

EXTRACTABILITY AND QUALITY OF OIL FROM SUNFLOWER SEEDS (*Helianthus annuus*) AND SOME OBSERVATIONS ON THE SEED AND OIL CAKE CHARACTERISTICS

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ABSTRACT

Seeds of seven varieties of sunflower (*Helianthus annuus*) cultivated at Kalawewa and Angunakolapelessa were analysed for their major chemical constituents. Their physical parameters were recorded. It was observed that the percentage of oil in the seeds varied from 32.9 to 45.3. The mean values of the percent protein, fiber, ash and carbohydrates were 22.3, 21.3, 3.8 and 15.1 respectively. When the oil was extracted using a mechanical expeller, the mean value of oil remaining in the cake was 8.1%. The recoverable oil from one metric ton of seeds varied from 257 to 370 kg or 267 to 402 l. It was found that in cooking applications, the refined sunflower oil was preferred against the unrefined form. Further, in a cooking trial panellists preferred unrefined coconut oil to both refined coconut oil and unrefined sunflower oil when tested at 1% significant level. Quality-wise the oil properties as indicated by iodine and saponification numbers met the specification stipulated by Sri Lanka Standards Institution. The extracted oil possessed the odour characteristics of sunflower and needs further refining particularly alkali refining and deodorization. The meal has a high percentage of fiber which restricts its direct use as an animal feed. Seed characteristics are reported which are of value to select seed processing equipment if sunflower cultivation is to be undertaken on a large scale.

KEY WORDS: Crude oil, Free fatty acids, Iodine value, Peroxide value, Sunflower.

INTRODUCTION

Sunflower (*Helianthus annuus*) is an oil seed crop grown in many parts of the world. There have been some attempts to cultivate sunflower in Sri Lanka for the purpose of extraction of oil. In the year 1995, net imports of sunflower oil with cotton seed oil exceeded 710 t and the value exceeded Rs.28 million. Imports of margarine exceeded 3276 t and the value was Rs.313 million. In the sector of fats, oils and fat based processed products, the quantity of imports had exceeded 48,100 t (External Trade Statistics,

Sri Lanka, 1995) and the value of imports had exceeded Rs.1.68 billion. Therefore, a vast potential exists to produce edible oil and other oil based products if the cost of production is economical.

In commercial sunflower production, emergence of two distinct industries can be observed. These are the use of seeds having 40 to 45% oil for oil extraction and the use of seeds having low oil for confectionery purposes. Although this is observed in traditionally sunflower growing countries, oil extraction is still being carried out in many

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parts of the world using both high and low oil varieties. The objective of the present study is to determine major constituents of seed of seven varieties of sunflower grown in two locations, their oil extractability and the quality. This paper reports major findings in the above study.

MATERIALS AND METHODS

Sunflower seeds

Seeds of seven varieties of sunflower from the fields established at Angunakolapelessa (A) and Kalawewa (K) during the Maha season, 1994/95 were used. Except for the variety Hysin33 all the other six varieties were cultivated in both locations, and the area of each plot per variety exceeded 0.5 ha. Hysin 33 was cultivated only at Kalawewa. At maturity the crop was harvested, seeds were extracted and cleaned. From each variety 65 kg of seeds were used for oil extraction.

Physical parameters

Weight, length and width of 100 seeds collected from each variety at random were recorded. Bulk density was determined and expressed in grams per litre.

Hull percentage

One kilogram of seeds from each variety was dehulled using a hand operated commercial dehuller constructed locally by Udaya Industries.

Oil extractability

The oil from sunflower seeds was extracted using a Simon Rosendown screw type mechanical oil expeller having an output of approximately 60 kg of feed per hour. Storage expelled 400 g of crude oil from each

variety were filtered through a buchner funnel using a Whatman No. 2 filter paper to remove suspended particles and to obtain a clear oil. This was used for laboratory analysis. The balance extracted oil was allowed to sediment for two days and the clear oil was decanted. Extractable oil therefore was the weight of the decanted oil and the weight of the sample taken for laboratory analysis.

Meal composition

Constituents in the meal were determined in four samples.

Laboratory analytical studies

The procedures described under Methods of Analysis of the Association of Official Analytical Chemists (AOAC, 1980) were used for the following determinations. The reference numbers of the test methods and unit of expression are given in the Table 1.

Matter volatile at 105°C and impurities

The method described under Sri Lanka Standards Institution, SLS 313: Part 3: 1993.

Colour

Lovibond colorimeter was used and expressed in Lovibond scale.

Density

Density was measured at 25°C using a specific gravity bottle.

Test of sunflower oil as a cooking material

Cooking trials were conducted to evaluate the suitability of sunflower oil for tempering and frying applications.

Table 1. The reference numbers of the test methods and the units of expression

Test method (AOAC)	Reference no of the test	Unit of expression
Percent moisture	14.004	%
Protein (Nx5.30)	14.068	%
Fiber	7.062	%
Ash	7.009	%
Carbohydrates by difference		%
Free Fatty Acids (FFA)	28.029	% as oleic acid
Peroxide value	28.022	Milliequivalent peroxide per kg
Saponification number	28.025	mg KOH to saponify 1 g of oil
Iodine number	28.020	Iodine number (Wijs method)
Relative density	28.081	g/ ml 25/25°C
Unsaponifiable matter	28.081	%

Tempering

A dhal curry was prepared using 500g of masoor dhal and was divided into four equal portions. The four portions were tempered using crude sunflower oil, refined sunflower oil, unrefined and refined coconut oil. The amount of oil taken was 20 ml per treatment. Curry leaves, chilli powder and red onion were used for tempering and amounts taken were 8, 5, 10 g respectively per treatment. Ranking method (Larmond, 1977) was used involving ten panellists to evaluate sensory attributes. Data were subjected to analysis of variance and Tukey's test was used to determine the samples that were significantly different from others.

Frying

Crude and refined sunflower oil were used to fry fresh fish. The temperature of boiling oil was recorded and observations were made. Samples were given to ten panellists and the triangle test (Larmond, 1977) was used to determine flavour differences between the commodities fried using refined and unrefined sunflower oil.

RESULTS AND DISCUSSION

Seed characteristics

The data on seed characteristics are shown in the Table 2. The hull percentage in the seeds varied from 25.4 to 35.8 with a mean value of 30 and standard deviation of 3.3. The variety DK 3873 is large seeded and relatively low in oil and as such suitable for confectionary purposes. Other seed characteristics such as length, width, weight and bulk density are important for selection of equipment for seed processing if sunflower cultivation is to be undertaken on a large scale. shown in the Table 2.

Major chemical constituents

The major chemical constituents of sunflower seeds are shown in Table 3. The oil content varied from 32.9 to 45.3% among the samples. A high degree of variability of the oil percentage within the same variety was observed in MSFH 8 and Hysin 45. The variety Hysin 33 grown at Kalawewa had the highest oil content and variety Hysin 45 Angunakolapelessa had the lowest oil

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Table 2. Seed characteristics of selected sunflower seeds

Variety & Location		Hull Percentage (%)	Seed Length (cm)	Seed Width (cm)	Weight of (100 seeds/ g)	Bulk Density (g/ l)
Thai 33	A	26.3	1.1	0.59	7.62	448
Thai 33	K	27.6	1.1	0.58	7.60	440
Hysin 33	K	30.0	1.1	0.62	7.63	453
Hysin 35	A	31.0	1.1	0.63	7.45	458
Hysin 35	K	30.6	1.2	0.58	7.52	456
Hysin 45	A	31.1	1.2	0.56	6.70	449
Hysin 45	K	33.0	1.2	0.69	6.55	450
MSFH 7	A	34.3	1.2	0.68	7.55	454
MSFH 7	K	35.8	1.1	0.54	7.53	453
MSFH 8	A	28.0	1.2	0.53	7.40	448
MSFH 8	K	31.0	1.1	0.60	7.35	446
DK 3873	A	25.4	1.3	0.77	10.35	430
DK 3873	K	25.5	1.3	0.76	10.45	426

A= Angunakolapelessa, K= Kalawewa

content. However Hysin 45 grown at Kalawewa had 42.5% oil and therefore it is highly probable that some agronomic factors could have contributed to this variation. Percent protein in the seeds varied from 17.1 to 24.5. The mean value of fiber was 20.8% with a standard deviation 1.7. Mean value of ash percentage was 3.73 with a standard deviation of 0.13. The varieties having a high percentage oil had low levels of carbohydrates.

Extractability of oil

The results of the pilot plant scale oil extraction studies are shown in Table 4. The data shown are recoverable oil from 1 t of seeds. As expected recoverable oil was more from seeds having high oil percentage. Soon after expelling the extracted oil was dark in colour on account of suspended materials, primarily crushed hulls, which are black in colour. The suspended matter was removed by allowing the oil to stand for two days for sedimentation. The clear oil was decanted

leaving the sludge. The data shown in Table 4 are the values obtained after sedimentation. The quantity of sediment is also shown in the table. From the data it is clearly evident that recoverable oil from 1 t of seeds varied from 257 to 370 kg or 267 to 402 litres.

Quality of oil

The laboratory analytical data on the quality of oil are shown in Table 5. These values representing objective analytical data can be broadly categorised into two groups. One group represents the degree of rancidity and presence of volatile matter. Free Fatty Acid value, peroxide value and matters volatile at 105°C represent this group. The other group represents the product identity of sunflower oil. Iodine number, saponification number, unsaponifiable matter and density represent this group. For the purpose of comparison, these data were compared with the Sri Lanka National Standards for sunflower oil. Therefore the information given

Table 3. Major chemical constituents in sunflower seeds.

Variety & Location		Moisture (%)	Oil (%)	Protein (%)	Fibre (%)	Ash (%)	Carbohydrates by Difference (%)
Thai 33	A	5.3	37.5	21.3	18.2	3.9	23.1
Thai 33	K	5.6	34.0	21.3	22.4	22.4	34.0
Thai 33	K	5.6	34.0	21.3	18.2	3.9	23.1
Thai 33	K	5.6	37.5	20.1	22.4	3.8	16.3
Hysin 33	K	5.5	45.3	22.4	18.0	3.7	8.1
Hysin 35	A	5.3	42.0	21.6	20.1	3.9	12.4
Hysin 35	K	5.7	41.5	20.8	22.0	3.7	12.0
Hysin 45	A	5.8	32.9	21.6	21.6	3.6	20.3
Hysin 45	K	5.6	42.5	23.9	22.0	3.4	8.1
MSFH 7	A	5.3	33.1	23.9	23.4	3.7	15.9
MSFH 7	K	5.4	36.2	24.5	20.3	3.8	9.2
MSFH 8	A	5.8	34.4	17.1	18.3	3.8	26.7
MSFH 8	K	5.1	43.9	23.4	22.1	3.7	7.8
DK 3873	A	5.2	34.4	23.0	21.0	3.8	17.8
DK 3873	K	5.6	36.6	24.1	21.0	3.8	8.9

A= Angunakolapelessa, K= Kalawewa

Table 4. Extractability of oil from one metric tonne of sunflower seeds.

Variety & Location		Percent oil	Percent extract	Weight (kg)	Volume (l)	Weight of Sediment (kg)
Thai 33	A	34.0	75.6	257	279	6.8
Thai 33	K	37.5	78.1	293	318	8.3
Hysin 33	K	45.3	81.7	370	402	11.3
Hysin 35	A	42.0	80.2	337	366	9.5
Hysin 35	K	41.5	80.0	332	360	9.4
Hysin 45	A	32.9	74.8	246	267	6.4
Hysin 45	K	42.5	80.5	342	371	8.9
MSFH 7	A	33.1	74.9	248	269	6.5
MSFH 7	K	36.2	74.6	270	303	7.0
MSFH 8	A	34.4	86.3	264	287	7.7
MSFH 8	K	43.9	79.5	349	379	9.1
DK 3873	A	34.4	75.9	261	283	6.8
DK 873	K	36.6	71.9	290	315	6.8

A= Angunakolapelessa, K = Kalawewa.

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in the document 946: 1991, Specifications for sunflower oil, Sri Lanka Standards Institution (SLSI) was used as reference for crude and refined oil .

Rancidity

For crude sunflower oil SLSI specifies a maximum of 1.50 as the upper limit of Free Fatty Acid (FFA) values. Ten out of thirteen samples examined had FFA values marginally above 1.50. In all the samples peroxide values determining oxidative rancidity were below the upper limit of 10 m eq/kg with 2 m eq/kg being the highest recorded.

Volatile matter

The upper limit specified by SLSI is 0.25 for matters volatile at 105°C and for impurities. Three samples had values above 0.25 indicating the presence of impurities and volatile matter. Volatile matter may include water and compounds responsible for the formation of odours and fumes.

Iodine and saponification values

The iodine and saponification values observed agreed with expected values indicating that the extracted oil contained the expected quality characteristics in relation to the fatty acid composition.

Table 5. Analytical data of Sunflower oil and SLSI specifications.

Variety & Location	D	FFA	PV	IN	SN	UM	MV
Thai 33 A	0.916	0.96	1.30	133	189	0.8	0.18
Thai 33 K	0.919	0.50	1.90	141	190	1.4	0.23
Hysin 33 K	0.918	1.70	2.00	135	193	0.9	0.22
Hysin 35 A	0.916	1.85	2.00	133	194	0.8	0.28
Hysin 35 K	0.917	2.56	1.85	—	193	1.6	0.32
Hysin 45 A	0.920	2.40	1.93	141	194	1.5	0.23
Hysin 45 K	0.917	1.30	1.35	128	189	1.8	0.18
MSFH 7 A	0.916	1.93	1.33	118	189	1.3	0.13
MSFH 7 K	0.918	1.30	1.75	133	189	1.3	0.14
MSFH 8 A	0.918	1.20	1.90	129	189	1.2	0.14
MSFH 8 K	0.919	1.50	1.95	132	191	1.8	0.13
DK 3873 A	0.915	2.10	1.80	138	192	1.1	0.30
DK 3873 K	0.917	1.15	1.93	133	191	0.8	0.13
SLSI Specifications							
Crude oil:	0.915-0.920	1.5*	10.0 143.0	110- 194	188*	1.5	0.25
Refined oil:	0.915-0.920	0.25*	10.0 143.0	110- 194	188*	1.5	0.15

D= density, g/cc 25/25°C, FFA= Free Fatty Acid as oleic acid, %, PV= Peroxide value meq/1000g, IN = Iodine number, SN= Saponification number, UM= Unsaponifiable matter % by mass and impurities max. MV= Matter volatile at 105°C, A= Angunakolapelessa, K= Kalawewa, * = maximum limit

Unsaponifiable matter

In sunflower oil unsaponifiable matter consists primarily of waxes and higher melting point glycerides. Only two samples showed unsaponifiable matter slightly above the limits specified by SLSI. The overall quality characteristics of the extracted oils agreed with the SLSI requirements as shown by the above parameters.

Sensory properties of oil

The crude oil processed had the strong odour characteristic of sunflower. The colour as measured by Lovibond colorimeter indicated red - 3 and yellow- 32 with minor deviations among the samples. The visual colour was amber. In three samples greenish taints were observed. Green taints in sunflower are attributed to the presence of trace amounts of chlorogenic acid, a polyphenolic compound (Brummett and Burns, 1972).

Cooking traits

As shown in the Table 6, it was found that there was a significant difference in taste of dhal prepared using refined and unrefined sunflower oil. Refined sunflower oil purchased from the market was preferred by the panellists. Further, it was found that unrefined coconut oil was preferred by the panellists as against refined coconut oil and unrefined sunflower oil. There was no significant difference between dhal prepared using refined sunflower and refined coconut oil.

The triangle test conducted for frying applications showed that the commodity fried with crude sunflower oil was significantly different from the commodity fried with refined sunflower oil. Out of ten panellists, eight identified correctly the sample fried with crude sunflower oil and therefore there

is a difference between the two treatments at one percent level of significance. Further seven panellists expressed the view that the sample fried with refined sunflower oil was preferred and therefore at 5 percent significance level use of refined sunflower oil was more acceptable. Further excessive frothing and fuming were observed when unrefined sunflower oil was used for frying applications. During frying the oil temperature varied from 168 to 173°C.

Overall quality attributes of oil

The major defect observed in the oil was the strong odour characteristic of sunflower. Presence of free fatty acids in six samples marginally above Sri Lanka Standards was another defect. In oil refining routine unit operations are alkali refining, deodorization, decolourisation and degumming. Winterization is carried out to remove waxes and high melting point glycerides. For the Sri Lankan market alkali refining and deodorization seem to be essential to be acceptable to local consumers.

Composition of meal

Table 7 shows the major chemical constituents of sunflower meal or oil cake. It is also possible to calculate the meal composition when the data in Table 2 and the extractability of oil are known. A noticeable feature of the meal is the high percentage of fiber associated with the meal which prohibits its use as animal feed (Kanto, 1988). The fiber in the seeds is mostly located in the hulls. Removal of hulls minimizes fiber in the feed as well as waxes since waxes are mostly associated with the hulls. Presence of fiber in sunflower meal in correct proportions has beneficial physiological properties both in human and animal subjects (Sosulki and Cadden, 1982).

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Table 6. ANOVA for sensory properties of crude sunflower oil as against three other forms of cooking oil

Treatment	Number of Panellists			
	Ranked 1	Ranked 2	Ranked 3	Ranked 4
Refined coconut oil (RC)	2	-	5	3
Unrefined coconut oil (UC)	6	4	-	-
Refined sunflower (RS)	2	6	2	-
Unrefined sunflower (US)	-	-	3	7

Treatment	Mean	Oil Characteristics	
		FFA	Peroxide value
RC	-.435	RC 0.08	2
UC	.748	UC 0.5	8
RS	.326	RS 0.1	3
US	-.90	US 1.3	1.75
	UC-RC = 1.18>0.93		
	UC-RS = 0.42<0.93		
	UC-US = 1.65>0.93		
	RS-US = 1.23>0.93		
	RS-RC = 0.75<0.93		

Taste difference LSD at 1% significance = 0.93

Table 7. Precent meal composition

Variety	Moisture	Oil	Protein	Fibre	Ash	Carbohydrates
Thai 33 A	4.1	8.3	28.3	24	5.1	34.3
Hysin 45 K	4.3	7.9	34.0	31	5.6	21.5
MSFH 8 A	3.8	8.2	35.1	32	5.7	19.0
DK 3873	4.1	8.1	32.0	27	5.8	27.3

A= Angunakolapelessa, K = Kalawewa.

Other observations

The materials used for the present study were hybrid sunflower seeds. The oil content in open pollinated varieties analysed by the same authors previously varied from 32.5-34.2% (unpublished data). Hence there is a distinct advantage of using hybrid varieties on account of high oil content in the seeds. However, there is a need to evaluate cost benefit of using hybrid seeds giving due consideration to availability of high inputs required to cultivate hybrid varieties. Facilities available in oil expelling mills in Sri Lanka designed for coconut milling can be used to extract oil from sunflower seeds. Based on the current observations a recommendation as

to the variety cannot be given as the oil yield depends on percent oil in the seed and the yield of seeds per hectare. Based on analytical data it was found that hysin varieties have high potential on account of high oil content associated with the seeds.

CONCLUSIONS

The extractable oil varied from 246 to 370 kg/ t depending on the oil content in the seeds. The quality of oil when compared to Sri Lanka national standards was found to be satisfactory. However, crude oil need to be refined, and particularly deodorized to make the commodity acceptable to consumers.

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