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Oil and Meal Quality of Ethiopian Sesame Varieties and their Implications for Quality Improvement

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ከዚህ በፊት በኢትዮጵያ የሰሊጥ ዝርያዎች ላይ የዘይት እና ሌሎች ንጥረ-ነገሮች ይዘታቸው በተለይም ከምርትና ጥራት የማሳደግ ሂደት ጋር ያላቸውን ተዛምዶ የሚያመለክቱ መረጃዎች እምብዛም ናቸው፡፡ ስለሆነም የንጥረ-ነገሮች እና የዘይት ጥራታቸውን እንዲሁም ከምርት እና ጥራት ማሳደግ ሂደት ጋር ያላቸውን ተያያዥነት ለመረዳት በኢትዮጵያ ውስጥ በተለቀቁ የሰሊጥ ዝርያዎች ላይ ደረጃቸውን በጠበቁ የምርምር ቅደም ተከተሎችን በመከተል የንጥረ-ነገሮቹን እና የዘይት ይዘታቸውን የመለየት፣ የመለካት እና የማመልከት የምርምር ክንውኖች ተደርገዋል፡፡ የሰሊጥ ዝርያዎቹ በዘሮቻቸው ውስጥ ያለው ጠቅላላ የዘይት (ከ44 እስከ 56)፣ የሀይል ሰጪ (ከ 3.6 እስከ 17.2)፣ የገነቢነት (ከ19.3 እስከ 27.1)፣ ጠቅለላላ የስራ ስር (ከ 4.6 እስከ 7.7) እና የአመድ (ከ 5.8 እስከ 7.4) መጠናቸው በመቶኛ በተዳዳኘ በተጠቀሰው ልክ ይለያያሉ፡፡ እንዱሁም ማዕድናት፤ Ca (ከ188. እስከ 2-666.6), Zn (ከ5.9 እስከ8.6) and Mg (ከ134.3 እስከ 165.6) ይዘታቸውበ (mg/100g) ለኬት የተለያዩ ናቸው፡፡ የዘይትን የውስጥ ይዘት መለኪያ የሆኑት፤ oleic acid (C18:1), linoleic acid (C18:2), palmitic acid (C16:0) and stearic acid (C18:0) እንደየቅደም ተከተላቸው በብዛት በሰሊጥ ዝርያዎቹ ውስጥ ይገኛሉ፡፡ጠቅላላ የዘይት መጠን እና linoleic acid ተብሎ የሚጠራው ይዘት ቀጥታ ተያያዝነት አላቸው፡፡ በአጠቃላይ በዘይት እና በሌሎች ተፈላጊ ንጥረ-ነገሮች የተሻሉት የሰሊጥ ዝርያዎች ለሚፈለገው አገልግሎት መዋል ከመቻላቸው በተጨማሪ ለፋብሪካ ምርቶች ግብአት እና ለቀጣይ የምርት እና ጥራት ማሻሻያ ምርምሮች ጠቀሜታቸው የጎላ ነው፡፡

Abstract

Reports on the physicochemical compositions and fatty acids of Ethiopian sesame genotypes and their implications on oil yield and quality improvement are limited. Proximate and mineral compositions and fatty acids of commercial sesame cultivars and their associations were examined using standard procedures like petroleum ether Soxhlet extraction and Gas chromatography-Mass spectroscopy analysis. Cultivars had immense proximate compositions, minerals, and fatty acids. The crude oil (44-56),carbohydrate (3.6-17.2), protein (19.3-27.1), crude fiber (4.6-7.7), and ash (5.8-7.4) proportion in percentage were variable in examined sesame seeds. Ca (188.2-666.6), Zn (5.9-8.6) and Mg (134.3-165.6) content (mg/100g) also varied. Oleic acid (C18:1), linoleic acid (C18:2), palmitic acid (C16:0) and stearic acid (C18:0), in that order, were the principal fatty acids identified. Crude oil was positively correlated with a linoleic acid.In all, best cultivars with more desirable constituent(s) can be used for intended purposes like industrial input and sesame oil yield and quality improvement programs.

Introduction

Sesame seed (*Sesamumindicum*) is an oil seed plant belongs to the family *Pedaliaceae*. It is cultivated mainly for oil and protein. Sesame is with high potential crop despite listed under high priority industrial underutilized crops (Williams and Haq, 2002).

Sesame has high nutritive and therapeutic qualities. It is a rich source of macro and micro nutrients (including proteins, dietary lignans, vitamins, calcium, phosphorus), and oil with high nutritive value so that used as a supplement for unbalanced diet. Nutraceuticals and pharmaceutical products of sesame can decrease the risk of neurological, dermatological, cancer and heart disease (Prasad *et al.*, 2012).

Sesame genotypes have wide genetic diversity (Ganesh *et al.*, 1995; Patil *et al.*, 1994), and variable in crude oil (Hwang, 2005), fatty acids (Saeed *et al.*, 2015, Were *et al.*, 2006), crude fiber (Hwang, 2005) and carbohydrate (Tunde-Akintunde *et al.*, 2012), and also have no genetic relationship in geographical origin (Laurentin and Karlovsky, 2006) indicating the gene pool is wide, opportunities for trait-based genotype selection and immense potential for the sesame breeding program. On the other hand, difficulty to put different origin sesame genotypes into different groups (Sehr, *et al.*, 2016). Thus, description of different set of sesame population demand independent study.

The examination of genetic relationship and seed constituents would aid to exploit the potential of sesame cultivars. However, studies associated with the Ethiopian sesame oil yield and quality improvement are limited. Thus the physicochemical compositions, fatty acidsprofile and their implications for sesame seed constituent improvement were examined.

Materials and Methods

Eleven commercial sesame cultivars (Table 1) seeds harvested in 2014 main cropping season were obtained from Oilseeds Research Program of Haramaya University, Ethiopia. Since the plant materials are released varieties through accredited procedure, biological traits are believed to be uniform and stabile.

Seed samples were cleaned manually to remove foreign materials, immature, shriveled and damaged seeds. Seed samples were then ground to a fine powder using Waring commercial laboratory blender (Torrington, U.S.A), sieved by 1mm sieve and stored in an airtight glass container at ambient temperature till used for the intended experiments.

Table 1. Hundred seed weight of 11 commercial sesame cultivars

Cultivar	Hundred seed weight (g)	Cultivar	Hundred seed weight (g)
E	0.29	*Mahadot*	0.31
T-85	0.29	*Adi*	0.30
Tate	0.27	*BaHa-necho*	0.26
Kelafo-74	0.29	*BaHa-zeyit*	0.21
Sarkamo	0.30	Local cultivar	0.27
Abasena	0.27		

Chemicals and reagents

All the chemicals and reagents used in this study were purchased from high-tech health care (India), BDH Chemicals (England), Merck and Sigma Aldrich (Germany).

Crude oil extraction

Oils of each powdered seed sample (25.00 g) were extracted for 8 hours with petroleum ether (Merck, boiling range 40 - 60 °C) in a Soxhlet apparatus. The extracted oils were dried over anhydrous sodium sulfate and the solvent was removed under reduced pressure in a rotary evaporator (JAICO, India). Oil percentage was determined by weight difference.

Moisture, ash, protein, carbohydrate and crude fiber contents

Moisture and nitrogen contents were determined on a dry weight basis using standard methods(AOAC, 1996). The nitrogen content was estimated by the Kjeldahl method and converted to protein percentage by using the conversion factor 5.46 (AOAC, 1996). Ash was determined by incineration in a muffle furnace at 600 °C (AACC, 2000). Carbohydrate content was estimated by difference with the other values. Experiments were done in duplicate. Crude fiber of each defatted sample was determined using the international standard method (AACC, 2000).

Mineral analysis

Minerals were determined by using the standard method (AOAC International, 2003) in duplicate. Calcium, zinc and magnesium were determined in each seed sample by Atomic Absorption Spectrometry (Buck scientific, 210 / 211VGP).

Fatty acid profile

Fatty acid methyl esters (FAMEs) were prepared by standard IUPAC method 2.301(IUPAC 1979). Briefly, samples of crude seed oil (100 mg)was accurately weighed, placed in 50 ml round bottom flask, followed by the addition of 1 N methanolicpotassium hydroxide solution (0.5 ml). The mixture was refluxed at 70 °C for 20 min. After cooling under running water, hexane (Sigma Aldrich, 10mL) was added, followed by distilled water (10 ml). The mixture was vortex mixed for 15 min and the upper phase (hexane layer) containing the FAMEs was separated and dried over anhydrous sodium sulphate. It was then filtered through What man No. 1 filter paper and transferred into an airtight sample vial for Gas chromatography-Mass spectroscopy (GC/MS) analysis.

GC-MS instrumentation

Analysis of FAME was performed on Agilent GC-MS (HP 6890) equipped with a split/split less injector. Separations were achieved using a fused silica phenylmethyl polysiloxane capillary column (30 m x 0.25 mm ID, 0.25 µm film thickness). Helium was used as the carrier gas at flow rates of 1.0 ml/min and a split ratio of 1:10. The injector temperature was maintained at 230°C. The GC oven temperature was programmed with a range of 100 to 300 °C for a hold of 10 min and increased to 250̊ C at a rate of 6°C/min. The MS conditions were: ionization energy, 70 eV; electronic impact ion source temperature, 200 ^{0}C; quadru pole temperature, 100 ^{0}C; scan rate, 1.6 scan/s; m/z, 40-500 amu. For the identification of the compounds the mass spectra of the samples were compared with those of the NIST/EPA/NIH Mass Spectral Library 2.0.

Statistical analysis

Analysis of variance performed using a statistical analysis system (SAS) software version 9.0 software (SAS Institute Inc., 2002). Spearman's rank correlation analysis, and hierarchical cluster analysis were performed to examine the trend of association and genetic relationship of sesame cultivars, respectively, using statistical procedures for social sciences (SPSS) software Version 20.Means were compared using Duncan's multiple range tests.

Results and Discussions

The analysis of variance (Table 2) revealed significant differences among sesame cultivars for physicochemical traits suggesting a further examination to identify the extent of difference.

Table 2. Analysis of variance of the physicochemical characteristics of 11 commercial sesame cultivars

Source	Df	Mean square							
		Moisture	Ash	Protein	Crude fiber	Ca	Mg	Zn	Carbohydrate
Variety	10	1.187**	0.597**	12.030**	2.030**	59697.669**	207.151*	1.364**	34.380**
Error	11	0.172	0.071	0.947	0.040	612.884	50490	0.223	1.428

** Significant at 1% probability level, * significant at 5% probability level.

The seed oils of sesame cultivars were pale yellow in color and in a liquid state at room temperature. The crude oil content of the cultivars were ranged from 44.00 - 56.00% (Table 3). *BaHa-zeyit* had the highest oil content (56%) followed by*BaHa-necho*(52%) andAbasena (52%).

Table 3. Seed oil content and the physicochemical characteristics of 11 commercial sesame cultivarsin percentage

Variety	Oil	Moisture†	Ash†	Protein†	Carbohydrate†	Crude fiber†
E	50.00	4.33^{ab}	6.64^{bc}	23.01^{b}	10.60^{c}	5.41^{d}
T-85	48.00	4.83^{a}	6.77^{ab}	19.69^{c}	14.32^{b}	6.39^{c}
Tate	48.00	3.00^{d}	7.41^{a}	19.25^{c}	15.59^{ab}	6.75^{bc}
Kelafo-74	44.00	4.67^{a}	7.03^{ab}	21.8^{b}	17.19^{a}	5.24^{d}
Sarkamo	50.40	4.50^{a}	7.14^{ab}	23.19^{b}	9.17^{cd}	5.60^{d}
Abasena	52.00	$3.50b^{cd}$	6.50^{bc}	23.63^{b}	6.68^{d}	7.70^{a}
Mahadot	48.00	4.50^{a}	6.97^{ab}	22.75^{b}	10.86^{c}	6.92^{b}
Adi	50.80	4.17^{abc}	5.80^{d}	24.24^{b}	8.43^{cd}	6.56^{bc}
BaHa-necho	52.00	3.33^{dc}	5.79^{d}	22.75^{b}	8.42^{cd}	7.70^{a}
BaHa-zeyit	56.00	2.67^{d}	6.12^{cd}	27.13^{a}	3.55^{e}	4.55^{e}
Local	48.00	4.83^{a}	7.05^{ab}	26.86^{a}	6.68^{d}	6.573^{bc}
Mean	49.75	4.03	6.66	23.12	10.14	6.31
MSE		0.172	0.071	0.947	1.428	0.040
CV (%)		10.28	3.99	4.21	11.79	3.15

†Means with same super script were not significantly different at $p < 0.05$.

The moisture content of the cultivars ranged from 2.67 (*BaHa-zeyit*) to 4.8% (local and *T-85*). The lowest seed moisture content the best would be prevention of rancidity and shelf-life of the oil. The ash content was ranged from 5.8 (*Adi* and *BaHa-necho*) to 7.4% (*Tate*). Ash is inorganic content and source of minerals; meaning it is an index for total mineral matter. Protein content ranged from 19.3 (*Tate*) to 27.1% (*BaHa-zeyit* and local cultivar). The carbohydrate was from 3.6 (*BaHa-zeyit*) to 17.2% (*Kelafo-74*). Oils with low carbohydrate content is might be useful for diabetics and hypertensive patients. The crude fiber was ranged from 4.6 (*BaHa-zeyit*) to 7.7% (*Abasena* and *BaHa-necho*in equal proportion). Fiber reduces blood cholesterol and glucose level (Bello *et al*., 2008).

Mineral composition

Mean values (mg/100g) of Ca in sesame cultivars were variable (Table 4). *Tate* (666.6),*Mahadot* (663.2) and *Sarkamo* (642.3), in that order, were best cultivars in Ca content. Calcium is helpful for muscle contractions, transmission of nerve impulses and bone formation (Cataldo *et al*., 1999). Zn content was highest in E (8.6),*Tate* (8.3) and *Mahadot* (7.9).Mg content was highest in T-85 (165.6), *Kelafo-74* (162.0) and *Abasena* (162.0), in that order. *Tate* and *Mahadot* can be selected at a time for Ca and Zn after the inheritance of the traits are confirmed. The lowest value of Ca, Zn and Mg were recorded in E (188.2), *BaHa-necho* (5.9) and *Sarkamo* (134.39), respectively. These essential minerals are useful for metabolic processes.

Table 4: Mineral contents of commercial sesame cultivars

Variety	Mean (mg/100g)		
	Ca†	Zn†	Mg†
E	188.23^{e}	8.57^{a}	144.39^{bcd}
T-85	445.54^{b}	7.51^{ab}	165.55^{a}
Tate	666.57^{a}	8.30^{a}	150.71^{abcd}
Kelafo-74	343.14^{c}	7.53^{ab}	162.03^{a}
Sarkamo	642.30^{a}	7.42^{ab}	134.29^{d}
Abasena	350.00^{c}	7.47^{ab}	162.03^{a}
Mahadot	663.20^{a}	7.87^{a}	138.57^{dc}
Adi	243.28^{d}	6.55^{bc}	160.68^{ab}
BaHa-necho	259.48^{d}	5.92^{c}	155.17^{abc}
BaHa-zeyit	334.50^{c}	6.63^{bc}	156.37^{ab}
Local cultivar	420.77^{b}	6.38^{bc}	154.60^{abc}
Mean	414.27	7.29	153.126
MSE	612.884	0.223	50.490
CV (%)	5.98	6.49	4.64

†Means with samesuperscript were non-significantat $p < 0.05$.

Dendrogram (Fig 1) suggested three families: the first family included*Sarkamo*, *Mahadot* and *Tate*. The other family encompassed *Adi, BaHa-necho* and *E*. The third family embraced *Abasena, BaHa-zeyit* and *Kelafo-74*.

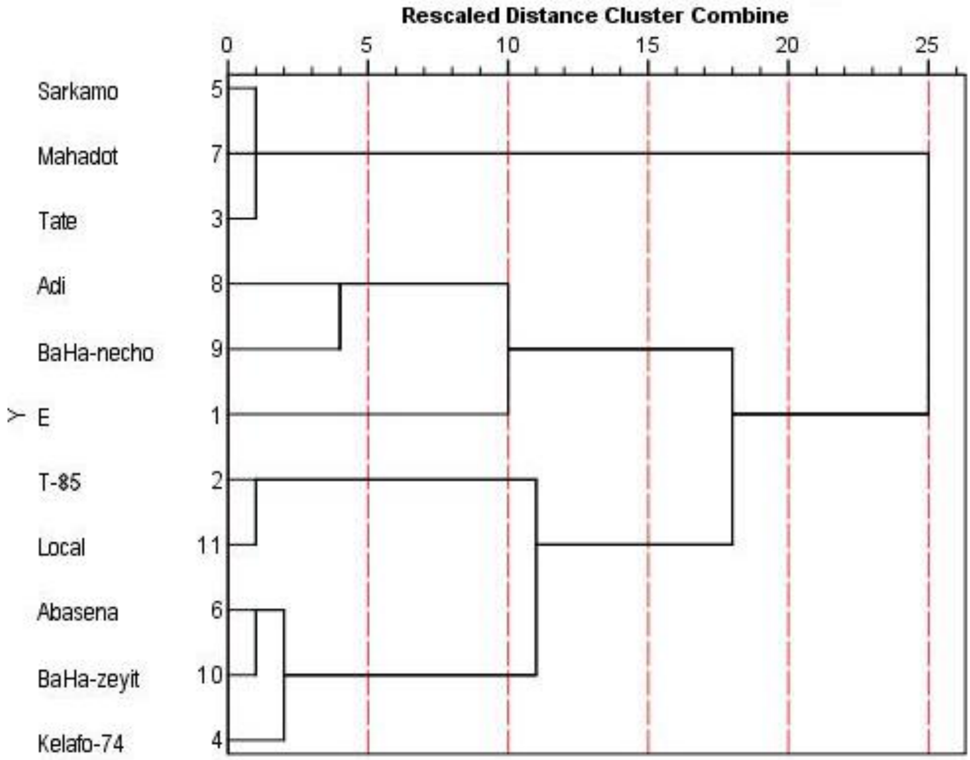

Figure 1. Dendrogram showing genetic relationships for physicochemical properties of 11 sesame cultivars. Cluster=ash, protein, carbohydrate, crude fiber, Ca, Zn and Mg. Method=single linkage. Measure=correlation. Id=cultivars. Plot=Dendrogram.

The second and the third families were more closely related than the first family, suggesting crosses between distant families may result substantial segregates and facilitate for further selection. *Adi* and *BaHa-necho,* and *Abasena* and *BaHa-zeyit* were among most related genotypes. Fascinatingly, the first pairs (as the names 'a*di*' and '*necho*' indicate in local languages) were white seeded, and the second pairs were grayish in seed color indicating the efficiency of Dendrogram to identify the relationships of genotypes based on physicochemical traits**.**

Fatty acid composition

GC coupled with MS (GC-MS) was applied to identify and quantify the composition of fatty acids in the seed oil of sesame cultivars. The saturated fatty acids (SFAs): Myristic acid (C14:0),palmitic acid (C16:0), stearic acid (C18:0), arachidic acid (C20:0), and unsaturated fatty acids (UFAs): Palmitoleic acid (C16:1),oleic acid (C18:1), linoleic acid (C18:2) and eicosenoic acid (20:1)were the major fatty acid components; among which oleic and linoleic acids had the highest retention time (**Fig. 2**).

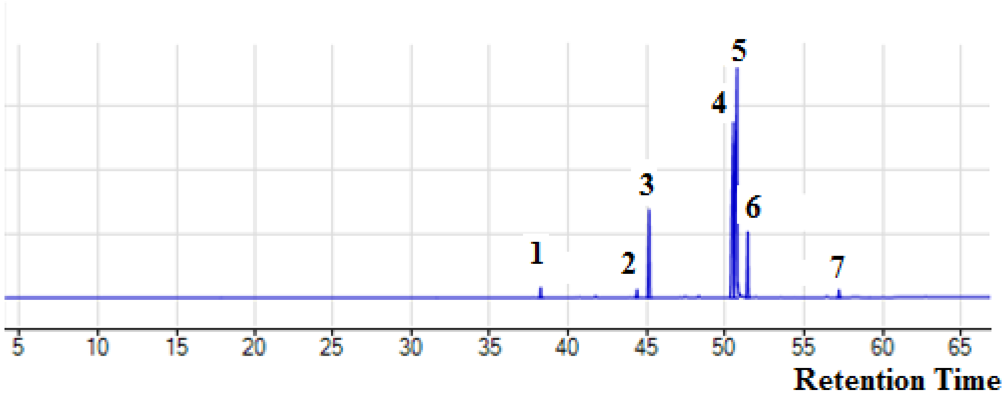

Figure 2. Gas chromatographic profiles of seed oil of sesame commercial cultivars
1: Myristic (14:0), **2**: Palmitoleic (16:1), **3**: Palmitic (16:0) **4**: Linoleic (18:2), **5**: Oleic (18:1), **6**: Stearic (18:0) and **7**: Arachidic (20:0) acids

Fatty acid profiles of seed oils of 11 commercial sesame cultivars revealed variation. Ten different fatty acids were identified in the examined seed oils. Sesame cultivars were deficient in either myristic, palmitoleic, or eicosenoic acids(Table 6.). Palmitic acid, linoleic acid, oleic acid and stearic acid were predominantly found in all sesame cultivars. Although in small proportion, arachidic acid was found in all examined cultivars, except in *Abasena*.

Table 6: Fatty acid composition, UFA/SFA and O/L ratios of Sesame seed oils

Variety	Fatty acid composition (%)								UFA/SFA	O/L
	C14:0	C16:1	C16:0	C18:2	C18:1	C18:0	C20:1	C20:0		
E	-*	-	9.76	39.32	41.41	7.59	-	0.80	4.45	1.05
T-85	-	-	9.79	40.11	40.64	7.50	-	0.81	4.46	1.01
Tate	-	-	8.49	37.32	43.00	7.19	-	0.88	4.85	1.15
Kelafo-74	-	-	8.11	39.70	43.48	7.44	0.24	1.03	5.03	1.10
Serkamo	0.96	0.61	10.72	35.64	41.88	7.91	-	0.93	3.81	1.18
Abasena	-	-	9.22	40.88	42.55	7.36	-	-	5.03	1.04
Mahadot	0.99	0.82	11.44	41.62	41.85	8.56	-	0.87	3.86	1.01
Adi	-	-	9.18	38.25	43.41	7.23	-	0.86	4.73	1.13
BaHa-necho	-	-	8.77	41.38	41.31	6.76	-	0.72	5.09	1.00
BaHa-zeyit	-	-	8.21	42.07	42.18	6.74	-	0.79	5.35	1.00
Local	-	-	10.20	34.24	39.94	6.52	-	0.63	4.28	1.17

C14:0 = Myristic, C16:1 = Palmitoleic, C16:0= Palmitic, C18:2= Linoleic, C18:1= Oleic, C18:0**=** Stearic, C20:1= Eicosenoicand C20:0= Arachidicacids, UFA= unsaturated fatty acid, SFA= saturated fatty acid, O= oleic acid, L= Linoleic acid,* = not detected

Oleic and linoleic acids were the major components of UFAs, while palmitic and stearic acids were predominant in SFAs.

Oleic acid was found in all examined cultivars, and ranged from 39.9 (local cultivar) to 43.5 (*kelafo-74*). It is good for cooking and salad oils (Green and Marshal, 1981).The highest percentage of linoleic acid was recoded in *BaHa-zeyit* (42.1%) followed by *Mahadot*

(41.6%), *BaHa-necho* (41.4%), and *Abasena* (40.9%), in that order, indicating had good quality cooking oils. The highest UFAs were recorded in *BaHa-zeyit* (84.3%) and Mahadot (84.3%).Comparatively *Mahadot* (11.4%) had the highest palmitic acid followed by *Serkamo* (10.7) and local cultivar (10.2). Palmitic acid is known for the production of fat products like margarine. *BaHa-zeyit* (5.1%), *BaHa-necho* (5.1%), *Abasena* (5.0%) and *Kelafo-74* (5.0%), in that order, had comparatively the highest UFA to SFA ratio. An equal proportion of crude fiber, crude oil and linoleic acid were recorded in *BaHa-necho* and *Abasena.* The cultivars had little differences in oleic to linoleic ratio (Table 6). The oleic to linoleic acid ratio is an indicator of oil stability and shelf-life, i.e., the higher oleic to linoleic ratio the better would be shelf-life, stability, and oil quality (Bansal *et al.,* 1993).

Table 7. Correlation coefficients of fatty acids of 11 commercial sesame cultivars

	Oil	Fatty acids						
		C14:0	C16:1	C16:0	C18:2	C18:1	C18:0	C20:1
C14:0	0.118^{ns}							
C16:1	0.118^{ns}	1.000**						
C16:0	-0.065^{ns}	0.674*	0.674*					
C18:2	0.620*	0.054^{ns}	0.054^{ns}	-0.227^{ns}				
C18:1	-0.210^{ns}	-0.081^{ns}	-0.081^{ns}	-0.600^{ns}	0.018^{ns}			
C18:0	-0.075^{ns}	0.674*	0.674*	0.518^{ns}	0.064^{ns}	0.055^{ns}		
C20:1	-0.256^{ns}	-0.148^{ns}	-0.148^{ns}	-0.500^{ns}	0.000^{ns}	0.500^{ns}	0.100^{ns}	
C20:0	-0.061^{ns}	0.431^{ns}	0.431^{ns}	-0.073^{ns}	-0.245^{ns}	0.500^{ns}	0.527^{ns}	0.500^{ns}

C14:0 = Myristic, C16:1 = Palmitoleic, C16:0= Palmitic, C18:2= Linoleic, C18:1= Oleic, C18:0= Stearic, C20:1= Eicosenoic and C20:0= Arachidic acids, UFA= unsaturated fatty acid, SFA= saturated fatty acid, O= oleic acid, L= Linoleic acid,'*' and '**' are significant at ($p<0.05$) and ($p<0.01$), respectively, ns=non-significant.

Majority pairs of crude oil content and fatty acids had no definite association (Table 7). Oil content is significantly ($p<0.05$) and positively correlated with linoleic acid. Myristic acid was significantly correlated with a palmitoleic acid ($p<0.01$), palmitic acid ($p<0.05$), and stearic acid ($p<0.05$). Palmitoleic acid was positively correlated with palmitic oil ($p<0.05$) and stearic acid ($p<0.05$). While any other pairs of oil content and fatty acids had insignificant correlations.

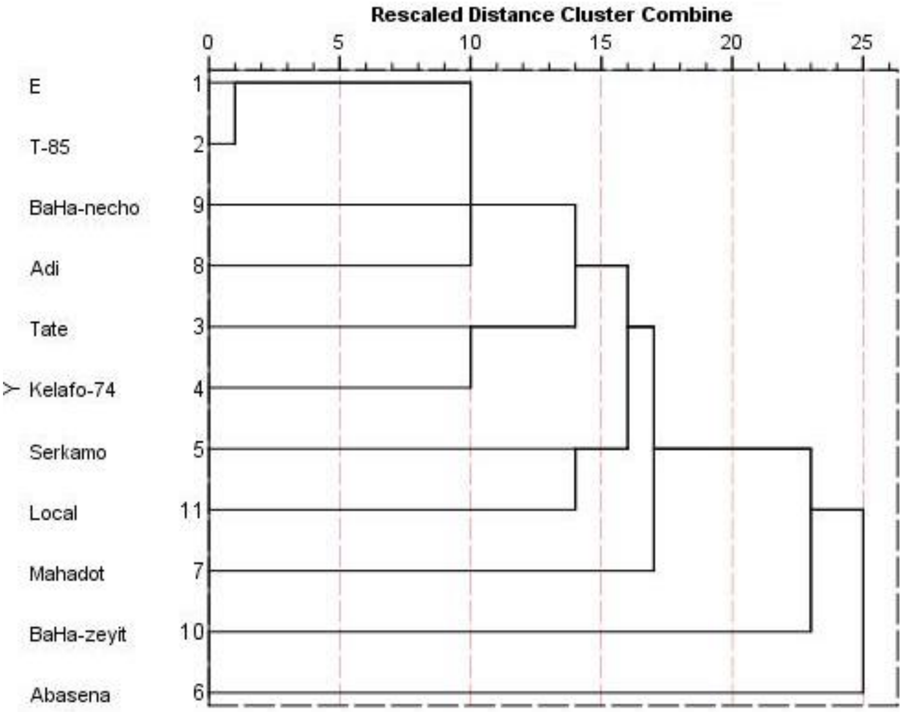

Figure 3. Dendrogram showing genetic relationships for oil content and fatty acid profiles of 11 sesame cultivars.
Cluster=oil, C14:0, C16:1, C16:0, C18:2, C18:1, C18:0, C20:1 and C20:0. Method=single linkage. Measure=Euclid. Id=cultivars. Plot=Dendrogram.

Oil content and fatty acids compositions based study (Fig 3) depicted that E and T-85 were most closely related cultivars. Adi and BaHa-necho were also among closely related cultivars. Abasena (simplicifolious, meaning clade with single leaf) was most closely related to BaHa-zeyit.

Conclusions

Ethiopian commercial sesame cultivars consists immense proximate and mineral composition, and fatty acids. *BaHa-zeyit* had low (2.7%) moisture compared to the other cultivars revealing best in the prevention of oil rancidity and had a long shelf-life. The best cultivars identified were: *Mahadot* in Ca (663.2mg/100g), Zn (7.9 mg/100g) and linoleic acid (41.6%), palmitic acid (11.4%) and UFAs (84%).*Sarkamo* in Ca (642.3 mg/100g) and palmitic acid (10.7%). *Kelafo-74* in *Mg* (162.0mg/100g), carbohydrate (17.2%) and oleic acid (43.5%).*Tate* in Ca (666.6 mg/100g), Zn (8.3 mg/100g), oleic acid (43.0%) and ash (7.4%).*BaHa-zeyit* in protein (27.1%), crude oil (56%), linoleic acid (42.1%), oleic acid (42.2%), UFAs (84%) and UFA to SFA ratio. E and T-85 in Zn (8.6 mg/100g) and Mg (165.6mg/100g).*BaHa-necho* and *Abasena* in crude fiber (7.7%), oil (52%), and linoleic acid (40.9%) in equal percentages. *Abasena* was also good in oleic acid content (42.6%); and the local cultivar in protein (27.1%) and palmitic acid (10.2%). Actually, the oleic acid content ranged from 39.9 (local cultivar) to 43.5% (*kelafo-74*).

Oil content significantly ($p<0.05$) and positively correlated with a linoleic acid, suggesting simultaneous breeding for oil content and linoleic acid. Myristic acid was significantly correlated with a palmitoleic acid ($p<0.01$), palmitic acid ($p<0.05$), and stearic acid ($p<0.05$). Dendrogram generated based on proximity and mineral compositions, crude oil and fatty acid compositions revealed *Adi and BaHa-necho,* and *Abasena* and *BaHa-zeyit* were closely related cultivars, while they were mainly variable in crude fiber, protein, crude oil and fatty acids.

In all, the examined commercial sesame cultivars have paramount industrial importance, and can be used in the yield and quality improvement program in days to come. The heritability and stability of traits of interest require verification using reliable and advanced techniques.

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References

AACC International. 2000. Approved methods of analysis. Method 08-03.01. Ash-rapid (2-hour, 600 ^{0}) method. American Association of Cereal Chemists, Inc. MN, USA.

AACC International. 2000. Approved methods of analysis. Method 32-10. Crude fiber in flours, feeds, and feed stuffs. American Association of Cereal Chemists, Inc. MN, USA.

AOAC International. 2003. Official methods of analysis of AOAC International. 17th edition. 2nd revision. Gaithersburg, MD, USA. Association of analytical communities.

AOAC. 1996. Official methods of analysis of the AOAC international. 16th edition. 2nd revision. Gaithersburg, MD, USA. The Association of Official Analytical Chemists.

Bansal, U.K., Satija, D.R., Ahuja, K.L. 1993. Oil composition of diverse groundnut *(Arachi hypogaea* L.) genotypes in relation to different environments, *Journal of Science Food Agriculture*. 63: 17-19.

Bello, M.O.I., Flade, O.S., Adewusi, S.R.A. and Olawore, N.O. 2008. Studies on the chemical composition and antinutrients of some lesser known Nigerian fruits. *African Journal of Biotechnology*. 7: 3972-3979.

Cataldo, C.B., DeBruyne, L.K., and Whitney, E.N. 1999. Nutrition and diet therapy: Principles and practice. Belmont, Calif: West/Wadsworth.

Ganesh, S.K., and Thangavelu, S. 1995. Genetic divergence in Sesame (*Sesamumindicum*L.). *Madras Agricultural Journal*. 82(4): 263-265.

Green, A.G., and Marshall, D.R. 1981. Variation of oil quantity and quality in linseed having reduced linolenic acid content. *Australian Journal of Agricultural Research*. 32: 599-607.

Hwang, L.S. 2005. Sesame oil. Bailey's industrial oil and fat products, Chapter 12, 6th Edition, Six Volume Set., John Wiley & Sons, Inc.

IBM Corp. Released. 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.

IUPAC. 1979. Standard methods for the analysis of oils, fats and derivatives. 6th edition. pp.96-98. Pergamon Press, Oxford ox3 0BW, England.

Laurentin, H. E and Karlovsky, P. 2006. Genetic relationship and diversity in a sesame (*Sesamum indicum* L.) germplasm collection using amplified fragment length polymorphism (AFLP). *BMC genetics.* 7:10.

Patil, R.R. and Sheriff, R.A. 1994. Genetic divergence in Sesame (*Sesamum indicum* L.). *Mysore Journal of agricultural science.* 28: 106-110.

Prasad, MN N., Sanjay, KR, Prasad, D.S. et al. 2012. A review on nutritional and nutraceutical properties of sesame. *Journal of Nutrition and Food Science*. 2:127.

Saeed, F., Qamar, A., Nadeem, M. T., Ahmed, R. S., Arshad, M. S., Afzaal, M. 2015. Nutritional composition and fatty acid profile of some promising sesame cultivars. *Pakistan Journal of Food Science.* 25 (2): 98-103.

SAS Institute Inc. 2002. User Guide for the SAS System, Version 9 for Microsoft Windows, Cary, NC: SAS Institute Inc.

Sehr, E.M., Okello-Anyanga, W., Hasel-Hohl, K., *et al*. 2016. Assessment of genetic diversity amongst Ugandan sesame (*Sesamum indicum* L.) landraces based on agro morphological traits and genetic markers. *Journal Crop Science and Biotechnology*.19 (1):117-129.

Tunde-Akintunde, T. Y., Oke, M.O. and Akintunde, B. O. 2012. Sesame seed, oilseeds. InTech.ISBN: 978-953-51-0665-4.

Were, B.A., Onkware, A.O., Gudu, S. *et al*. 2006. Seed oil content and fatty acid composition in East Africa sesame (*Sesamumindicum* L.) accessions evaluated over 3 years. *Field Crops Research.* 97: 254-260.

Williams, J.T. and Haq, N. 2002. Global research on underutilized crops. An assessment of current activities and proposals for enhanced cooperation. ICUC, Southampton, UK.