Proximate and Fatty Acid Composition of Sunflower and Safflower Cultivars

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Abstract

Proximate and fatty acid compositions of two sunflower cultivars (Rassian black and Oissa) and one safflower (Turkana) cultivar were evaluated. Proximate analysis of the sunflower and safflower seeds was carried out using AOAC method and fatty acid profile was determined using Gas Chromatograph-Mass Spectrometer. The result showed that sunflower cultivar Oissa was higher in percentage of fat (46.9%) than Rassian black (44.3 %) was and oil content of safflower cultivar Turkana was 25.1 %. The fatty acid composition of seed oil indicated that the predominant fatty acid in Turkana was linoleic (74.9 %), followed by oleic (16.5%), palmitic (6.7%) and stearic (1.8 %).The fatty acid composition of cultivar Oissa was higher in linoleic (56.2%),compared to Rassianblack (32.9%). On the other hand, Rassianblack was higher in percentage of long chain mono unsaturated fatty acid (oleic acid) content (56.6%), compared to Oissa (31.7%), and had lower palmitic and stearic acid content than did Oissa. Therefore, sunflower and safflower cultivars with high linoleic and oleic fatty and low saturated fatty acids (palmiticand stearic) appeared to be suitable for human consumption.

Introduction

Oilseeds are the mainstay of the rural agrarian community and play an important role in the nationaleconomy of Ethiopia. Oilseeds, apart from being source of oil, have a lot of nutritional value. They provide 35-50% fat or oil, 20-30% protein, 20-35 carbohydrate and 4-6% essential minerals that have numerous health benefits (Misteru *et al*., 2013). Oil content and fatty acid synthesis of crops are influenced by many factors, such as genotype, ecology, morphology, physiology and management (timeliness of field operations, variety, plant density, fertilization etc.) (Al Surmi *et al*. (2015).

Lipids and triacylglycerol naturally occur in oils and fats. Their chemical composition involves saturated and unsaturated fatty acids and glycerides. Unsaturated Fatty acids (FAs) are classified as monounsaturated (MUFA) and poly unsaturated (PUFA) fatty acids. Edible oil is an essential nutrient and an important source of energy providing nine kcal/g.Edible oils are vital constituents of our daily diet, which provide energy, essential fatty acids and serve as a carrier of fat-soluble vitamins. Oils in the diet are available to the body as fatty acids, which are excellent sources of dietary calorie intake. However, high fat dietsenhance the incidence of coronary heart disease (Romon *et al.*, 1995, Simon *et al.*, 1995).

Nutritionists recommend vegetable oils asimportant part of a healthy diet due to their high contentsof fatty acids (Maehre *et al.*, 2014). However, distribution and content of fatty acids differ with plant sources of oils and processing technology used for their production. Sunflower and safflower oil is considered premium oil due to its lightcolor, mild flavor and low level of saturated fats (Putnam *et al*., 1990). The aim of this study was therefore, to evaluate nutritional composition and fatty acid profile of improved sunflower and safflower cultivars.

Materials and Methods

Twosunflower cultivars namely, Rassian black and Oissa and one safflower cultivar, Turkana, were evaluated for proximate and fatty acid composition. A Kg of seed was collected fromnational oil seed research program based at Holetta Agricultural Research Center.

Sample preparation

The collected samples were ground with ultra-centrifugal mill and stored in a plastic vial for laboratory analysis.

Proximate composition analysis

Moisture content

Moisture content of the oil seeds was determined using oven drying method. Two g of ground sample was dried in air conviction oven at 130^0C and the weight difference (before and after drying) was calculated and expressed as percentage moisture content (AOAC, 2000).

Crude fat (oil content)

The oil content of ground sunflower and safflower seeds was determined by extracting 2 g of sample with hexane for 6 hours in soxhlet extraction system according to AOAC (2000)**.**

Protein content

Crude protein content was determined using Micro Kjeldahlsystem. 0.25g of sample was digested by adding 10ml of sulfuricacid with selenium mixture as catalyst for 2 hours. After light green color was observed, the digest solution wascooled, transferred into 100ml volumetric flask, and made up to final volume of 100 ml with distilled water. Micro Kjeldahl distillation apparatus was used to distill 25ml of the prepared digest by the addition of 70 ml of 40% sodiumhydroxide. The blue color changed to dark brown as distillation proceeded. The released ammonia was condensed and collected into a receiver containing 30mlof boric acid with indicator solution. The condensedammonia was then back titrated with 0.01M HCl to pink color end and crude protein content was calculated from the nitrogen content as follows.

$$\% \ Kjeldahl \ Nitrogen = \frac{(V_S - V_B) \ x \ N \ x \ 14.01}{^{164}W \ x \ 10}$$

Where: V_S = ml of standardized acid used to titrate a sample, V_B = ml of standardized acid used to titrate a reagent blank, N = normality of standard HCl, 14.01= atomic weight of nitrogen, W = weight, in grams, of sample, 10 = factor to convert mg/gram to percent:

% Crude protein = % Kjeldahl Nitrogen × 6.25

Ash content

Ash content of ground seed was determined by incinerating the sample in furnace using crucible. There gram of the ground sample was weighed out into the crucible and placed in a temperature-controlled furnace at 500^0C for about 5hours. The crucible was then cooled in desiccator and immediately weighed, and ash content was calculated as:

$$\% \text{ Ash} = \frac{Wt\ of\ ash}{Wt\ of\ sample} x\ 100$$

Analysis of fatty acid methyl esters

Analysis of fatty acid methyl ester (FAME) was carried out using Gas Chromatograph Mass spectrophotometer (GC-MS) (Agilent Technology model 7820A). The GC was equipped with Mass Spectrometer detector and stainless-steel column (30 x 0.250m). The column was conditioned at 180 ℃ for about 2 hours to attaining thermal stability before use. The operating condition was programmed at oven temperature of 150 ^{0}C (hold time 5min) with increasing rate of 8℃/min to190 ℃ (hold time 0 min) and injection temperature at 350 ℃. Peak identification was established by comparing the retention times with very spectral library and quantified based on relative peak area of the fatty acid spectrum.

Result and Discussion

Proximate composition

The proximate composition of sunflowercultivars Oissa and Rassian blackshowed moisture content of 6.9 and 7.0%, protein content of 14.9 and 16.5%, fat content of 46.9 and 44.3 %, and ash content of 3.6& 2.4%, respectively. The oil yield of Oissa was higher than that of Rassian blackand both cultivarsfulfil the Australian oilseeds federation (AOF) standards, which is a minimum of 40% (AOF, 2016).On the other hand, safflower cultivar Turkana was found to have 8.1% moisture, 9.6% protein, 25.1% oil (25.1%) and 2.2% ash (Table 1). The oil content of Turkana falls within the range of 24.53 % to 28.47 % which some safflower varieties exhibited in Ankara, (Bilal *et al*, 2007).In general, the result of the present study showed that sunflower seed oil, protein and total mineral were higher than that of safflower (Table 1).

Table 1: Proximate composition of sunflower and safflower cultivars

Cultivar	Protein (%)	Moisture (%)	Oil (%)	Ash (%)
Oissa	14.9	6.9	46.9	3.6
Rassian black	16.5	7.0	44.3	2.4
Turkana*	9.6	8.1	25.1	2.2

**Safflower cultivar*

Fatty acid composition

The fatty acid composition of total lipids extracted from seed of sunflower and safflower cultivars is presented in Table 2. The result showed that, the predominant fattyacids in seed oil of safflower cultivar Turkana were linoleic acid (74.9 %), followed by oleic (16.5%), palmetic (6.8%) and stearic (1.8 %). These results agree with data previously reported by Bilal *et al,* (2007) and Al Surmi*et al*. (2015) in Turky and Egypt, respectively. Linoleic acid is relevant for human health in the prevention of particularly cardiovascular disease, coronary heart disease and cancer, inflammatory, hypertension; diabetes type two, renal diseases and rheumatoid arthritis. Their non-substitutable roles in many biological pathways are crucial (De Caterina *et al*., 2000, Abedi and Sahari, 2014). Furthermore, Al Surmi*et al*., (2015) have reported that the fatty acid composition of vegetable oil is a main factor affecting its commercial uses and influenced by a lot of factors such as genotype and environmental conditions.

Table 2: Fatty acid composition of seed oil of two sun flower and one safflower cultivars (in % total fatty acids)

Fatty acid	Sunflower		Safflower
	Oissa	Rassian black	Turkana*
Palmitic ($C_{16:0}$)	7.37	6.82	6.75
Stearic ($C_{18:0}$)	5.75	3.59	1.84
Oleic ($C_{18:1}$)	30.67	56.66	16.49
Linoleic ($C_{18:2}$)	56.19	32.91	74.90

*Safflower cultivar

Fatty acid composition of the two sunflower cultivars Rassian black and Oissa was highly different (Table 2). It was observed that Oleic acid (C18:1) was the major fatty acid in Russian black (56.6%), and it is believed to be very useful in lowering cholesterol content (Gard *et al.,* 1989). On the other hand, linoleic acid (C18:2) was the major fatty acid in Oissa (56.2%). In line with this, relative concentration and distribution of fatty acids in dietary fats has been reported to be an important factor in considering nutritional values of lipids as well as the key factor with proved effects of lowering the risk of cardiovascular diseases (Mišurcová*et al.*,2011). According to Codex Alimentarius (Codex stan210-1999), sunflower seed oil for edible purpose should have 5-7.6% palmitic,2.7-6.5% stearic,14-39.4% oleic and 48.3-74% linoleic andfor safflower, palmiticshould be 5.3-8%,stearic1.9-2.9%,oleic8.4-21.3% and linoleic67.8-83.2%.Hence,all the fatty acids detected for both sunflower and safflower seed oil in the present study were in the acceptable range.

Conclusion

Proximate and fatty acid composition of sunflower and safflower cultivars generally varied andthere was also a difference in fatty acid composition of the two sunflower cultivars.Sunflower seed had higher oil content than safflower seed. Between the two sunflower varieties, Oissa had higher oil yield than did Rassian black. It was observed that the predominant fatty acid in safflower cultivar Turkana and sunflower cultivar Oissa seed oil was linoleic acid. On the other hand, the major fatty acid in seed oil of Rassian black was oleic acid. In general, all the oil seeds evaluated in the present study meet the FAO codex standards for human consumption. Therefore, consider these oil seedscan good sources of essential fatty acids and suitable for human consumption, though amino acid composition of the seeds and physico chemical characteristics of their oil need further study.

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