of the fresh material of each sample were weighed into separate petridishes and dried in an oven at 100°C to 105°C until constant weight was obtained. Then moisture content was calculated in per cent. One (1.0) gram of dried sample was taken in a crucible and heated in a muffle furnace for about 5-6 hours at 600°C. It was then cooled in a desiccator and weighed. Then total ash was calculated using the following equation as mentioned by Raghuramulu et al. [12].

$$\text{Ash content (g/100 g sample)} = \frac{Weight\ of\ ash \times 100}{Weight\ of\ sample}$$

2.4 Estimation of Fat

Fat was estimated as crude ether extraction of the dry materials. The dried sample (about 5.0 g) was weighed into a conical flask and plugged with fat free cotton. The flask was then placed in an electric shaker and extracted with anhydrous ether for about 16 hours. The ether extract was filtered into another weighed conical flask. The flask containing the original ether extract was washed 4 to 5 times with small quantities of ether and the washings were also transferred to the conical flask. The ether in the conical flask was then removed by evaporation, and the flask with the residue was dried in an oven at 80°C to 100°C, cooled in a desiccator and weighed. Fat content in sample was estimated as follows:

$$\text{Fat contents (g/100 g of dried sample)} = \frac{Weight\ of\ ether\ extract \times \%\ of\ dried\ sample}{Weight\ of\ the\ dried\ sample\ taken}$$

2.5 Determination of Crude Fiber

Two (2) gram of dry sample was taken in a beaker and 200 ml of boiling 0.255N H_2SO_4 was added in to the beaker. The mixture was boiled for 30 minutes and water was added at frequent intervals to keep volume constant. Filtration was done by a muslin cloth and washed with hot water for removing acid. Then the residue was transferred to the same beaker and 200 ml of boiling 0.313N NaOH was added to it. After boiling for 30 minutes (keeping the volume constant as before) the mixture was filtered through a muslin cloth and the residue was washed with hot water till free from alkali, followed by washing with some alcohol and ether. It was then transferred to a crucible, dried overnight at 80-100°C and weighed (We) in an electric balance. The crucible was heated in a muffle furnace at 600°C for 5-6 hours, cooled and weighed again (Wa). The difference in the weights (We-Wa) represents the weight of crude fiber. Then crude fiber was calculated using the following formula as mentioned by Raghuramulu et al. [12].

Therefore,

$$\text{Crude fiber (g/100 g sample)} = \frac{100 - (Moisture + Fat) \times (We - Wa)}{Weight\ of\ sample}$$

2.6 Determination of Total Nitrogen, Non-protein Nitrogen and Actual Protein

Total nitrogen content of mushroom samples was determined by Kjeldahl method by digestion with concentrated H_2SO_4 and digestion mixture (K_2SO_4: $CuSO_4$: Selenium powder = 100: 10: 1) and then distilling with 40% NaOH. The ammonia distilled over was absorbed in boric acid indicator and titrated against 0.05N H_2SO_4 [13]. The % N is mushroom sample was calculated by using the following formula-

$$\%\ \mathrm{N} = \frac{(\mathrm{T} - \mathrm{B}) \times \mathrm{N} \times 1.4}{\mathrm{W}}$$

Where,

T = Actual titration reading (mL)
B = Blank titration reading (mL)
N = Normality of H_2SO_4
W = Sample weight in g

The crude protein % was calculated by multiplying the nitrogen % with a factor of 5.85.

Non-protein nitrogen (NPN) was determined by trichloroacetic acid (TCA) precipitation method as described by Atkinson et al. [14] followed by determination of nitrogen in aliquots of the supernatant by Kjeldahl method. On the other hand, actual protein (AP) was calculated by the following formula:

AP = (Total nitrogen – Non-protein nitrogen) × 5.85

2.7 Estimation of Nitrogen Free Extract

Nitrogen free extract (NFE) was estimated as soluble carbohydrate by subtracting the sum of percent moisture, crude protein, crude fat, crude fiber and ash from 100 by using the following formula-

NFE = 100 – % (Moisture + crude protein + crude fat + crude fiber + ash)

2.8 Determination of Starch and Total Sugar

To determine starch 1.0 g of oven dried and powdered sample was extracted in water and then the content of starch was measured following the method described by Sadasivam and Manickam [15] using Fehling's solutions. The percent of starch was calculated from the following relationship-

%starch = %glucose × 0.9

Amount of total sugar was determined according to Hall and Haczkaylo [16].

2.9 Extraction of Oil from Sunflower Seeds

Oil from ground whole sunflower seed meal was extracted with n-hexane. Extraction was carried out in a bottle with shaking and mixture was left overnight. The n-hexane was separated by filtration and the oil was recovered by evaporating the solvent. The oil sample was treated with anhydrous $(NH)_2SO_4$ and centrifuged. By this method a fair quantity of oil was obtained which was used to study some of its characteristics as given below.

2.10 Physical and Chemical Characteristics of Oil

Physical (viscosity, colour, transparency, specific gravity and smoking point) and chemical (acid value, saponification value, iodine value and peroxide value) characteristics of oil were determined according to procedure described in AOAC [10].

2.11 Determination of Fatty Acid Composition of Oil

Fatty acids (palmitic, stearic, oleic and linoleic acids) compositions were determined by Gas Liquid Chromatograph (GLC). A Phillips PU 4500 Chromatograph instrument was used with flame ionization detector (FID). About 12 mg of oil samples were extracted and trans esterified at the same time with 5 ml ethylate reagent {petroleum ether/ 0.02 M sodium hydroxide in ethanol (2/3) and shaken. The samples were kept for overnight at room temperature. Then 10 mL salt solution (80 g NaCl and 3 g sodium hydrogen sulfate in 1.0 L water) was added to it and shaken. As soon as the two layers were separated, the benzene phase was transferred to small test tubes and was then ready for Gas Chromatography. A glass column (1.5 × 4 nm) was packed with BDS. Nitrogen flow rate was 22 mL/min and the injection volume was 2 µmol. Peak areas were measured with electronic digital integrator.

3. RESULTS AND DISCUSSION

3.1 Proximate and Nutrient Composition of Sunflower Seeds

The proximate and nutrient compositions of whole ground seed of two cultivars are presented in Table 1. The data have been calculated on moisture free basis for better comparison of the different fractions. According to Ahsanullah et al. [17], moisture of seeds should not be more than 8-9% for storage. Moisture content of Kironi and Hysun-46 samples were 4.46 and 8.03%, respectively. This means moisture difference of the two cultivars was due to different level of sun drying. Dry matter of Kironi and Hysun-46 sample was 95.54 and 91.97%, respectively. The crude fibre content of Kironi was 10.45% whereas of Hysun-46 was 15.6%. These values were 10.94 and 16.96% (Table 1), respectively on moisture free basis. Ash content of Kironi was less (8.43%) than Hysun-46 (12.33%). The crude fat was found to be 32.25% for Kironi and 32.77% for Hysun-46. These values were 33.76 and as 35.63% on moisture free basis, indicating that Hysun-46 had higher oil content. These values were more or less similar to the reports published earlier [18-20].

Table 1. Proximate and nutrient composition of two varieties of sunflower seeds (values in parenthesis are on moisture free basis)

Variety	Moisture (%)	Dry matter (%)	Ash (%)	Crude fiber	Crude fat	Total nitrogen	Total crude protein (TN)	Non-protein nitrogen (NPN)	Actual protein (TN-NPN)×5.85	Nitrogen free extract	Sugar	Starch
Kironi	4.46	95.54	8.43 (8.82)	10.45 (10.94)	32.25 (33.76)	2.76 (2.89)	16.15 (16.90)	0.055	15.80	28.26 (29.58)	3.80	3.90
Hysun-46	8.03	91.97	12.33 (13.41)	15.60 (16.96)	32.77 (35.63)	2.15 (2.34)	12.58 (13.70)	0.572	9.23	18.69 (20.32)	1.28	7.05

Table 2. Changes in physical characteristics of sunflower oil from two varieties stored under different conditions for two months

Variety	Physical characters																					
	Viscosity						Colour						transparency						Specific gravity			Smoking temperature
	R		F		H		R		F		H		R		F		H		R	F	H	°C
	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S				
Kironi	Low (+)	Increased (++)	Low (+)	Low (+)	Low (+)	Increased (+++)	Light yellow	Yellowish (turbid)	Light yellow	Bright yellow	Very light yellow	Light yellow	Transparent	Transparent	Transparent	Transparent	Transparent	Transparent	0.91	0.91	0.92	165
Hysun-46	Low (+)	Increased (++)	Low (+)	Low (+)	Low (+)	Increased (+++)	Bright yellow	Yellowish (turbid)	Bright yellow	Bright yellow	Light yellow	Yellowish (turbid)	Transparent	Transparent	Transparent	Transparent	Transparent	Transparent	0.95	0.90	0.92	160

R= room temperature; F = Fridge temperature; H = heated and cooled at room temperature; I = Initial observation and S = observation after storage for 2 months

The crude protein content of Kironi and Hysun-46 was 16.15 and 12.58%, respectively indicating that Kironi contained more crude protein. These values were 16.9 and 13.7%, respectively on moisture free basis. The crude protein reported by Peredi and Balogh [21] were distinctly higher than these values but the reported value of Kaffka et al. [18] and Ahsanullah et al. [17] were similar to these values. Nitrogen free extract contained by Kironi and Hysun-46 were 28.26 and 18.69%, respectively which were 29.58 and 20.32%, when calculated on moisture free basis. Among nutrient composition of the two varieties of sunflower seeds, sugar content was found to be 3.80 and 1.28% and starch content was found to be 3.9 and 7.05%, respectively for Kironi and Hysun-46. Actual protein content was calculated to be 15.8 and 9.23%, respectively for the Kironi and Hysun-46 sample. The proximate and nutrient composition showed that seeds contained high amount of oil, protein and substantial amount of carbohydrate.

3.2 Physical Characteristics of Oils

For the extracted oil stored at different condition some physical characteristics were studied and results are presented at Table 2. Both samples of oil at room temperature had initially low viscosity, but after some day's viscosity of both samples were increased. At refrigerator temperature, samples were initially stable for some days and no substantial change occurred. Heated oils of both the varieties were initially low in viscosity but after some days increased. However, high content of linoleic acid makes the oil dry which is suitable for varnishes. Maskan and Gogus [22] reported that viscosity of sunflower oil varied with storage temperature. At room temperature colour of Kironi oil looked initially light yellow but in Hysun-46 it was bright yellow. After some days colour of both oil turned turbid yellow at room temp. When oils were stored into freeze, both samples were bright yellow. Heated oil of Kironi sample was initially very light yellow and turned light yellow whereas Hysun-46 sample was initially light yellow and finally turned to turbid yellow. Lakshmidevi et al. [23] reported that the oil from seed changed from light yellow to yellow. Belitz and Grosch (1999) reported that sunflower seeds yielded a light yellow oil because of dispersed colouring matter or pigments (chlorophyll, carotenoids, pheophytins) and their autoxidation caused the change of colour.

Oil samples of both varieties stored at room temperature as such and heated to storage looked transparent for some days but turned translucent after a few days. Colour of oil of both varieties at refrigerator temperature unchanged during storage and remained transparent. According to Zufarov et al. [24] the crude oil of sunflower contains phosphatides and vegetable gums, a colouring matter and heavy metals like Fe and Cu. These components influence the stability of edible oils by oxidative and thermal polymerization and degradation reactions. Belitz and Grosch [19] reported that the oil contain phospholipids, free fatty acids, some odour and taste imparting substances, waxes, pigments, degradation products, phenolic compounds, trace metal ions and autoxidation products. Specific gravity of Kironi and Hysun-46 oil was recorded at room temperature to be 0.91 and 0.95, at refrigerator temperature (4.0±0.5°C) 0.91 and 0.90, and at heated condition 0.92 and 0.92, respectively. Smoking temperature was recorded to be 165°C and 160°C, respectively for Kironi and Hysun-46 sample.

3.3 Chemical Characteristics of Oils

The chemical parameters of the two oil samples are presented in the Table 3. These parameters were determined for freshly extracted oil from Kironi and Hysun-46 samples. Acid values of Kironi and Hysun-46 were found to be 5.5 and 98.75, respectively. High acid value in Hysun-46 was unexpected as freshly extracted oil is not expected to be rancid. Iodine values were found to be 123.79 and 109.85, respectively for those samples, including the former had greater proportion of unsaturation. Saponification values of these oils were found to be 168.38 and 179.04, respectively, showing that average chain length of fatty acid of the later is shorter than that of the former. Peroxide values were found to be 107.83 and 92.0, respectively, including that the content of reactive oxygen is more in Kironi than Hysun-46. Hence rancidity due to oxidation for Kironi is more than the other.

3.4 Keeping Quality of Sunflower Oils

To study the keeping quality of the sunflower oils under different conditions, the oils were kept in open and closed flask, in amber coloured bottles at room temperature and refrigerator temperature (4.0±0.5°C) and at room temperature after being heated. Different chemical parameters over the period of two month are presented in the Table 3.

Acid values of freshly prepared oils were 5.5 for Kironi and 98.75 for Hysun-46. Such high acid

value in fresh condition seems difficult to explain entirely on rancidity. The acid value in open and closed vessels up to 60 days remained constant for Kironi although there has been some reduction in Hysun-46 oil perhaps due to polymerization of the FFA. Oil kept at room temperature in amber coloured bottle did not show any significant change over 60 days. Oil of Hysun-46 kept in amber coloured bottle at 4.0±0.5°C exhibited reduction in acid value to less than half after 30 days and no change thereafter. This shows that cold temperature caused polymerization of most of the free fatty acid but there was no reduction after 30 days. No such effect was observed with Kironi seeds oil. Oils boiled and stored at room temperature showed different effect. In Kironi oil increase in acid value was observed whereas in Hysun-46, acid value reduced as it did in cold storage. The effect in Kironi may be attributed to process of rancidity whereas in Hysun-46 effect is due to polymerization. The highest and lowest acid values of Kironi were 12.37 after 30 days when cooled at room temperature after boiling and 4.77 after 30 days in open vessel at room temperature, respectively. Those values for Hysun-46 were 101.21 after 60 days in amber bottle at room temperature, and 39.87after 60 days in boiled sample, respectively.

Iodine values of freshly extracted oils from Kironi and Hysun-46 were found to be 123.79 and 109.85, respectively including that unsaturation in the later is less than in the former. But after 30 days and 60 days Iodine values were found to have gradually decreased in all storage condition, whereas in open vessel for Kironi in amber bottle at refrigerator temperature, for both samples showed less decrease of Iodine value. The highest and the lowest iodine values of Kironi were found to be 123.79 on zero day and 80.17 at room temperature in amber bottle after 30 days, respectively and incase of Hysun-46 those values were found to be 109.85 on zero day and 76.35 at room temperature in open vessel after 60 days, respectively. So, Kironi showed more unsaturation or absorption of iodine in double bond than that of Hysun-46.

Saponification values of initially extracted oil from Kironi and Hysun-46 were found to be 168.38 and 179.04, respectively. Saponification values of former were found to be less than those of the later. So average chain length of Hysun-46 was shorter than that of Kironi. After 30 days and 60 days these values for Kironi and Hysun-46 increased when kept in closed vessel at room temperature, in amber bottle at room temperature, decreased when kept in open vessel at room temperature, in amber bottle at 4.0±0.5°C and when cooled at room temperature after boiling. The highest saponification value for Kironi in amber bottle at room temperature was 191.57 after 60 days and the lowest value was 124.85 in amber bottle at 4.0±0.5°C after 60 days. In case of Hysun-46, the highest value was 192.87 in close vessel after 60 days and the lowest value was 136.35 in open vessel after 60 days.

Peroxide value of freshly extracted oil from Kironi was found to be 107.83 and that of Hysun-46 was 92.0 at different storage conditions. So, those values of Kironi were found to be greater than those of Hysun-46, indicating the content of reactive oxygen to be more in Kironi than Hysun-46. Rancidity due to oxidation for Kironi is more than of Hysun-46. After 30 days and 60 days these values for Kironi increased with storage period but decreased after 30 days when stored in amber bottle at 4.0±0.5°C. Hysun-46, the values increased after 30 days at all storage conditions but decreased when stored in flask at room temperature, after boiling in amber bottle at 4.0±0.5°C. The highest and the lowest peroxide value for Kironi were found to be 260.94 in amber bottle at room temperature, after 60 days and 31.96 in amber bottle at 4.0±0.5°C after 30 days, respectively and those values for Hysun-46 were found 362.8 in close vessel at room temperature after 60 days and 26.0 in amber bottle at 4.0±0.5°C after 30 days, respectively. Both samples had low rancidity due to oxidation after 30 days when stored in amber bottle at 4.0±0.5°C, but Kironi showed greater rancidity.

3.5 Fatty Acid Composition

Fatty acid composition of sunflower oil from two varieties was determined by Gas Liquid Chromatograph (GLC) method and results are presented at Table 4. It was found that total saturated fatty acid was higher in Hysun-46 (7.48%) than that in Kironi (6.93%) and total unsaturated fatty acid was higher in Kironi (93.07%) than in Hysun-46 (92.52%). The ratio of linoleic acid to oleic acid in Kironi (2.3:1) is higher than that in Hysun-46 (1.9:1), indicating that Kironi had more semidrying capacity and suitable for edible purpose. Due to the presence of higher linoleic acid in Kironi (64.93%) it might be dry earlier than Hysun-46 (60.65%) and more suitable to industrial purposes.

Table 3. Effect of storage time and condition on the chemical characteristics of the oils

Parameters	Time interval (days)	Storage condition									
		Open vessel (Room temp.)		Close vessel (Room temp.)		Amber bottle (Room temp.)		Amber bottle (Refr. temp.)		Boiled oil (Room temp.)	
		Kironi	Hysun-46	Kironi	Hysun-46	Kironi	Hysun-46	Kironi	Hysun-46	Kironi	Hysun-46
Acid value	0	5.50	98.75	5.50	98.75	5.50	98.75	5.50	98.75	5.50	98.75
	30	4.77	94.34	5.04	94.90	6.11	100.83	5.62	40.83	12.37	40.23
	60	5.02	93.50	5.29	93.55	6.13	101.21	5.60	41.45	12.28	39.87
Iodine value	0	123.79	109.85	123.79	109.85	123.79	109.85	123.79	109.85	123.79	109.85
	30	110.28	81.16	96.12	105.50	94.27	102.46	119.52	103.10	82.41	91.65
	60	102.02	76.35	96.37	97.50	80.17	96.95	116.37	103.04	81.06	86.41
Saponifica-tion value	0	168.38	179.04	168.38	179.04	168.38	179.04	168.38	179.04	168.38	179.04
	30	162.23	151.35	179.31	188.07	187.21	183.24	143.07	162.14	165.06	172.14
	60	155.68	136.35	187.00	192.87	191.57	187.19	124.85	144.00	161.56	163.86
Peroxide value	0	107.83	92.00	107.83	92.00	107.83	92.00	107.83	92.00	107.83	92.00
	30	110.23	94.37	103.80	98.00	121.98	103.95	31.96	26.00	134.10	69.75
	60	120.40	98.21	168.24	362.80	260.94	190.00	90.72	56.16	243.93	216.00

Refr.= Refrigerator; temp.= temperature

Table 4. Fatty acid composition in percent of total oil from two varieties of sunflower seeds

Samples	Total SFA	Total UFA	Palmitic	Stearic	Oleic	Linoleic	Linoleic :Oleic
Kironi	6.93	93.07	5.35	1.58	28.14	64.93	2.3:1
Hysun-46	7.48	92.52	5.85	1.63	31.87	60.65	1.9:1

SFA = Saturated fatty acid; UFA = Unsaturated fatty acid

4. CONCLUSION

The work was conducted on sunflower seed and its oil to determine proximate composition and some nutrient contents, to study the physical and chemical properties of freshly extracted oil including its fatty acid composition and the keeping quality of oils under different conditions. Proximate composition showed that moisture, ash content, crude fibre, crude fat, crude protein, NFE were in some case Kironi is higher, in some case is lower than Hysun-46 and also nearly same. Nutrient composition showed that sugar content of Kironi was higher than Hysun-46, starch content was higher in Hysun-46 than in Kironi. Total nitrogen was nearly same for Kironi and Hysun-46 and actual protein was higher in Kironi than in Hysun-46. Proximate and nutrient compositions indicate that each variety of sunflower seeds contained high amount of oil, protein and substantial amount of carbohydrate. Among the physical characteristics at different storage conditions, viscosity, colour, transparency etc. changed with time during storage; specific gravity and smoking temperature remained unchanged. Acid values of Kironi and Hysun-46 ranged from 4.77 to 12.37 and 39.87 to 101.21 at different storage conditions. The Iodine value for Kironi ranged from 80.17 to 123.79 on different storage condition, while in case of Hysun-46, the values varied from 76.35 to 109.85. Saponification values of Kironi were found to be less than those of Hysun-46, indicate average chain length of Hysun-46 was shorter than that of Kironi. As regards to peroxide values, the study results revealed that in most storage conditions Kironi exhibited higher peroxide value. So Kironi oil seems to be more susceptible to rancidity. The total saturated fatty acid was higher in Hysun-46 (7.48%) than in Kironi (6.93%) and total unsaturated fatty acid was higher in Kironi (93.07%) than in Hysun-46 (92.52%). The ratio of linoleic acid to oleic acid in Kironi oil (2.3:1) is higher than in Hysun-46 (1.9:1), indicating that Kironi had more semidrying capacity and suitable for edible purpose. The freshly solvent extracted oil had attractive appearance with high content of Linoleic acid and is good for human health, for reduction of blood cholesterol content. Quality of the oils keep well at room temperature. Of these two oil samples Kironi seems to be somewhat superior to Hysun-46.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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