Yield, Characteristics and Composition of Oil-Type Hybrid Sunflower Seed Grown in North Dakota[1]

M.L. DREHER[a], W.W. ROATH[b], E.T. HOLM[a] and B. D'APPOLONIA[c], North Dakota State University, [a]Food and Nutrition Department, College of Home Economics, [b]USDA-ARS, [c]Cereal Chemistry and Technology Department, Fargo, ND 58105

ABSTRACT

Oil-type sunflower seed hybrids grown in North Dakota were evaluated for yield, seed characteristics and composition. The study consisted of 74 hybrids grown at Casselton, ND, during 1981. Mean analytical values were: yield ($\bar{x}$ = 2047 kg/hectare), seed weight ($\bar{x}$ = 9.9 g/200 seed), test weight ($\bar{x}$ = 40.3 kg/hectare), hull ($\bar{x}$ = 26.7%), embryo ($\bar{x}$ =73.7%), oil ($\bar{x}$ = 45.3%), protein ($\bar{x}$ = 20.8%), ash ($\bar{x}$ = 3.5%), lysine ($\bar{x}$ = 4.5 g/100 g protein) and chlorogenic acid ($\bar{x}$ = 2.0%). Increasing the lysine content of hybrid sunflower protein appears to have possibilities for further study. The mean chlorogenic acid content was slightly lower than levels previously reported.

INTRODUCTION

Sunflower *(Helianthus annus)* is a major world oilseed crop (1), and North Dakota ranks first in the United States in production of sunflower seed (2). In 1981, oilseed types comprised 95% of the US sunflower crop planted, which is about normal (3). Oilseed types yield both nutritious, high quality vegetable oil and meal with substantial amounts of protein (3,4). The high polyunsaturated fatty acid content of northern grown sunflowers results in a good oil for products such as margarine and salad dressings (4). Sunflower meal is used primarily in ruminant feeds (3), but its unique organoleptic, nutritional and functional properties (3), and extremely low levels of aflatoxin (5), make sunflower meal potentially useful in human foods.

Variations in sunflower seed composition have mainly been reported for oil or complete analyses of open-pollinated varieties grown at southern locations. Robertson and coworkers (6) showed the linoleic acid content of open-pollinated sunflower oil to vary inversely with temperature during seed development. More recently, Robertson and associates (4) found temperature and latitude to have no significant effect on total oil content, although seed grown at cooler locations had slightly higher oil contents than that grown at warmer locations. These researchers reported significant differences in oil content between growing seasons, but the same varieties consistently had the higher or lower total oil contents. Variation in sunflower meal composition has not been as extensively evaluated as in the oil. Wan and associates (7) have shown the achene of southern grown seeds to vary in protein from 19.6 to 27.1%. Earle and coworkers (8) noted that lysine (3.4-4.2 g/100 g protein) is the first limiting amino acid in open-pollinated varieties. Dorrell (9) correlated the chlorogenic acid content in open-pollinated seed with genotype and environment. The objective of this study is to evaluate the important characteristics of modern oilseed hybrids grown in North Dakota.

EXPERIMENTAL PROCEDURES

Materials

The study consisted of 74 oil-type hybrid sunflower seed varieties, from the 1981 National Sunflower Performance Trial reported by Roath (10), and additional experimental hybrids. These hybrids were grown at Casselton, North Dakota, during the 1981 season which was a typical year for precipitation and temperatures.

Methods of Analysis

Whole seed had been previously dried to ca. 3.5% moisture prior to receipt at our laboratory for analyses. Yield, weight per 200 seed and test weight were determined by standard procedures. Total oil content was determined on oven-dried whole seed by a Newport nuclear magnetic resonance analyzer. Whole seed was ground to less than 20 mesh in a Waring blender for subsequent analyses including: crude protein (N% x 6.25) by the Kjeldahl method (modified AOAC method 14.068), ash (600 C for 2 hr) by AOAC method 7.009 (11) and moisture in an air-drying oven at 105 C. Fifty seeds of each hybrid were hand-dehulled to determine hull and kernel proportions. All analyses were performed in duplicate and reported on a dry weight basis.

Lysine was determined by a modified spectrophotometric method (12). Ca. 100 mg of dehulled sunflower seed was pulverized in a ground glass tissue homogenizer with 2 mL of 0.075 N NaOH for 7 min. The sample was then quantitatively transferred to a centrifuge tube with 5 mL 0.075 N NaOH and vortexed for 30 sec before centrifugation. Lysine content of the preparation was determined using a lysine standard in each sample group (12).

Chlorogenic acid was determined by a modified spectrophotometric method (13). For each determination, 50-60 mg of ground dehulled sunflower seed was weighed into a tissue homogenizer, 2 mL 70% methanol solution added, and the sample homogenized for 5 min. The mixture was then transferred into a 125-mL Erlenmeyer flask, the tissue homogenizer rinsed with 70% methanol three times, and enough 70% methanol solution added to make a total volume of ca. 70 mL. The reference procedure (13) was then followed.

Data were analyzed statistically for mean, standard deviation, coefficient of variation and correlation coefficient ($P < 0.01$) (14).

RESULTS AND DISCUSSION

Yield and seed characteristics of sunflower hybrids grown at Casselton, North Dakota, are shown in Table I. The hybrids exhibited a wide variation in yield (1045-2427 g/hectare), seed weight (8.0-12.3 g/200 seed) and test weight (35.5-45.8 kg/hectare). The percentage kernel was significantly correlated with oil content ($r = 0.50$). The yield was positively correlated with lysine content ($r = 0.21$) and seed weight was negatively correlated with lysine content ($r = -0.21$), but these results were not significant.

Seed composition of the hybrids is shown in Table II. For the whole seed, the oil, protein and ash means were 45.3%, 20.8% and 3.5%, respectively. Sunflower hybrid seed in this study had higher oil and lower protein contents than the southern grown hybrids reported by Robertson and coworkers (6). These differences may be due to genetic manifestations but also laboratory variability, since different methods of analysis were used. The crude oil and protein contents of these hybrids were relatively uniform (coefficient of variation (CV) of 4.6% and 5.1%, respectively). The ash level was more variable (CV of 13.4%) than ex-

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TABLE I

Yield and Seed Characteristics of 74 Oilseed Hybrids, 1981

	Yield (kg/hectare)	Seed weight (g/200 seed)	Test weight (kg/hectare)	Hull (%)	Kernel (%)
Hybrids					
Mean	2047	9.9	40.3	26.7	73.7
Range	1045-2427	8.1-12.3	37.2-44.3	21.3-29.4	70.7-78.8
SD ±	213	0.9	1.7	2.0	2.0
CV %	10.4	9.2	4.1	7.5	2.7

TABLE II

Compositional Data of 74 Oilseed Hybrids, 1981

	Whole seed			Dehulled seed	
	Oil (%)	Protein (%)	Ash (%)	Lysine (g/100 g protein)	Chlorogenic acid (%)
Hybrids					
Mean	45.3	20.8	3.5	4.5	2.0
Range	38.6-54.0	18.5-23.2	2.0-4.1	2.7-5.4	1.7-2.4
SD ±	2.2	1.1	0.5	0.6	0.2
CV %	4.6	5.1	13.4	13.2	7.4

pected, since these varieties were grown under the same conditions. Ash content was not significantly correlated with either oil or protein content. For the dehulled seed, lysine and chlorogenic acid means were 4.5 g/100 g and 2.0%, respectively. Although different methods of analysis were used, hybrids in this study showed a higher mean lysine content (g/100 g protein) than the mean of 3.8 g/100 g protein (range 3.4-4.2 g/100 g protein) previously reported for open-pollinated dehulled sunflower meal (8). These results tend to agree with swine feeding data reported by Dinusson (15). Several hybrids had mean lysine contents approaching the FAO/WHO standard of 5.44 g/100 g protein (16). According to Baudet and coworkers (17), the lysine level is directly related to the protein content. The feasibility of improving the lysine content of the hybrid sunflower meal should be explored. Chlorogenic acid (CA) levels in this study were slightly lower than the CA levels for open-pollinated varieties reported by Dorrell (9). Current hybrids appear to be slightly lower in chlorogenic acid than the open-pollinated varieties previously studied. There was no significant correlation between percentage kernel and CA content level or seed size and CA level. Generally, this study showed tendencies for lower levels of CA to be associated with greater test weight and protein content.

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