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Chemical Compositions of Sunflower (*Helianthus Annuus L.*) Hybrids Planted in Different Natural Locations in Northern Nigeria

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ABSTRACT

The effects of planting locations on the chemical compositions of *Helianthus Annus* (Sunflower) varieties viz. Inter state (IS) 7111, IS 3107, Northropking (NK) 265 and Hybrid sample (HS) 897 planted in Nigeria were studied. All the hybrids gave high percentage of crude protein (18.24 ± 0.06 and 27.34 ± 0.06) although it was highest with samples from Dikankan and lowest at Minna. Hybrid sample obtained from Bida gave the highest percentage oil content (42.15 ± 0.08) while sample from Kano gave the lowest oil level (24.89± 0.04) although values for the other hybrids were similarly high. Apart from the hybrid planted at Kano which gave better ash content (3.99± 0.05), sample harvested at Bida gave superior values for other chemical parameters considered. All the hybrids had low concentrations of C14:0 and C17:0 fatty acids. Concentrations of C16:0 and C18:0 were observed to be identical. Trace amounts of C16:1 and C18:3 were observed in the hybrids. Samples harvested from Kano had the highest concentration of total unsaturated fatty acids (86.38 ± 5.08). With a specific gravity of 0.921± 0.002 and a refractive index of 1.46 ± 0.00 the oil falls into the category of nutritionally advantaged edible oils. The crude fibre content (%) of the hybrids (undehulled) ranged from 13.08 ± 0.00 - 20.56 ± 0.54 but did not vary appreciably. Tannins and polyphenols were in the range 0.53 ± 0.04 - 1.66 ± 0.11mg/g catechin equivalent, and 6.48 ± 0.03 - 16.40 ± 0.00 mg/g tannic acid equivalent, respectively. All the parameters considered gave good indices of good quantity/quality which were essential for commercial utilization of the seeds. On the basis of the above, samples harvested from Bida are recommended for commercial utilization.

Key words: Chemical Compositions, Sunflower, *Helianthus Annuus*

Introduction

With the increasing demand for edible oils in the international market and the attendant price increases globally and in Nigeria in particular, there is the need to expand the edible oil base. This demand calls for the need to update information that would be placed at the disposal of potential investors in the edible oil processing industries.

Various oil seeds such as the oil palm, coconut and more recently the soybean have been used in Nigeria to provide edible oils. However, the broad uses of some of these oil seeds have met with some limitations. Where the high saturation of the oil is not limiting (as in oil palm and coconut oils), the problem of oil stability usually gives cause for concern (as in soybean oils). Sunflower oils, however, does not suffer from these setbacks.

The cultivated sunflower (Helianthus annuus L.) presently ranks as the fourth major oil seed, third most important source of edible oil and fourth largest source of food and food protein (Saeed and Cheryan, 1988).

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Tremendous potentials exist in the crop for meeting the ever increasing demand for edible oils and proteins in Nigeria by virtue of its high oil content, high oil yield per acre and relatively high protein content of the meal which is potentially useful both in human foods and animal feed formulations.

Sunflower oil is rich in unsaturated fatty acids especially linoleic acid (18:2). This is an essential fatty acid required in the human diet as it prevents heart and vascular diseases. With high protein content, relatively low antinutritive component levels, and a significant percentage of lecthins, the seed has a high potential as an industrial and agricultural raw material. It is also desirable to locate natural ecosystems where the various hybrid can be cultivated with low external input for easy adoption by both poor and commercial farmers as well as for the purpose of environmental health and continuous sustainable cropping with little risk of accumulation of toxic waste from the environment (Khan 2001).

However, the chemical composition of the seeds of sunflower has been reported to vary with planting locations and seed genotypes (Barker and Hilditch, 1950; Carvin, 1965, Kinman and eark, 1964; Robertson et. al. 1971; Durrel, 1978). The yield potentials of the crop and oil stability could therefore depend on the extent of the environmental influence on the chemical composition of the sunflower seeds (Durrel, 1978).

Though Saeed and Cheryan (1988) examined some high yielding varieties of sunflower seeds in the USA and found 22% protein, there is no information in the literature on the chemical evaluation of these exotic breeds planted in Nigeria. It was the objective of this study therefore, to evaluate the chemical compositions of the exotic sunflower (Helianthus annuus L.) seeds: viz. Inter state (IS) 7111, IS 3107, Northropking (NK) 265 and Hybrid sample (HS) 897 grown on various environmental farms located at different favourable agronomic locations in Nigeria.

Materials and methods

Sunflower hybrids developed in America coded as: Interstate (IS) 3107, 7111, Northropking (NK) 265 and Hybrid 897 - all of which were obtained from Interstate seed company (Fargo, ND, USA). All of these were planted in experimental farms in each of the four locations in Nigeria - Kano (lat.12 $1/8^0$N, log. 7 $1/4^0$E), Minna (9 $5/6^0$N, 6 $1/2^0$E), Bida (9 $1/8^0$N, 5 $1/2^0$E) and Dikankan (12^0N, 8 $1/2^0$E). Seeds harvested were used for the analysis.

Seed weight analysis: The weight of randomly picked one thousand seeds of each sample was determined.

Proximate Analysis: The seeds were analyzed for ash, total nitrogen, crude fat, using standard methods of the Association of Official Analytical Chemists (AOAC, 2006). Carbohydrate was calculated by difference. Total dietary fibre was determined as described (AOAC, 2006).

Mineral Analysis: The mineral content (except phosphorus) was determined by the standard AOAC (2006) wet ashing method. Analysis and quantification of the minerals were obtained with an Atomic Absorption Spectrophotometer (Perkin-Elmer Model 5000). Phosphorus was determined by the colorimetric method described by Fiske and Subarrow (1925) with slight modification in color development time.

Antinutritive Components - Phytate was analyzed by the method of Harland and Oberleas (1988); Phytochemical screening exercise was carried out as described by Odebiyi and Sofowora (1978). Tannin was estimated quantitatively by the spectrophotometric approach described by Price and Butler, 1981. Polyphenols determination was by the modified Folin - Ciocalteu method (McGrath et. al. 1982).

Lipid Analysis - Fatty acids were analyzed as Fatty Acid Methyl Esters (FAME). The esters were prepared and quantified as described by Afolabi et. al, 1991. Analysis was performed by gas chromatography: Perkin-Elmer Sigma 3B, with 15cm 4mm id Pyrex column packed with 1% SE- 30 on 100/120 mesh Gas-Chrom Q (Applied Sciences Laboratory, State College, PA). Operating conditions for fatty acids: column temperature programmed for 180^0C for 30 mins at 3^0 per minute for 10 mins. and subsequently maintained at 210^0 for 26mins. Additional conditions: injector and detectors temperatures - 300^0C, hydrogen flow rate - 20cm^3/min, air flow rate - 30cm^3/min and inlet pressure 18 psig.

Results and discussion

In terms of seed weight, variety IS 3107 planted at Dikankan gave the best result (65.24g/1000 seeds). IS 7111 gave the poorest yield at NYSC Kano (32.31 g/1000 seeds).
(table 1)

The proximate composition of the seeds, fatty acid spectrum of the oil, the levels of tannins, polyphenols and minerals in the seed meal for the four hybrids of sunflower (Helianthus annuus L.) seeds planted in the four different locations were as presented in table 2. For crude protein content, H897 (Dikankan) gave the best result (37.34 $\pm$ 0.09%) ($P < 0.05$) followed by IS 3107 (35.76 $\pm$ 0.09%) in the same location. IS 3107 gave the best hybrid mean (26.51 $\pm$ 7.8%) for all the locations (table 3).

Table 1: WEIGHT PER 1000 SEEDS OF SUNFLOWER (g)

HYBRID	NYSC KANO	NYSCMINNA	NBLBIDA LEVENTIS	DOGONDAWA
IS 7111	32.31 ± 1.22	48.52 ± 2.09	42.24 ± 2.11	45.16± 1.87
IS 3107	45.83 ± 2.64	38.59 ± 2.34	48.98 ± 3.32	61.24± 2.99
NK 265	44.59 ± 2.02	45.58 ± 1.22	56.16 ± 2.27	49.69± 1.32
HS 897	42.13 ± 0.90	32.28 ± 3.00	42.40 ± 2.98	65.07± 2.01

Values are means of 4 determinations ± standard deviation of means.

Table 2: PROXIMATE COMPOSITION OF SUNFLOWER SEED HYBRID HS 897

	KANO	MINNA	BIDA	DOGONDAWA
Protein (%)	25.95 ± 0.82	26.28 ± 0.70	27.64 ± 0.42	24.28 ± 0.38
Fat (%)	32.09 ± 0.42	31.80 ± 0.78	32.60 ± 0.92	29.28 ± 0.69
Ash (%)	3.99 ± 0.05	3.26 ± 0.01	3.48 ± 0.06	3.12 ± 0.02
Carbohydrate by difference	26.59 ± 0.62	25.00 ± 1.04	26.28 ± 1.02	25.78 ± 0.48
Moisture (%)	5.90 ± 0.071	5.80 ± 0.04	6.28 ± 0.10	5.95 ± 0.42
Crude fibre (%)	5.48 ± 0.034	5.43 ± 0.42	6.28 ± 0.38	5.96 ± 0.21

Values are means of 4 determinations ± SD of means

Table 3: CRUDE PROTEIN CONTENT OF SUNFLOWER SEEDS (%)

HYBRID	LOCATIONS			
	KANO	MINNA	BIDA	DOGONDAWA
IS 7111	25.76 ± 0.26^{b}	18.92 ± 0.03^{b}	24.47 ± 0.08^{b}	26.63 ± 0.01^{b}
IS 3107	26.05 ± 0.13^{c}	20.51 ± 0.05^{a}	20.46 ± 0.08^{c}	25.76 ± 0.09^{b}
NK 265	21.77 ± 0.01^{d}	18.72 ± 0.02^{c}	21.03 ± 0.02^{d}	26.26 ± 0.06^{d}
HS 897	25.95 ± 0.82^{e}	26.28 ± 0.70^{d}	27.64 ± 0.42^{c}	24.28 ± 0.38^{c}

1. Percent dry weight basis (undefatted)
2. Values are means of 4 determinations ± standard deviation (SD) of means. Values with similar superscripts in the same column are not significantly different.

Table 4: CARBOHYDRATE CONTENT[8] OF SUNFLOWER SEEDS (%)

HYBRID	LOCATIONS			
	KANO	MINNA	BIDA	DOGONDAWA
IS 7111	18.52± 0.92	18.70 ± 2.01	15.44 ± 2.01	18.97 ± 0.98
IS 3107	13.03± 1.11	19.36± 1.85	19.11± 2.01	18.29 ± 1.34
NK 265	15.93±0.69	21.37± 2.14	15.86± 2.22	21.34 ± 0.75
H 897	26.59± 0.62	25.00 ± 1.04	26.28 ± 1.02	25.78 ± 0.48

*Determined by difference.
Values are means of 4 determinations ± standard deviation of means.

For the oil content, IS 3107 (Bida) gave the best result (42.15 ± 0.08%) ($P<0.05$) followed by HS897 (Dikankan) with 37.32 ± 1.9%) for all the locations (table 5).

Table 5: OIL CONTENT OF SUNFLOWER SEEDS (%)

HYBRID	LOCATIONS			
	KANO	MINNA	BIDA	DOGONDAWA
IS 7111	24.89 ± 0.04^{c}	29.95 ± 0.06^{b}	29.28 ± 0.02^{d}	28.63 ± 0.04^{c}
IS 3107	30.25 ± 0.07^{b}	29.57 ± 0.04^{c}	34.15 ± 0.08^{b}	35.76 ± 0.08^{a}
NK 265	31.72 ± 0.11^{a}	29.32 ± 0.04^{d}	31.05 ± 0.06^{c}	26.23 ± 0.03^{d}
HS 897	32.09 ± 0.42^{a}	31.80 ± 0.78^{a}	37.60 ± 0.92^{a}	29.28 ± 0.69^{b}

1. Percent dry weight basis (undefatted).
Values are means of 4 determinations ± standard deviation (SD) of means. Values with similar superscripts in the same column are not significantly different.

Table 6: FATTY ACID PROFILE OF SUNFLOWER SEED OIL HYBRID HS 897

	KANO	MINNA	BIDA	DOGONDAWA
C 14:0	0.07 ± 0.01	0.05 ± 0.00	0.06 ± 0.00	0.08 ± 0.00
C 16:0	6.05 ± 0.35	5.32 ± 0.00	5.46 ± 0.04	6.20 ± 0.03
C 17:0	0.05 ± 0.00	0.01 ± 0.00	0.15 ± 0.00	0.64 ± 0.00
C 18:0	5.60 ± 0.01	5.12 ± 0.61	6.28 ± 0.72	5.28 ± 0.01
C 18:1	19.32 ± 2.66	19.68 ± 4.68	18.34 ± 3.42	18.98 ± 2.98
C 18:2	66.98 ± 2.19	65.26 ± 3.01	66.10 ± 2.81	65.34 ± 1.99
C 18:3	0.078 ± 0.23	0.036 ± 0.00	0.042 ± 0.00	0.065 ± 0.01
Total saturated	11.77 ± 0.37	10.50 ± 0.61	11.95 ± 0.76	12.20 ± 0.04
Total unsaturated	86.38 ± 5.08	84.98 ± 7.69	84.48 ± 6.23	84.39 ± 4.96

Values are means of 4 determinations ± SD of means

Moderately high levels of total dietary fibre were observed in all the samples. Overall, the values ranged between 13.08 ± 0.09% for HS897 at Dikankan to 20.56 ± 0.09% for IS 7111 at Minna. The fibre values for the hybrid means did not differ significantly. Hybrid IS 7111 gave consistently high total dietary fibre in all the locations.

Values obtained for the crude protein ranged between 16.92% and 37.34%. These values are moderately high and comparable with values reported for soybean, peanut, cashew and water melon seeds (Oyenuga and Fetuga, 1975, Fetuga *et. al*. 1974). Significant difference exists between the crude protein content of one hybrid to the other (P< 0.01). The hybrids grown at Dikankan gave higher crude protein contents than the other locations. Similar variations in protein levels of sunflower hybrids with planting locations were reported by Robertson *et. al*, (1971).

Analysis of variance revealed significant differences (P<0.01) in the oil contents of the hybrids in each location. Samples grown at Dikankan and Bida locations seemed to favour higher oil levels in the hybrids than other locations. HS897 and IS 3107 were relatively low in oil compared to the other hybrids. Similar findings by Robertson et. al. (1971), have shown oil contents ranging from 28.8% to 44.3% for sunflower hybrids grown at different planting locations in the United States of America.

All the hybrids grown at Minna and Bida locations gave the highest percentage (90%) of total unsaturated fatty acids reported. Hybrids produced at the Kano location gave the lowest percentage for these same acids.

The ratio of the unsaturated fatty acids to the saturated fatty acids of the sunflower oil is high (table 7) with a high percentage (90%) of total unsaturated fatty acids, which makes the oil to fall within the class of nutritionally advantaged oil.

Table 7: UNSATURATED FATTY ACID/SATURATED FATTY ACID RATIO OF SUNFLOWER OIL

HYBRID	LOCATIONS			
	KANO	MINNA	BIDA	DOGONDAWA
IS 7111	6.36^{c}	8.05^{a}	6.74^{b}	6.80^{b}
IS 3107	6.99^{b}	7.83^{b}	6.15^{d}	7.17^{a}
NK 265	6.34^{c}	7.48^{b}	6.60^{c}	6.17^{c}
HS 897	7.34^{a}	7.09^{c}	7.07^{a}	6.92^{ab}

1. Values with similar superscripts in the same column are not significantly different. (P < 0.05)

Table 8: CHEMICAL PROPERTIES OF SUNFLOWER SEED 0IL (HYBRID HS 897)

	KANO	MINNA	BIDA	DOGONDAWA
Saponification Value	188.51 ± 0.02	190.61 ± 0.02	191.88 ± 0.02	189.90 ± 0.03
Iodine value	78.45 ± 0.02	82.50 ± 0.03	80.90 ± 0.02	81.78 ± 0.03
Free fatty acid (%)	0.22 ± 0.02	0.19 ± 0.02	0.18 ± 0.02	0.21 ± 0.03
Peroxide value	0.89 ± 0.03	0.89 ± 0.03	0.95 ± 0.02	0.90 ± 0.03

Values are means of 4 determinations ± SD of means.

Table 9: PHYSICAL PROPERTIES SUNFLOWER SEED OIL (HYBRID HS 897)

	KANO	MINNA	BIDA	DOGONDAWA
Refractive Index at 20^{o}C	1.464 ± 0.0016	1.471 ± 0.0013	1.467 ± 0.0016	1.460 ± 0.0016
Specific gravity at 15.5^{o}C	0.921 ± 0.0017	0.919 ± 0.0021	0.923 ± 0.0021	0.918 ± 0.0016
Colour	Pale Yellow	Pale Yellow	Pale Yellow	Pale Yellow

Values are means of 4 determinations ± SD of means

The fatty acid spectrum (table 7) of the sunflower oils, is similar to what is obtained for some other oil seeds e.g. cotton seed and safflower but quite different from those of soybean oil, rapeseed oil and coconut oil in that it does not contain appreciable levels of linolenic acid (C18:3), or low chain (10:0 - C14:0) fatty acids. The absence of the former is desirable because C18:3 is associated with flavour deterioration and autoxidation.

The values reported here for crude protein, oil, ash and carbohydrate are within the range reported by other workers for hybrid varieties (Robertson et. al, 1971; Dreher et al., 1983, Saeed and Cheryan, 1988).

The tannin content ranged from 0.33mg/g catechin equivalent (H897) to 1.95mg/g catechin equivalent (IS 7111). The tannin levels observed are generally low in all locations. This is in agreement with Nagis (1982) observation that sunflower meals contained lower tannins than other seed meals. This low level may be a consequence of plant breeding interests for low sunflower tannin hybrids (Fick, 1978).

For the polyphenols, levels observed (Table 10) are generally low, lower than Guar seeds (Kanshal and Bhattia, 1982) sorghum grains (McGrath, *et. al*, 1982) and red acalypha tea (Afolabi *et. al*, 1988). The range (6.70 - 15.54 mg/g) is quite comparable to the findings of Sabir, *et. al*., (1974) and Dorrell (1976) for sunflower seeds.

Table 10: POLYPHENOL CONTENT[1] OF SUNFLOWER MEALS (Mg/g)[2]

HYBRID	LOCATIONS			
	KANO	MINNA	BIDA	DOGONDAWA
IS 7111	11.94 ± 0.03^{c}	13.62 ± 0.03^{a}	8.06 ± 0.09^{b}	12.64 ± 0.79^{b}
IS 3107	14.14 ± 0.04^{b}	9.84 ± 0.00^{c}	14.04 ± 0.00^{a}	12.62 ± 0.03^{b}
NK 265	9.74 ± 1.56^{d}	9.92 ± 0.17^{c}	14.14 ± 0.14^{a}	16.40 ± 0.00^{a}
HS 897	16.98 ± 0.04^{a}	11.04 ± 0.00^{b}	7.42 ± 0.03^{c}	10.06 ± 0.02^{c}

Values are means of 4 determinations ± standard deviation of means.
Mg/g tannic acid equivalent Values with similar superscripts in the same column are not significantly different. (P 0.05)

Table 11: TANNIN CONTENT[1] OF SUNFLOWER MEALS (Mg/g)[2]

HYBRID	LOCATIONS			
	KANO	MINNA	BIDA	DOGONDAWA
IS 7111	0.85 ± 0.00^{b}	0.93 ± 0.04^{b}	1.66 ± 0.11^{a}	0.60 ± 0.00^{d}
IS 3107	0.71 ± 0.01^{c}	0.87 ± 0.02^{b}	0.73 ± 0.03^{b}	0.87 ± 0.02^{b}
NK 265	1.40 ± 0.00^{a}	0.90 ± 0.00^{ab}	0.60 ± 0.01^{c}	1.15 ± 0.00^{a}
HS 897	0.71 ± 0.01^{c}	1.05 ± 0.01^{a}	0.43 ± 0.04^{d}	0.71 ± 0.00^{c}

1. Values are means of 4 determinations ± standard deviation of means.
2. Mg/g catechin equivalent
Values with similar superscripts in the same column are not significantly different. (P < 0.05)

All varieties had high levels of minerals especially for calcium and magnesium. The variation of the mineral levels in the sunflower seeds within the locations have not followed any particular trend but may be more related to levels of these elements in the soil and their availability.

In conclusion, these preliminary chemical evaluations of samples obtained from the trial plantings of sunflower have demonstrated the potential of the plant as a commercial crop in the humid tropics such as Nigeria. The yield, including levels if major chemical components: carbohydrate, crude protein, oil, tannin, fibre, minerals compare favourably well with values obtained for the same plant grown under a different agronomic condition (Dorrell, 1978). The best results for all the attributes considered seem to come from the two locations: NBL, Bida and UAC, Dikankan. On the basis of all parameters considered, hybrid HS 897 from Bida appeared most favoured for adoption as a commercial crop.

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