Research Paper

Physical Properties, Proximate Composition and Fatty Acid Profile of Sesame Varieties and Promising Lines of Sri Lanka

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Abstract

Sesame is one of the oldest oil seed crops known for its extraordinary nutritional and pharmaceutical value. The objective of this research was to generate information on physical properties, proximate composition and fatty acid profile of the varieties and the promising lines of sesame cultivated in Sri Lanka. Moisture, crude fat, crude protein, ash and carbohydrate contents were measured following the procedures in Association of Analytical Chemists (AOAC). The fatty acid profile of sesame seeds was determined by Gas Chromatography (GCMS) according to SLS 313 part 4/ section 1:2000. *Uma*, ANKWS 02, and ANKWS 06 belong to large seeded category while MI-3, ANKBS02, and ANKBS05 were belong to medium seeded category and the rest belong to small seed category. Promising line ANKWS 05 reported a significantly high crude fat content (48%). The line ANKBS 05 reported a significantly high ash content (11%) whereas, both ANKWS 04 and *Malee* showed the highest crude protein content (23%) in the dry basis. Sesame promising line ANKBS 05, a black seeded line reported the highest Oleic acid (45%) and the lowest Linoleic acid (41%) contents, which leads to high oxidative stability. The promising line ANKWS 05, which was a small sized white seeded sesame line reported the highest crude fat content (48%). The variety *Malee* reported the highest Linoleic acid (51%) and the lowest Oleic acid (35%) contents among the tested varieties and the promising lines of sesame.

Keywords: Fatty acid profile, Proximate composition, Sesame

Introduction

Sesame (*Sesamum indicum* L.) belongs to family Pedaliaceae, is one of the oldest oil seed crops of the world. Based on its nutritional, pharmaceutical values and anti-oxidative potential, sesame seed is called "Queen of oil seeds". Sesame is mainly cultivated in Asian and African continent from ancient times. A number of different wild relatives of sesame available with a vast diversity is reported in African continent. Sesame seeds have been mainly used for oil extraction. Moreover, it has been used in cosmetics and pharmaceutical industry as well.

Sesame seed contains higher portion of oil (44 – 58%) and protein (18 - 25%) in its composition (Borchani *et al*., 2010).

Further, it is a good source of micro nutrients (Ca, Mg, Zn, Fe, Cu, and Se), dietary fibre and vitamins (Nzikou *et al*., 2010). Oleic and Linoleic acids are the major fatty acids present in sesame seed oil. Moreover, it has been confirmed the, presence of significant amount of lignases namely sesamin (0.5 - 1.0%) and sesamolin (0.2 - 0.6%) in sesame oil (Fukuda *et al*., 1985).

In the year 2018, the cultivation extend of sesame in Sri Lanka was 11872 ha whereas the production was 8589 t. Among all the oil seeds, sesame is the only oil seed crop exported from Sri Lanka (Exportation of 3616 t in the year 2018) (Agstat, 2019). The varieties *Uma* and *Malee* are the most popular sesame varieties that have been released by the Department of Agriculture, Sri Lanka. The objective of this research was to generate the information on physical, proximate and fatty acid profile of the varieties and the promising lines of sesame available in Sri Lanka, which will be important for the plant breeders and practitioners in the food industry to select suitable varieties for their intended purposes.

Materials and Methods

Three varieties (*Uma*, *Malee*, and MI-3) and six promising lines (ANKWS 02, ANKWS 04, ANKWS 05, ANKWS 06, ANKBS 02, and ANKBS 05) were chosen from the germplasm available at the Grain Legumes and Oil Crops Research and Development Centre (GLORDC), Angunakolapelessa, Department of agriculture, Sri Lanka.

Physical properties of the selected varieties and the promising lines of sesame

The seed colour, texture, 1000 seed weight and size of the seed were tested under the physical properties. The experiment was arranged in the Completely Randomized Design (CRD) with three replicates.

The proximate composition and the fatty acid profile

Proximate composition was tested for the contents of moisture, crude fat, crude protein, ash and carbohydrates. Associations of Official Analytical Chemists (AOAC, 2000) standard methods were used for the determination of proximate composition. The moisture content was determined by keeping 3 g of sample in an oven (Memmert, England) at 105 °C until a constant weight was obtained. The ash content was determined by igniting a 1 g of sample in a muffle furnace at 550 °C for 5 hrs. The crude protein was measured by Kjeldhal procedure using 1 g of sample (6.25 was use as the N factor). The crude fat content was determined using the extraction obtained from a sample of 1 g using petroleum ether (40 - 60 °C) as a solvent. The total carbohydrate content was computed based on the values obtained for the above components (100 - [moisture + Ash + Crude protein + Crude fat]). The extracted oil was stored at -20 °C in a nitrogen storage until further analysis. The Lipid was analyzed for the saturated as well as for the unsaturated fatty acids. The fatty acid profile of each variety and line was determined by a gas chromatographic technique according to SLS 313 part 4/ section 1: 2010, adopted from the ISO method specified in 2000 (ISO 5509:2000-E).

Statistical analysis

Analysis of variance (ANOVA) procedure was performed using Statistical Analysis Software (SAS) 9.1.3 and the means were compared using Duncan's Multiple Range Test (DMRT).

Results and Discussion

Physical properties of the selected varieties and the promising lines are given in the Table 1. The pericarp colour and the texture were identified into 7 and 4 categories, respectively. *Uma*, ANKWS 02, and ANKWS 06 had higher 1000 seed weight whereas, ANKWS 04 showed the lowest 1000 seed weight.

The moisture contents of the sesame seeds varied from 3.7 to 5.5%. *Uma* and ANKBS 05 had higher moisture content compared to *Malee*. The ash contents varied from 6.8 - 10.8%. The promising line ANKBS 05 reported the highest ash content (10.8%) whereas ANKWS 05 showed the lowest (6.8%) (Table 2). The crude fat contents varied from 37.6 to 47.6% (Table 2). Moreover, the promising line ANKWS 05 reported the highest crude fat content (47.6%) whereas, the variety Uma showed the lowest (37.6%) (Table 2). The crude protein contents varied from 14.3 to 23.3% (Table 2). *Malee* and ANKWS 04 reported significantly higher crude protein contents compared to ANKBS 02, ANKBS 05, ANKWS 02, and ANKWS 05 whereas, ANKWS 02 and ANKWS 05 showed the lowest crude protein contents.

The total carbohydrates contents of sesame seeds varied from 18.81 to 27.09% (Table 2). Based on all the compositional values, the sesame promising line ANKBS 05 reported higher ash, crude fat and crude protein contents while showing the lowest total carbohydrate content highlighting its importance as a good oil seeded variety for oil extraction purposes (Table 2). Palmitic and Stearic acids are the saturated fatty acids whereas, Oleic and Linoleic acids are found as unsaturated in the sesame seed oil.

Table 1: Physical properties of the selected varieties and the promising lines of sesame

Variety/ Line	Colour of pericarp	Seed texture	Weight of 1000 seeds (g)	Size of Seed
Uma	Pale brown	Smooth	3.17[a]	Large
Malee	Brown	Partially rough	2.49[b]	Small
MI-3	White	Smooth	2.87[b]	Medium
ANKWS 02	Pinkish white	Partially rough	3.20[a]	Large
ANKWS 04	Brown	Partially reticularly rough	2.23[d]	Small
ANKWS 05	White	Smooth	2.53[c]	Small
ANKWS 06	Beige	Smooth	3.19[a]	Large
ANKBS 02	Dull black	Smooth	2.89[b]	Medium
ANKBS 05	Black	Reticularly rough	2.85[b]	Medium
CV%			2.77	

Means with the same letters along the column are not significantly different at $p < 0.05$.

Table 2: The proximate composition of the tested varieties and the promising lines of sesame

Variety/ Line	Moisture (%)	Ash (%)	Crude fat (%)	Crude protein (%)	Carbohydrates (%)
Uma	5.40^{a}	9.36^{b}	37.58^{g}	22.31^{ab}	25.36^{abc}
Malee	3.71^{c}	7.84^{c}	40.94^{ef}	23.26^{a}	24.24^{abc}
MI-3	5.08^{ab}	8.09^{c}	42.56^{cd}	21.93^{abc}	22.32^{c}
ANKWS 02	4.62^{abc}	7.90^{c}	45.75^{b}	14.71^{d}	27.01^{a}
ANKWS 04	4.37^{abc}	9.62^{b}	39.78^{f}	23.27^{a}	22.94^{bc}
ANKWS 05	4.13^{bc}	6.77^{d}	47.66^{a}	14.33^{d}	27.09^{a}
ANKWS 06	4.54^{abc}	7.46d^{c}	40.91^{ef}	20.85^{bc}	26.22^{ab}
ANKBS 02	4.72^{abc}	7.83^{c}	41.73^{de}	19.64^{c}	26.07^{ab}
ANKBS 05	5.50^{a}	10.82^{a}	43.4^{c}	21.46^{bc}	18.81^{d}
CV%	14.96	6.27	2.26	6.94	7.98

Means with the same letters along the column are not significantly different at $p < 0.05$.

All the tested varieties and the promising lines reported higher unsaturated fatty acid contents compared to the contents of the saturated fatty acids (Table 3). Palmitic fatty acid content varied from 7.6 to 9.8% (Table 3). The variety MI-3 reported significantly higher content (9.8%) of Palmitic acid whereas ANKWS 05 and ANKWS 06 showed comparatively lower Palmitic acid contents in their fatty acid profiles (Table 3). Stearic acid contents of the sesame seeds varied from 3.8 to 5.0%. The black seeded sesame reported fairly high Stearic acid content compared to those in the white and cream-color seeded sesame varieties or lines. ANKWS 06 showed the lowest stearic acid content (Table 3). Except the black seeded sesame lines (ANKBS 02 and ANKBS 05), the rest of the varieties and lines reported higher Linoleic acid (L) contents compared to Oleic acid (O) in their fatty acid profiles. A greater stability of oil seeds can be achieved by lower Linoleic and Linolenic acids with higher Oleic acid contents in the fat profile (Warner and Knowlton, 1997). O/L ratios of the black seeded sesame were greater than 1 whereas, the rest of the varieties and the lines showed the O/L ratios of less than 1. Thus, the black seeded sesame lines (ANKBS 02 and ANKBS 05) have higher stability compared to that of the white and cream color seeded sesame varieties or lines.

Among the two black seeded sesame lines, ANKBS 05 reported significantly lower Linoleic acid content (40.6%) compared to that of ANKBS 02 (41.7%). The sesame variety *Malee* showed significantly lower Oleic acid content (35.1%) and significantly higher Linoleic acid content (51.21%), giving more benefits as an essential fatty acid (EFA) in human nutrition. Oils with high amount of unsaturated fatty acids known to be undergone the oxidation process due to unsaturated nature of that oil (Guillen and Goicoechea, 2008). However, due to its inherent antioxidative compounds such as Sesamol, Seasamolin and Gamma-tocopherol, sesame oil can remain without oxidation even though it contains the higher levels of unsaturated fatty acids (Corso *et al*., 2010).

Table 3: Fatty acid profile of the tested varieties and the promising lines

Variety/line	Palmitic (% in oil)	Stearic (% in oil)	Oleic (% in oil)	Linoleic (% in oil)
Uma	8.97^{b}±0.10	4.29^{cd}±0.03	36.92^{f}±0.04	48.46^{b}±0.10
Malee	8.21^{cde}±0.10	4.38^{bcd}±0.03	35.15^{g}±0.04	51.21^{a}±0.10
MI-3	9.80^{a}±0.11	4.25^{d}±0.02	40.52^{c}±0.02	44.31^{e}±0.07
ANKWS 02	9.03^{b}±0.10	4.42^{bcd}±0.03	39.60^{d}±0.07	45.83^{d}±0.06
ANKWS 04	8.70^{bc}±0.02	4.49^{bc}±0.02	41.47^{b}±0.02	44.17^{e}±0.02
ANKWS 05	7.61^{e}±0.32	4.22^{d}±0.11	38.28^{e}±0.16	48.98^{b}±0.60
ANKWS 06	7.91^{e}±0.57	3.77^{e}±0.12	40.01^{d}±0.35	47.37^{c}±0.60
ANKBS 02	7.96^{de}±0.29	4.58^{b}±0.15	44.77^{a}±0.24	41.66^{f}±0.43
ANKBS 05	8.68^{bcd}±0.09	5.03^{a}±0.07	44.42^{a}±0.06	40.62^{g}±0.13
CV%	8.12	7.50	7.61	7.35

Means with the same letters along the column are not significantly different at $p < 0.05$.

Conclusions

According to the proximate composition data, the promising line ANKBS 05 which is a medium sized, black seeded sesame line reported comparatively high ash, crude fat, and crude protein contents with lowest total carbohydrates content. Therefore, it could be considered as the best promising line among all the tested varieties and promising lines of sesame in the means of proximate composition and high oil stability due to low Linoleic acid (41%) and high Oleic acid (45%) contents. The promising line ANKWS 05 showed the highest crude fat yield (48%). Among the tested varieties and lines, the sesame variety *Malee* reported the highest Linoleic acid (51%) content and the lowest Oleic acid (35%) contents. Considering all the compositional data, a sesame variety or a promising line could be selected for an intended purpose in the future.

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