that the −3.18 R fractions may have contained 6-8% peanuts and/or peanut parts. Aflatoxin levels for 1982 plots were lower overall than in 1981. Plot A (Table III) was by far the most heavily contaminated, with 6500 ppb of aflatoxin in the damaged seed category. Plots B-D were less contaminated than A and did not contain enough seed in the damage category for an aflatoxin analysis. Aflatoxin was detected in peanuts from the 4 sample lots, and highest concentrations in edible peanuts from these lots were 3100, 250, 330 and 20 ppb, respectively (8). In each lot where aflatoxin had been detected, hulls in the smallest fraction contained the most aflatoxin (Table III). No aflatoxin was detected in hulls riding a 6.35 mm S or larger screen. Aflatoxin in peanuts and peanut parts thus appeared to be the source for aflatoxin found in peanut hulls. Lee et al. (12) separated cottonseed into hulls, fines (small, dry particles of kernels) and meats. Assays for aflatoxin indicated a marked concentration of aflatoxin in the fines and revealed an avearage 17-fold difference between fines and meats. A similar situation appears to exist in peanut hulls.

The data indicate that aflatoxin may be found in peanut hulls due to inclusion of aflatoxin containing peanuts and peanut parts in the hulls. In a worst case situation, as presented in Table I, unacceptably high aflatoxin levels may result when heavily contaminated peanuts are shelled. However, equal consideration must be given to the fact that no aflatoxin was found in hulls when aflatoxin-free peanuts were shelled. This represents by far the majority of peanuts. The risk associated with use of peanut hulls in animal feed should be relatively low. Segregation III peanuts generally account for less than 3% of national production (1970-1980 average) and are shelled distinctly separate from Segregation I peanuts. Feeding hulls from Segregation I peanuts should involve no greater risk than that presently associated with peanuts using existing U.S. grading methods. Use of peanut hulls in dairy operations, wherein contamination may be transmitted to milk, may warrant analysis of suspect hulls.

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☘ Variability for Oil and Fatty Acid Composition in Castorbean Varieties

LUIS CARLOS DA SILVA RAMOS[a], **JOAO SHOGIRO TANGO**[b], **ANGELO SAVI**[a] and **NILSON ROBERTO LEAL**[a], of [b]ITAL, Instituto de Tecnologia de Alimentos, Campinas, SP, Brasil, and [a]S. Genetica, S. Oleaginosas, and S. Computaçao, of IAC, Instituto Agronomico de Campinas, Campinas, SP, Brasil

ABSTRACT

Thirty-six castorbean varieties were surveyed for oil and fatty acid composition, in order to determine variability of these seed compounds. A large variability of seed oil percentage was observed, ranging from 39.6 to 59.5%. Concerning the fatty acids, little variability was observed for ricinoleic acid, which was the most abundant in the oil, ranging from 83.65 to 90.00%. The other fatty acids appeared in small concentrations and showed a small range: 0.87 to 2.35, 0.68 to 1.84, 2.96 to 5.64, 3.19 to 5.98, and 0.34 to 0.91%, for palmitic, stearic, oleic, linoleic, and linolenic acid, respectively. Non-significant correlations were observed between fatty acids and seed oil percentage. However, significant correlations were observed among fatty acid concentrations: positive and negative ones. These significant correlations could be associated with the biosynthetic pathways of the fatty acids, which are not fully elucidated. They suggest, however, that selection for a particular fatty acid will tend to increase those positively correlated, and decrease those negative ones. Selection and plant breeding techniques could then be applied to modify the oil content of the castorbean seeds, considering the variability observed. For the fatty acid composition, however, the variability was not large enough to make substantial changes in their concentrations by selection procedures. More varieties should be surveyed to find out if such variability is available.

INTRODUCTION

Variability in seed oil content and fatty acid composition is known for several oilcrops, and this knowledge has been used in breeding programs aiming to adjust the food properties of oilseeds (1).

The castorbean oil, however, is used only for industrial purposes (2). Although the chemical compositions of the castorbean and the oil are known (3,4,5,6), information concerning the germplasm variability for fatty acid composition is lacking, except when affected by different environmental conditions (7).

Therefore, 36 castorbean varieties were surveyed for chemical composition in order to find out the variability for fatty acid and oil content, for breeding purposes.

MATERIALS AND METHODS

Seeds of 36 castorbean varieties (*Ricinus communis, L*) from the collection of the Instituto Agronomico de Campinas, São Paulo, Brasil, were analyzed for oil content and for fatty acid composition.

These varieties were grown under field conditions in the Campinas Experimental Center in 1979. Samples of the seeds were taken from the first racemes when they reached the harvest point for chemical analysis. Other plant characteristics, including height, color, bloom, earliness, seed color and size, also were determined in these varieties. However, they were not used for comparisons in this work.

The oil content was measured with three replications by the Ae 3-52 AOCS method (8) on the dry weight basis. The fatty acid composition of the oil was determined by gas chromatography (GC) by the Ce 1-62 AOCS method (8), whereas the methyl esters were prepared by the Ce 2-66 AOCS method (8).

RESULTS AND DISCUSSION

The oil content and fatty acid composition of the 36 castorbean varieties are shown in Table I. A large variability for oil content was observed, ranging from 39.6 to 59.5%. The commercial varieties IAC 38, Campinas and Guarani showed intermediate values for oil content: 48.0, 49.8 and 53.6%, respectively. The 19.9% amplitude found for oil content within the 36 varieties shows the potential of selection or breeding for this characteristic.

Regarding the fatty acids, the average composition observed for these 36 varieties was found to be similar to reported values (3,4,6,9). Little variability was observed for ricinoleic acid, which is the main component of castorbean oil, ranging from 83.65 to 90.00%. The other fatty acids appeared in low concentrations, with a small amplitude: 0.87 to 2.35, 0.68 to 1.84, 2.96 to 5.64, 3.19 to 5.98, and 0.34 to 0.91, for palmitic, stearic, oleic, linoleic and linolenic acid, respectively. Since the high proportion of ricinoleic acid to the other fatty acids is relatively contant for the varieties, it could be assumed that this proportion would be difficult to change by conventional breeding systems if using only the germplasm of these 36 varieties.

Some interesting correlations were observed among the fatty acid contents (Table II). However, no significant correlations were observed between seed oil content and the fatty acid composition like those found for linseed (9). This indicates that oil content may be changed without significant modification in the fatty acid composition. The percentage of ricinoleic acid was negatively correlated with those of palmitic, stearic, oleic and linoleic: $r = -0.80$, -0.75, -0.37, and -0.59, respectively. Conversely, the percentage of linoleic acid was positively associated with palmitic and stearic: $r = 0.61$, and 0.43, respectively. Moreover, the percentage of palmitic acid is highly correlated with stearic: $r = 0.79$. The positive correlations indicate that selection directed to increase linoleic acid also would increase palmitic and stearic acids. Negative correlations, however, indicate that selection to increase palmitic or stearic acid would cause a decrease in the proportion of ricinoleic acid.

These correlations may be explained as a function of the biosynthetic pathways of the castorbean fatty acids, which are not fully elucidated yet. However, it is known that oleic acid is a precursor of ricinoleic acid (10), and that during the formation of ricinoleic, a large decrease in the levels of palmitic, oleic and linoleic acid is observed (6). This suggests that these acids are metabolized to form ricinoleic acid. Therefore, highly negative correlations between ricinoleic and palmitic, stearic, oleic and linoleic, found within the varieties studied, indicate also that they might participate in the ricinoleic biosynthetic pathways. Similar associations also have been made to explain the interrelationships among the fatty acids of linseed oil (9).

TABLE I

Fatty Acid Composition and Seed Oil Percentage of Castorbean Varieties

Varieties	Palmitic	Stearic	Oleic	Linoleic	Linolenic	Ricinoleic	Oil
Paraguaia 2	1.07	0.91	4.48	4.60	0.55	87.99	51.1
Paraguaia 3	1.22	0.81	3.02	4.73	0.42	89.80	49.8
Preta	1.13	0.78	4.08	4.50	0.44	89.07	53.9
Med. Argentina	0.98	0.91	4.91	4.16	0.34	88.70	51.2
Borracha	1.25	1.28	4.23	4.56	0.42	89.26	59.5
Argentina 7-1	1.30	0.91	4.00	3.85	0.38	89.56	47.9
Argentina 7-2	1.22	0.93	3.97	3.96	0.40	89.52	49.1
Argentina 7-3	1.45	1.22	4.38	5.73	0.47	86.75	39.6
Americana (Votup.)	1.46	0.88	4.69	5.69	0.41	86.92	51.6
Caturra	1.10	0.75	3.62	4.59	0.50	89.44	53.2
Cafelista 1	1.08	0.85	3.21	4.34	0.52	90.00	50.3
Cafelista 2	1.35	0.76	3.35	4.99	0.59	88.96	52.6
Indonesia	1.34	0.78	3.39	4.32	0.57	89.60	54.7
Pirapozinho 1	1.53	1.02	3.85	5.10	0.71	87.79	49.6
Pirapozinho 2	1.61	0.92	3.83	5.13	0.52	87.93	48.5
Minas Gerais 1(1)	2.35	1.84	5.64	5.98	0.54	83.65	55.6
Minas Gerais 1(2)	1.69	1.14	4.55	5.46	0.52	86.64	47.6
Minas Gerais 1(3)	1.59	1.04	3.79	4.64	0.67	88.64	53.6
Minas Gerais 2	1.10	0.75	3.93	4.68	0.62	88.73	54.3
Minas Gerais 3	1.25	0.89	4.28	4.72	0.65	88.21	54.4
Minas Gerais 4	1.29	1.20	4.10	4.81	0.45	88.15	54.5
Minas Gerais 5(1)	1.18	0.87	4.51	3.74	0.91	88.29	55.1
Minas Gerais 5(2)	1.09	0.75	4.10	4.33	0.59	89.13	44.3
Minas Gerais 6	1.13	0.80	4.41	4.69	0.88	88.09	53.9
Minas Gerais 7	1.31	0.97	4.75	4.17	0.85	87.95	57.4
Vermelha	1.27	1.00	4.78	3.82	0.83	88.30	51.4
Aregentina (Pirapoz.)	1.23	1.05	4.83	4.03	0.71	88.15	52.7
Preta Inerme R	0.87	0.82	3.70	4.40	0.41	90.00	57.7
Preta Inerme V	1.18	0.88	5.47	4.23	0.63	87.61	57.9
Guarani	0.93	0.68	5.40	3.19	0.65	89.15	53.6
Campinas	1.15	0.84	3.96	4.62	0.69	83.72	49.8
IAC 38	1.03	0.80	2.96	4.61	0.59	90.00	48.0
N86	1.22	1.02	4.08	3.83	0.68	89.07	47.3
(C6)x(N86)	1.21	1.07	4.01	4.18	0.70	88.83	49.6
Vermelha (Preta)	1.31	1.20	4.07	4.77	0.38	88.26	49.8
Rio Claro/Pira 7/79	1.68	1.29	5.64	4.14	0.41	86.84	46.9
Mean	1.28	0.96	4.22	4.54	0.57	88.30	51.6
Standard Deviation	0.04	0.04	0.11	0.10	0.02	0.24	0.7
LSD 0.05	0.09	0.08	0.23	0.20	0.05	0.50	1.4

TABLE II

Matrix of Simple Correlation Coefficients for Fatty Acids and Oil Content of Castorbean Seed Varieties

	Stearic	Oleic	Linoleic	Linolenic	Ricinoleic	Oil
Palmitic	0.79*	0.13	0.61*	-0.06	-0.80*	-0.11
Stearic	–	0.19	0.43*	-0.13	-0.75*	-0.07
Oleic	–	–	-0.06	-0.04	-0.37*	0.18
Linoleic	–	–	–	-0.26	-0.59*	-0.17
Linolenic	–	–	–	–	-0.07	0.21
Ricinoleic	–	–	–	–	–	0.04

*:$P < 0.05$.

The castorbean varieties showed a low variation for fatty acid composition, but more surveying may result in greater variability. However, the variability in seed oil content indicates that further selection or breeding could be carried out.

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Oxidative Stability of Soybean Oil at Different Stages of Refining[1]

T.W. KWON, Division of Biological Science and Engineering, Korea Advanced Institute of Science and Technology, P.O. Box 131, Dongdaemun, Seoul, Korea, and **H.E. SNYDER*** and **H.G. BROWN,** Department of Food Science, University of Arkansas, Route 11, Fayetteville, AR 72101.

ABSTRACT

Oxidative stabilities of soybean oil samples at 7 different stages of commercial refinement were measured by weight increases. Also, a method was developed for isolating essentially pure soybean triglyceride, and its oxidative stability was measured. Crude oil was most stable and the highly purified soybean triglyceride was least stable, with other samples being intermediate in stability. Adding phospholipids and tocopherols to the highly purified soybean triglyceride gave its oxidative stability, and in combination they were synergistic in delaying oxidation. The weight increase method demonstrated that surface exposure is an important variable in rates of autoxidation.

INTRODUCTION

Understanding of the causes of oxidative stability in soybean oil would help produce better quality soybean oil and possibly improve processing technology.

The effect of processing technology on oxidative stability has been investigated by Going (1), who established that alkali refined and bleached soybean oil oxidized faster than crude soybean oil, and that hydrogenation after bleaching and alkali refining increased oxidative stability. Going's results were based on changes in peroxide values.

Cowan (2) observed that bleached soybean oil is less susceptible to off-flavor development than non-bleached oil. This result was based on peroxide values and sensory evaluation of 2 types of fully refined soybean oil: one that had been bleached and one that had not been bleached.

Park et al. (3) found that oxidative stability of soybean oil was greatly decreased by purification, although it was not clear what kind of soybean oil was used as starting material for the purification.

We have studied changes in the oxidative stability of soybean oil due to refining. The results are presented herein.

EXPERIMENTAL METHODS

Materials

Soybean Oils. Seven samples of soybean oil were received from Riceland Foods (Stuttgart, Arkansas) and were used without further treatment. They were: crude oil (SBO-1), degummed oil (SBO-2), alkali-refined oil (SBO-3), bleached oil (SBO-4), deodorized oil (SBO-5), partially hydrogenated

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*To whom correspondence should be addressed.