Nutrient Constituents from Eight Lines of Naked Seed Squash (*Cucurbita pepo* L.)†

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Seeds from eight lines of naked seed squash (*Cucurbita pepo* L.) were evaluated for their proximate analysis, amino acid and fatty acid compositions, and mineral content. Moisture content was not significantly different ($P < 0.05$) among seed types. Protein values were significantly different among seed types and ranged from 37.1 ± 0.45% to 44.4 ± 0.45%. Oil content was high in all seeds and varied from 34.5 ± 0.42% to 43.6 ± 0.06%. Carbohydrates, calculated by difference, varied significantly among seeds. Ash values ranged between 5.1 ± 0.04% and 6.3 ± 0.10%. Energy levels were from 549 ± 3 to 598 ± 1 kcal/100 g. Amino acid patterns were similar among the seed lines. Cysteine and methionine contents were low. Fatty acid composition varied significantly ($P < 0.05$) among the seeds of selected lines. Oleic acid was significantly the most concentrated (46.6 ± 0.15% to 60.4 ± 0.19%) followed by linoleic (9.6 ± 0.16% to 27.9 ± 0.15%) and palmitic acid (12.8 ± 0.17% to 15.8 ± 0.56%). With the exception of magnesium and manganese, all other endogenous mineral contents varied significantly among seed samples. Potassium, magnesium, and calcium were the most prevalent minerals, respectively.

Keywords: *Naked seed squash; chemical composition; Cucurbita pepo L.*

INTRODUCTION

Culture and use of cucurbits or squashes (*Curcubita foetidissima, C. pepo,* and *C. lagenaria*) have been traced to more than 10 000 years ago (Bemis et al., 1978a). Although still not widely used by the food industry, squashes are consumed worldwide. Fruits are consumed as vegetables or dessert (pie) and seeds as nuts and, to a lesser extent, as cooking oil (Lazos, 1986, 1992). Because of their resistance to drought and the high protein (23−35%) and oil (25−55%) contents of their seeds, squashes have attracted the attention of many growers and plant breeders within the past 50 years (Curtis, 1946; Shahani et al., 1950; Bemis et al., 1978b; Scheerens et al., 1991). Although many works have been reported on squashes, only a few were related to the naked seed variety (Curtis, 1948; El-Gharbawi, 1977; Abak et al., 1990). In recent years, Warid et al. (1993) have evaluated 8 lines of naked seed squash from a pool of 100 Austrian lines on the bases of production performance, number of fruit, weight of seeds, and pepo size. Plants produced one to nine fruits weighing 0.47−12.67 kg. The number of seeds per fruit ranged from 16 to 393. Individual naked seed weight ranged from 46 to 223 mg. Naked seeds have the advantage of lacking the seed coat, making them less costly to produce since there is no need for the expensive decorticating process. They therefore may be favored by the oil and nut industries for commercial production.

The purpose of this investigation is to determine the chemical and nutritional values of the seeds collected from these eight lines of naked seed squash and to make recommendations for their potential commercial production.

MATERIALS AND METHODS

Seed Sources and Sample Preparation. Two different naked seed squash (*C. pepo* L.) strains referred to as 2 and 5 of Austrian origin were grown at the Experimental Station of the University of Sonora (Hermosillo, Mexico) and used to select eight new lines (2-2-2, 5-2-5, 5-4-2, 5-6-1, 5-8-1, 5-11-3, 5-16-8, and 5-25-2) (Warid et al., 1993). Duplicate seed samples from lines were ground in a laboratory Wiley mill to pass through a 10 mesh size screen and further crushed to finer particles in a mortar and pestle.

Proximate Analysis. Moisture, protein, crude oil, and ash were analyzed according to AOAC (1990) Methods 925.08, 984.13, 920.39, and 923.03, respectively. Carbohydrate contents were determined by difference [100 − (protein + crude fat + ash)]. Energy levels were calculated by multiplying protein and carbohydrate contents by a factor of 4 and fat by 9. All analyses were carried out in duplicate on dried samples.

Fatty Acid Composition. Oil of the freshly ground seeds was extracted from duplicate samples (1 g) using hexane as solvent. The oil−solvent mixture was evaporated to dryness under nitrogen and then transesterified with sulfuric acid in the presence of methanol for 3 h at 100 °C. The resulting fatty acid methyl esters were run through a column containing $MgSO_4$ plus silica and evaporated again to dryness by heating the solution to 60 °C while flushing with nitrogen. The fatty acid methyl esters were redissolved in 1−2 mL of hexane and analyzed in a Shimadzu Model GC-8A gas−liquid chromatograph equipped with a Supelcowax 10 capillary column (30 m × 32 mm i.d.) packed with 0.25 mm fused silica. Injection volumes were 1 μL/sample. Methyl esters of the different samples were identified by their relative retention times compared to those of reference standards (GLC-68, NuChek Prep Inc., Elysian, MN) and quantified by their relative peak areas.

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Table 1. Proximate Chemical Composition of Seed of Selected Naked Seed Squash Lines[a]

squash lines	moisture (%)	protein (%)	crude oil (%)	CHO[b] (%)	ash (%)	energy[c] (kcal/100)
2-2-2	5.8 ± 0.09[a]	37.1 ± 0.46[d]	34.8 ± 0.42[f]	21.9 ± 0.27[a]	6.3 ± 0.11[a]	549 ± 3[e,f]
5-2-5	5.1 ± 0.38[a]	41.5 ± 0.21[c]	43.6 ± 0.06[a]	9.9 ± 0.23[f]	5.1 ± 0.04[e]	598 ± 1[a]
5-4-2	5.4 ± 0.19[a]	43.1 ± 0.01[b]	41.5 ± 0.10[b]	10.0 ± 0.15[f]	5.5 ± 0.04[d]	582 ± 4[b]
5-6-1	5.7 ± 0.16[a]	42.0 ± 0.35[c]	35.6 ± 0.28[e]	16.3 ± 0.01[c]	6.1 ± 0.07[b]	554 ± 1[de]
5-8-1	5.6 ± 0.57[a]	43.7 ± 0.57[ab]	35.0 ± 0.37[f]	15.5 ± 0.91[c]	5.8 ± 0.04[c]	552 ± 2[e]
5-11-9	4.8 ± 0.11[a]	43.0 ± 0.74[b]	39.6 ± 0.23[c]	11.3 ± 0.98[e]	6.1 ± 0.01[b]	574 ± 1[c]
5-16-8	5.5 ± 0.00[a]	44.4 ± 0.45[a]	37.0 ± 0.37	12.5 ± 0.05[d]	6.1 ± 0.13[ab]	559 ± 3[d]
5-25-2	5.3 ± 0.04[a]	41.5 ± 0.28[c]	34.4 ± 0.11[c]	17.8 ± 0.27[b]	6.3 ± 0.10[a]	546 ± 1[f]
CV[d] %	6.100	0.055	0.091	0.294	0.071	0.033

[a] Expressed on dry weight basis (mean ± SD, $n = 2$). Mean values with the same superscript within columns are not significantly different ($P < 0.05$). [b] CHO = carbohydrates, calculated by difference: 100 − (protein + crude fat + ash). [c] Energy determined by multiplying fat by 9 and CHO and protein by 4. [d] CV = coefficient of variation.

Amino Acid Analysis. Amino acid composition was determined by using the Spackman et al. (1958) method. Duplicate fat-free dry samples (100 mg) were hydrolyzed under vacuum in 5 mL of 6 N HCl for 18 h at 100 °C. Amino acid analysis was performed with a Spectra Physics SP 8000A amino acid analyzer using a Beckman fluorescence detector.

Mineral Analysis. Duplicate 0.5 g samples of defatted dry samples were wet ashed as described previously by Idouraine et al. (1996). Samples (0.5 g) were digested in the presence of hydrogen peroxide in 5 mL of concentrated nitric acid for 1 h at 100 °C. The solution was adjusted to 10 mL with deionized water and centrifuged at 3000 rpm for 10 min. Supernatants were either measured directly or diluted to the appropriate concentrations for elemental analysis by flame atomic absorption. Minerals were measured at the appropriate wavelength using a Hitachi Model 180-70 spectrophotometer and quantified by reference to standard curves made from standard mineral solutions (Fisher Scientific, Pittsburgh, PA). Ca and Mg were determined in the presence of 1% lanthanum oxide to avoid interferences with other compounds.

Statistical Analysis. Data were statistically analyzed using one-way analysis of variance with means separated and least significance difference set at $P < 0.05$ (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

Proximate Chemical Composition. The chemical analysis of the seeds from eight squash lines is reported in Table 1. Moisture content was not significantly ($P < 0.05$) different among samples. Protein levels varied significantly among samples. Lines 5-16-8 and 5-8-1 showed the highest protein content while line 2-2-2 the lowest. The coefficient of variation (CV) of the proteins was low, suggesting that the differences observed most likely have been caused by genetic variation. However, environmental factors, such as the place where the fruits grew, maturity of the seeds at the time of harvest, and fertilization conditions, might have played a minor role in the differences. Protein values of the seeds of lines selected from strain 2 appeared to be significantly lower than those of lines selected from strain 5. Protein values found in this study are higher than the 20−25% range reported by some (Scheerens et al., 1991; Lazos, 1986; Vasconcellos et al., 1981; El-Gharbawi, 1977) but lower than the 49−72% range indicated by others (Mansour et al., 1993; Lazos, 1992; Vasconcellos et al., 1980) for *C. pepo* and other species.

Crude oil level was over 40% in lines 5-2-5, 5-4-2, and 5-11-3 and no lower than 34% in the remaining lines. The CV was relatively low, suggesting that the variations observed might be related to growth and fertilization conditions and time of harvest. The oil values of the present selected lines are in the high range of the 21−43% and 23−35% cited by Vasconcellos (1981) and Scheerens et al. (1991), respectively, and agree with those reported by El-Gharbawi (1977), Vasconcellos et al. (1980), and Lazos (1986).

Carbohydrates, calculated by difference, varied significantly among seed samples. Seeds from line 2-2-2 (selected from strain 2) showed the highest level of total carbohydrates. The CV was high and might be related to some environmental factors. Values were similar to those indicated by Mansour et al. (1993), Lazos (1986, 1992), and El-Gharbawi (1977) but lower than the range (23−35%) found by Scheerens et al. (1991). Species variations and environmental conditions may explain these variations.

Ash content was relatively low and similar to that reported in the literature (Scheerens et al., 1991; Lazos, 1986; El-Gharbawi, 1977). Calculated energy was high and showed low CV.

The chemical analysis of seed samples from the eight squash lines in this study exhibited overall superior oil and protein contents compared to most of those reported in the literature.

Amino Acid Composition. The amino acid profile of the protein from eight squash lines is shown in Table 2. With the exception of a few amino acids, there was no major significant difference in amino acid content among different lines. Methionine, threonine, histidine, and tyrosine were the lowest in concentration. As for most legumes, the sulfur amino acid content was low. Although low in all samples, methionine appeared to be significantly higher in concentration in lines 5-2-2, 5-4-3, and 5-8-1. Genetic factors most likely explain these differences. Threonine content was lower than that reported by Mansour et al. (1993) and Jacks et al. (1972). As reported in the literature, all seeds from the selected lines were rich in glutamic and aspartic acids and arginine. Values were similar to those previously reported (Mansour et al., 1993; Hensarling et al., 1973; Jacks et al., 1972).

Fatty Acid Composition. The major fatty acids of the oil extracted from the seeds from the eight progeny lines are shown in Table 3. Oleic ($C_{18:1}$), linoleic ($C_{18:2}$), and palmitic ($C_{16:0}$) acids were sequentially the highest in concentration followed by stearic acid ($C_{18:0}$) at less than 8% and other fatty acids at an even lower content (<1%). Total unsaturated fatty acids ranged between 70% and 79%. Lines 5-8-1 and 5-25-2 contained significantly more oleic acid than the other lines. The CV for this fatty acid was low, suggesting that the variation noted might be related to genetics. Palmitic acid content was not significantly different among seed samples. As reported by Bemis et al. (1967) and El-Gharbawi (1977), oleic acid was found to be the major oil constituent in all progeny lines. Our values agree with those indicated by these authors (50% and 46%

Table 2. Amino Acid Composition (Percent) of Seed of Selected Naked Seed Squash Lines[a]

	line							
amino acid	2-2-2	5-2-5	5-4-2	5-6-1	5-8-1	5-11-9	5-16-8	5-25-2
aspartic acid	8.8 ± 0.25[a]	9.7 ± 0.42[a]	9.5 ± 0.05[a]	8.9 ± 0.25[a]	9.4 ± 0.04[a]	9.5 ± 0.93[a]	8.3 ± 0.02[a]	9.0 ± 0.16[a]
glutamic acid	19.9 ± 0.30[c]	23.4 ± 1.13[a]	23.6 ± 0.10[a]	21.4 ± 0.47[bc]	23.3 ± 0.39[ab]	23.1 ± 1.66[ab]	19.8 ± 0.63[c]	20.5 ± 0.92[c]
serine	4.0 ± 0.10[a]	4.6 ± 0.28[a]	4.6 ± 0.30[a]	4.0 ± 0.18[a]	4.5 ± 0.40[a]	4.4 ± 0.01[a]	4.0 ± 0.41[a]	3.3 ± 0.42[b]
histidine	1.9 ± 0.02[a]	2.2 ± 0.07[a]	2.1 ± 0.04[a]	2.1 ± 0.13[a]	2.2 ± 0.04[a]	2.2 ± 0.12[a]	1.9 ± 0.11[a]	2.0 ± 0.33[a]
glycine	7.9 ± 0.03[a]	8.4 ± 0.09[a]	9.1 ± 0.21[a]	8.3 ± 0.18[a]	8.7 ± 0.41[a]	9.0 ± 0.67[a]	8.1 ± 0.67[a]	7.7 ± 0.37[a]
threonine	1.7 ± 0.08[a]	1.7 ± 0.12[a]	1.6 ± 0.06[a]	1.7 ± 0.10[a]	1.6 ± 0.11[a]	1.6 ± 0.09[a]	1.4 ± 0.22[a]	1.5 ± 0.28[a]
arginine	14.7 ± 0.14[b]	18.7 ± 0.68[a]	18.6 ± 0.10[a]	16.7 ± 0.02[b]	18.6 ± 0.33[a]	18.3 ± 1.00[a]	15.8 ± 1.2[b]	16.1 ± 1.20[b]
alanine	5.2 ± 0.36[c]	5.9 ± 0.03[ab]	6.0 ± 0.16[a]	5.4 ± 0.07[c]	6.0 ± 0.26[a]	5.9 ± 0.04[ab]	5.5 ± 0.15[bc]	5.3 ± 0.26[c]
tyrosine	2.5 ± 0.03[a]	2.8 ± 0.08[a]	2.8 ± 0.03[a]	2.5 ± 0.01[a]	2.8 ± 0.01[a]	2.6 ± 0.21[a]	2.5 ± 0.16[a]	2.5 ± 0.20[a]
methionine	1.4 ± 0.07[c]	1.4 ± 0.02[c]	1.8 ± 0.11[a]	1.4 ± 0.01[c]	1.6 ± 0.01[b]	1.3 ± 0.03[c]	1.3 ± 0.06[c]	1.9 ± 0.09[a]
valine	4.8 ± 0.08[a]	5.2 ± 0.18[a]	4.9 ± 0.32[a]	4.7 ± 0.15[a]	5.2 ± 0.02[a]	5.1 ± 0.34[a]	4.5 ± 0.42[a]	4.7 ± 0.32[a]
phenylalanine	4.7 ± 0.80[a]	5.3 ± 0.25[a]	5.3 ± 0.03[a]	4.8 ± 0.11[a]	5.2 ± 0.04[a]	5.2 ± 0.33[a]	4.6 ± 0.32[a]	4.6 ± 0.08[a]
isoleucine	3.9 ± 0.07[bc]	4.5 ± 0.03[a]	4.6 ± 0.01[a]	4.2 ± 0.09[ab]	4.5 ± 0.12[a]	4.4 ± 0.42[a]	3.7 ± 0.27[c]	4.15 ± 0.18[ab]
leucine	7.1 ± 0.11[b]	8.4 ± 0.32[a]	8.2 ± 0.02[a]	7.3 ± 0.01[ab]	8.2 ± 0.07[a]	8.1 ± 0.13[a]	7.0 ± 0.15[b]	7.0 ± 0.13[b]
lysine	4.2 ± 0.2[c]	4.2 ± 0.36[d]	4.9 ± 0.04[a]	4.4 ± 0.01[bc]	4.6 ± 0.01[abc]	4.7 ± 0.37[b]	4.3 ± 0.33[bc]	4.3 ± 0.18[bc]
total	93	106	108	98	106	105	93	95

[a] Determined in duplicate fat-free samples (mean ± SD), expressed as a percentage of protein (N × 6.25). Mean values with the same superscript within rows are not significantly different ($P < 0.05$).

Table 3. Fatty Acid Composition (Percent) of Seed of Selected Naked Seed Squash Lines[a]

squash line	palmitic 16:0	stearic 18:0	oleic 18:1	linoleic 18:2	linolenic 18:3	arachidic 20:0	gadoleic 20:1	eicosadienoic 20:2	others[b]
2-2-2	14.6 ± 3.95[a]	8.2 ± 0.55[a]	47.0 ± 0.47[d]	19.8 ± 0.01[c]	0.79 ± 0.20[a]	0.99 ± 0.13[a]	1.74 ± 0.87[a]	0.89 ± 0.36[a]	6.1 ± 4.44[a]
5-2-5	14.8 ± 4.15[a]	5.2 ± 0.18[e]	53.8 ± 2.52[c]	17.8 ± 0.34[de]	0.12 ± 0.03[b]	0.35 ± 0.18[c]	0.80 ± 0.22[a]	0.16 ± 0.36[b]	7.0 ± 6.89[a]
5-4-2	13.7 ± 0.54[a]	6.4 ± 0.01[d]	52.7 ± 1.88[c]	24.0 ± 1.15[b]	0.14 ± 0.00[b]	0.50 ± 0.01[bc]	0.66 ± 0.03[a]	0.12 ± 0.01[b]	1.9 ± 0.17[a]
5-6-1	14.8 ± 0.32[a]	7.1 ± 0.05[bc]	53.8 ± 1.75[c]	18.7 ± 0.36[cd]	0.25 ± 0.02[b]	0.61 ± 0.20[bc]	1.47 ± 0.39[a]	0.30 ± 0.17[b]	3.0 ± 0.72[a]
5-8-1	12.8 ± 0.17[a]	6.7 ± 0.14[cd]	60.4 ± 0.19[a]	16.3 ± 0.46[f]	0.33 ± 0.07[b]	0.49 ± 0.11[bc]	0.98 ± 0.48[a]	0.51 ± 0.21[ab]	1.6 ± 0.25[a]
5-11-9	13.4 ± 0.42[a]	7.4 ± 0.29[b]	55.5 ± 2.97[bc]	17.0 ± 0.63[ef]	0.13 ± 0.00[b]	0.56 ± 0.02[bc]	0.96 ± 0.33[a]	0.32 ± 0.03[b]	4.9 ± 4.39[a]
5-16-8	12.9 ± 0.36[a]	8.3 ± 0.01[a]	46.6 ± 0.58[d]	27.9 ± 0.15[a]	0.16 ± 0.00[b]	0.59 ± 0.00[bc]	1.05 ± 0.08[a]	0.29 ± 0.01[b]	2.2 ± 0.19[a]
5-25-2	15.8 ± 0.56[a]	6.9 ± 0.17[bcd]	59.1 ± 0.09[ab]	9.6 ± 0.16[g]	0.12 ± 0.00[b]	0.75 ± 0.09[ab]	2.33 ± 0.39[a]	0.25 ± 0.15[b]	5.1 ± 0.16[a]
CV (%)	0.753	0.142	0.093	0.287	0.897	0.319	0.449	0.693	0.519

[a] Expressed as percent of total fatty acids in duplicate dry samples (mean ± SD, $n = 2$). Mean values with the same superscript within columns are not significantly different ($P < 0.05$). [b] Other fatty acids (calculated by difference).

Table 4. Mineral Contents (Micrograms per Gram) of Seed of Selected Naked Seed Squash Lines[a]

squash line	Ca	Mg	K	Zn	Cu	Fe	Mn
2-2-2	2217 ± 404[abc]	7966 ± 207[a]	26043 ± 350[bc]	266 ± 13[a]	26 ± 0[a]	225 ± 6[a]	117 ± 6[a]
5-2-5	243 ± 30[ab]	8163 ± 11[a]	20692 ± 724[d]	204 ± 6[de]	20 ± 1[d]	164 ± 4[d]	110 ± 2[a]
5-4-2	1916 ± 402[bcd]	8154 ± 6[a]	25030 ± 1363[c]	231 ± 13[b]	24 ± 2[ab]	220 ± 13[a]	112 ± 6[a]
5-6-1	2788 ± 61[a]	8561 ± 63[a]	25436 ± 1001[c]	215 ± 6[bcd]	23 ± 0[bc]	200 ± 4[b]	114 ± 4[a]
5-8-1	1744 ± 68[cd]	8075 ± 1[a]	21641 ± 109[d]	214 ± 0[cd]	20 ± 1[d]	191 ± 1[bc]	107 ± 1[a]
5-11-9	2028 ± 8[bcd]	7676 ± 584[a]	27551 ± 296[ab]	197 ± 2[e]	24 ± 0[ab]	184 ± 3[c]	107 ± 0[a]
5-16-8	1498 ± 366[d]	7650 ± 564[a]	25968 ± 150[bc]	207 ± 2[cde]	21 ± 1[cd]	186 ± 5[c]	105 ± 1[a]
5-25-2	2377 ± 335[abc]	7352 ± 1[a]	28384 ± 401[a]	223 ± 0[bc]	21 ± 0[cd]	231 ± 1[cd]	111 ± 0[a]
CV (%)	0.195	0.048	0.367	0.098	0.098	0.117	0.036

[a] Determined in duplicate fat-free dry samples (mean ± SD). Mean values with the same superscript within columns are not significantly different ($P < 0.05$).

oleic acid, respectively) but disagree with other works. Vasconcellos et al. (1980, 1981) reported a predominance of linoleic acid (39−77% vs 10−32% oleic acid), while Lazos (1986) reported a value close to the middle of this range (43% linoleic acid vs 38% oleic acid). Varietal genetic difference may be the major factor, although oil processing could possibly contribute a small amount of variation.

Mineral Content. The seeds from the eight squash lines appeared to be an important source of minerals (Table 4). Potassium content was significantly the highest followed by magnesium (Mg) and calcium (Ca). Zinc (Zn), iron (Fe), copper (Cu), and manganese (Mn) levels were lower. Mg and Mn contents were not significantly different among seed samples. The CVs were low, suggesting that genetics was the major factor in differences. However, environmental factors such as fertilization and soil composition might be responsible for a small amount of the differences observed. Overall, naked squash seeds appeared to be a good source of macro- and microelements. Although reporting different levels, Lazos (1986, 1992) and Mansour et al. (1993) indicated similar trends for K, Mg, Ca, and the remaining microelements.

Squash Lines Selected for Potential Commercialization. On the basis of chemical analyses and seed production, squash lines 5-2-4, 5-4-2, 5-8-1, and 5-16-8 (Table 5) appeared to be the best suited for potential commercial production. Their oil contents are high and their ratios of unsaturated to saturated fatty acids preferable. The presence of a large proportion of oleic acid in the oil makes them more nutritionally attractive for the consumer. Protein levels appear to be higher, and deficient amino acids are relatively in good proportions when compared to other cucurbits. The number of seeds per fruit and weight of 100 seeds are in the range of those cited in the literature (Scheerens et al.,

Table 5. Characteristics of Selected Naked Seed Squash Lines

component	line 5-2-5	5-4-2	5-8-1	5-16-8
crude oil (%)	43.6	41.5	35.0	37.0
fatty acids (%)				
unsaturated	71.7	76.8	77.0	74.7
saturated	20.4	20.6	20.0	21.8
ratio	3.5	3.8	3.9	3.4
proteins (%)	41.5	43.1	43.7	44.4
amino acids (%)				
isoleucine	4.5	4.6	4.5	3.7
leucine	8.4	8.2	8.2	7.0
lysine	4.2	4.9	4.6	4.3
methionine	1.4	1.8	1.6	1.3
number of seeds/fruit	200	206	208	215
seed weight (g/100)	18.2	18.3	17.6	14.9
seed weight (g/fruit)	6.4	37.7	36.6	32.0

1991; Vasconcellos et al., 1981) and are, therefore, considered to be acceptable.

Conclusion. Seeds from self-pollinated squash lines of strains 2 and 5 were found to contain high oil and protein contents. Overall, progeny lines from strain 5 showed nutritionally the best nutrient composition and production. On the basis of chemical composition, lines 5-2-5, 5-4-2, 5-8-1, and 5-16-8 appeared to have the best potential, but several years and locations must be tested to estimate commercial production. Their chemical and nutritional compositions indicate that the seeds should be well received by both the consumer and the oil and nut industries. Further work may be needed for the evaluation of their protein composition and functional properties.

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