Variation in the Wax Content of Sunflower Seed with Location and Hybrid

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ABSTRACT

Three genetically different types of oilseed sunflower hybrids grown at six different locations were evaluated for the influence of hybrid and location on wax content of hull and oil. Analysis of variance showed that differences in the amount of hull and wax content of the hull were related to both location and hybrid. However, location and hybrid were not found significantly to influence wax content of the oil.

The wide acceptance of sunflower seed oil as a quality cooking oil and not just as a health food item has increased the awareness of quality control. As a new hybrid sunflowers replaced open pollinated varieties in the USA, some processors reported that the wax content of the oil from hybrid seed was higher than that from open pollinated varieties. In an earlier report, we showed a significant negative correlation between the percentage hull in the seed and the wax content of the oil (1). As these new hybrids were bred for higher oil content by reducing the percentage of hull, these reports were not at all surprising. Whereas more efficient dehulling would decrease the wax content of the oil, too low a hull content reduces extraction efficiency (2). Processors have overcome this problem by combining dewaxing with either degumming (3) or cold alkali refining (4). Since waxes are located almost exclusively on the surface of the hull, a rapid method of described has been reported which involves washing the seed with hot hexane and suggests an efficient approach for dewaxing (5). The objective of this study was to determine the influence of growing location on the wax content of three genetically different hybrid sunflower seed.

MATERIALS AND METHODS

Sunflower seed used were samples from the 1977 National Sunflower Variety Trials which had been frozen until evalutated. The hybrids investigated were Cargill 204, Sunbred 223, and Sungro 380. These seed were grown in (1) Laurinburg, North Carolina; (2) Leoti, Kansas; (3) Medford, Oregon; (4) Watertown, South Dakota; (5) Rothdrum, Idaho; and (6) Manitoba, Canada. The percentage of hull and kernel in the seed was determined by hand separation. A known weight of hulls was ground with Hyflo Super Cel in a high speed grinder and extracted with hexane in a Soxhlet apparatus for 6 hr. Solvent was evaporated and the flask dried to constant weight. To the known weight of residue was added triacontane as an internal standard. Wax content and waxy alcohol distribution were determined by gas liquid chromatography (GLC) (6). Oil was obtained by grinding whole sunflower seed in a Krups 75 grinder followed by extracting with hexane in a Soxhlet apparatus. Fatty acid composition was determined by GLC (7). Total oil was measured using a NewPort Mark III wide line nuclear magnetic resonance (NMR) analyzer (8). All samples were run in triplicate and analysis of variance of the data was performed using the Statistical Analysis System (9).

TABLE I

Characteristics of Sunflower Hybrids

Location[a]	Hybrid	Wax in hull (ppm)	Wax in oil (ppm)	hull (%)	Oleic acid (%)	Linoleic acid (%)	Total oil (%)	Waxy alcohols (%)		
								C-22	C-24	C-26
1	204	876	475	24.0	28.8	63.0	48.4	12.4	45.6	41.9
	223	855	400	21.4	35.1	56.5	50.5	13.1	52.0	35.0
	380	705	290	22.6	25.3	66.2	51.2	10.4	48.0	41.7
2	204	2020	600	25.3	33.0	57.9	39.6	17.8	49.0	33.3
	223	1430	690	31.0	40.5	49.7	38.7	23.5	48.1	28.3
	380	1340	515	21.7	44.7	46.8	44.9	15.9	52.1	35.0
3	204	1485	683	27.4	17.5	71.0	43.3	21.6	50.3	28.1
	223	1010	457	24.5	20.1	68.4	47.6	19.6	53.7	26.8
	380	965	475	25.6	19.9	68.2	46.1	17.0	52.0	31.1
4	204	1015	572	26.6	22.1	63.0	46.1	26.1	49.1	24.9
	223	896	442	23.6	24.0	62.1	45.0	26.2	52.1	22.7
5	204	1375	622	31.0	14.6	73.4	42.2	18.5	48.9	33.6
	223	1505	675	23.7	16.9	70.4	42.7	25.3	49.3	26.4
	380	1040	623	23.1	13.8	74.2	46.0	22.5	45.8	31.7
6	204	1219	695	29.1	14.9	75.9	45.6	26.0	50.6	23.5
	223	1135	450	27.1	16.6	74.0	46.3	22.2	52.4	27.7
	380	1390	620	23.2	14.9	75.8	49.5	24.7	52.4	22.9

[a](a) Laurinburg, NC; (2) Leoti, KS; (3) Medford, OR; (4) Watertown, SD; (5) Rathrum, ID; (6) Manitoba, Canada.

TABLE II

Mean Values for Wax Content and Hull Content within Locations and Hybrids

Hybrids	Hull (%)	Hull wax (ppm)	Oil wax (ppm)
204	27.2	1331	608
223	25.1	1137	519
380	23.2	1088	507
Locations			
1	22.6	812	388
2	26.0	1596	601
3	25.8	1153	538
4	25.1	952	507
5	25.8	1306	640
6	26.4	1248	588

RESULTS AND DISCUSSION

The three hybrid sunflower seed used represent genetically different lines. Table I shows the mean of triplicate analyses for a number of parameters. Analysis of variance was significant at the 98% level for hull content with location interaction and at the 99% level for the hull content with hybrid interaction. The dependence of hull content with location has been shown to be due to differences in climatic conditions. Russian investigators (10) have shown that for seed harvested in two different years, the difference in hull content was ca. 2.3%, with 5-20% of the seed having a low hull content (below 24%). Other studies have shown significant differences in hull content of a number of parental and sublines (11). Table II shows the mean values for hull content within locations and hybrids. Hybrid 204 had the highest overall mean hull content, 27.2%, and hybrid 380 the lowest, 23.6%. It appears that hull content of seed grown further north is higher than for seed grown at more southern latitudes. However, there are not sufficient data to fully verify this trend.

Analysis of variance was significant at the 98% level for the interaction between wax content of the hull and hybrid and at the 99% level for the interaction between wax content of the hull and location. The mean hull content for each hybrid was positively correlated with the mean wax content of the hull within hybrids using a linear regression analysis and had an $r^2 = 0.91$. Although the mean values for wax content of the oil appeared to show the same trend, analysis of variance failed to show any significant interaction.

The composition C-22 and -26 alcohols of the wax esters showed a significant interaction with location and hybrid. There was no significant interaction with the fatty acid composition of the oil. The percentage of C-22 alcohol ranged from 10.4 to 26.0% and the C-26 ranged from 22.7 to 41.9%. The content of C-22 alcohol was also negatively correlated (r = -.71) with the amount of C-26 alcohol.

Earlier work showed the hull content of the seed to be negatively correlated with the wax content of the oil (1). These results were based on a comparison of one confectionery hybrid with two open pollinated varieties and two hybrids. Our current work suggests that in the hybrids of the present study, the correlation between hull content and wax content of the oil is positive (r = .58), and negative (r = -.77) between oil content and the wax content of the oil. This suggests that, as hull content is reduced, the wax content of both hull and oil are reduced. It appears that for the extreme ranges of hull content as in the earlier study (17-42% hull), wax content is inversely related to hull content. In the range of hull content often seen in commercial plantings of new high oil hybrid (20-26% hull), there may be the opposite relationship; however, there is some indication that environmental factors associated with dates of planting may have even greater effect. Nevertheless the wax content of all seed is sufficiently high that some form of dewaxing is needed.

In our earlier work (1), the wax content of the oil was calculated from the amount of wax in the hull and compared to the amount found. The predicted values were consistently higher than the actual values and were attributed to incomplete extraction of the waxes from the ground seed. The solvent used was petroleum ether (bp 30-60 C) and later work showed that when hexane was used, predicted values agreed within 10% of the actual values for the amount of wax in the oil.

Factors influencing the wax content in sunflower seed are complex and not easily explained. Preliminary results suggest that planting date also has an effect on the wax content and further investigations in this area are underway.

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