Chemical and physical characteristics are presented in Table 1. Significant differences in viscosity, pH, density, and total solids were not found between groundnut milks made from Florman and Colorado Irradiado seeds. The protein level of Florman groundnut milk was lower than that prepared from Colorado Irradiado. The protein content in Florman seeds is lower agreeing with previously reported results (Grosso and Guzmán 1995). Lipid, ash, and carbohydrate contents did not show significant differences. A good level of total dietary fiber, which is a important component for the human diet, was found in the beverage. Fatty acid composition is similar to values previously reported in the Florman and Colorado Irradiado groundnut cultivars (Grosso and Guzmán 1995). Oleic and linoleic acids, oleic to linoleic ratio (O/L) and iodine values were significantly different between the groundnut milks of Florman and Colorado Irradiado cultivars. Florman groundnut milk showed higher oleic acid and lower linoleic acid. Therefore, the oleic to linoleic ratio (O/L) was higher and iodine value (IV) was lower in this cultivar. A lower level of linoleic acid could be better for stability over a longer period of storage. Groundnut milk prepared with Argentinian groundnut cultivars showed higher total solids and protein levels and slightly lower lipid percentages than those found by Lee and Beuchat (1992). This variation could be due to type and origin of groundnut cultivars and different conditions of cultivation.

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Induced Genetic Variation for Seed Quality Traits in Groundnut

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Fatty acid composition of groundnut seed oil largely determines its potential application in industrial and food uses. Oleic (O) and linoleic (L) fatty acids together account for 75–80% of the total fat in groundnut (Dwivedi et al. 1993). Although both are nutritionally important, linoleic acid is also associated with reduced shelf life of the oil or seed products (Worthington and Hammons 1977).

Induced mutants with altered fatty acids are reported in several oilseed crops. These include mutants with a high concentration of palmitic and stearic fatty acids in sunflower (Osorio et al. 1995), high stearic and low linoleic fatty acids in soybean (Wilcox et al. 1984, Graef et al. 1985), a low linoleic fatty acid in linseed (Rowland and Bhatty, 1990), reduced polyunsaturated fatty acids and increased oleic fatty acid in rapeseed (Auld et al. 1992), and a low linoleic fatty acid in groundnut (Sharma et al. 1985).

Although a naturally-occurring mutant of groundnut (F 435) with extremely low linoleic (2%) and high oleic (80%) fatty acids was reported from the University of Florida, USA (Norden et al. 1987), its availability for exploitation is restricted. Recently, SunOleic 95R cultivar with an O/L ratio of 29 has been released in the USA (Gorbet and Knauft 1997).

The present study was therefore initiated to enlarge genetic variation in O/L ratio by induced mutagenesis in groundnut.

Dry seeds (1000) of JL 24 (a widely grown early-maturing spanish cultivar in India) and ICGV 88448 (a large-seeded late-maturing virginia breeding line) were soaked in distilled water for 16 h and then exposed to

Table 1. Mean oil (g kg^{-1} seed) and fatty acids (g kg^{-1} oil) contents of selected groundnut mutants and controls, rainy (1993–96) and postrainy (1992/93–95/96) seasons, ICRISAT-Patancheru.

Genotype[1]	Oil	Palmitic	Oleic	Linoleic	Eicosenoic	Behenic	Lignoceric	TSF	O/L ratio
ICGV 96230	501.0*	83.6*	611.6*	201.5*	11.5	30.5	13.2	175.2	3.33*
ICGV 96234	501.1*	80.2*	625.6*	190.8*	11.9	29.9	13.2	171.5	3.51*
ICGV 96235	474.7*	121.3*	374.3*	400.7*	11.5	35.7*	17.9*	212.6*	0.94*
ICGV 96236	461.5*	118.8*	387.5*	389.7*	11.5	35.3*	17.0*	223.0*	1.03*
ICGV 96237	465.7*	122.9*	377.4*	398.4*	11.6	35.7*	17.3*	212.5*	0.95*
ICGV 96238	503.5*	105.9*	520.2*	266.3*	13.8*	38.6*	14.8*	200.2	1.96*
ICGV 96239	518.3*	105.0*	519.3*	272.1*	12.7*	35.4	13.8	195.8*	1.94*
ICGV 96240	505.7*	106.4*	518.0*	266.3*	13.4*	38.8*	15.4*	201.6	1.97*
Control									
ICGV 88448	487.5	93.9	544.5	262.5	11.3	31.2	12.3	180.3	2.08
JL 24	469.3	126.2	389.7	383.1	9.6	34.2	13.0	217.9	1.03
SE	± 4.09	± 1.86	± 12.81	± 11.0	± 0.72	± 1.29	± 0.39	± 6.26	± 0.098

1. ICGVs 96230, 96234, 96235, 96236, and 96237 originated from ICGV 88448 and ICGVs 96238, 96239, and 96240 from JL 24.;
* Significant at 0.05 probability level.

0.3% (vol/vol) ethyl methan sulfonate (EMS) solution with intermittent shaking for 8 h. The seeds were then rinsed with running tap water for 30 minutes and sown in the field. The M_1 generation was bulk harvested. The M_2 and subsequent generations were handled following standard breeding procedure. Twenty-five M_3 progeny bulks with altered fatty acid composition were selected. These mutants were advanced to four generations and evaluated for oil and fatty acid composition. Fourteen phenotypically uniform mutants along with ICGV 88448 and JL 24 were evaluated in a replicated trial for seed quality traits during the rainy (1996) and postrainy (1995/96 and 1996/97) seasons at ICRISAT-Patancheru, India.

Sound mature seeds were analysed for oil and fatty acids contents. Total saturated fat (TSF = palmitic acid + stearic acid + arachidic acid + behenic acid + lignoceric acid) and O/L ratio were also determined. The oleic desaturation ratio (ODR = oleic acid / (oleic acid + linoleic acid)) was used to measure the activity of desaturation enzyme.

Eight seasons data (M_3-M_7 generations and replicated trial) on oil and individual fatty acid contents, with unequal replications, were analysed following the residual maximum likelihood (REML) method in GENSTAT (Thompson and Welham 1993).

EMS treatment caused significant differences among mutants in oil content, palmitic, oleic, linoleic, eicosenoic, behenic, and lignoceric acids contents, TSF, and O/L ratio. Stearic and arachidic acids were not affected by EMS.

Mean oil and individual fatty acids contents, TSF, and O/L ratio of the selected mutants and controls are presented in Table 1. In comparison with controls (ICGV 88448 and JL 24), oil content significantly increased in ICGVs 96230, 96234, 96238, 96239, and 96240 and decreased in ICGVs 96235, 96236, and 96237. Differences in oil content also brought significant changes in fatty acid composition. Increased oil content led to high oleic and O/L ratio and low palmitic and linoleic acids in ICGVs 96230, 96234, 96238, 96239, and 96240. Behenic and lignoceric acids in ICGVs 96238 and 96240, and TSF in ICGV 96239 also increased significantly. On the contrary, although ICGVs 96235, 96236, and 96237 had reduced oil content, they showed increases in palmitic, linoleic, behenic, and lignoceric acids, and TSF, and decreased oleic acid and O/L ratio.

The ratio of linoleic acid/(oleic acid + linoleic acid) indicates the proportion of substrate desaturation from oleic to linoleic acids (Velasco et al. 1997). Genotypes with a high oil content had a lower oleic desaturation ratio (ODR = 0.234 to 0.344) compared with those with a low oil content (ODR= 0.501 to 0.517) . Low oil content in ICGVs 96235, 96236, and 96237 is probably associated with a high ODR ratio which results in a lower O/L ratio and, therefore, shorter shelf life of the groundnut product/oil.

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