The results of the two digestibility trials are shown in Table V. In the first, Brazil nut oil showed a coefficient of digestibility of 98.8% while olive oil, corn oil, cottonseed oil, and butterfat resulted in average digestibility of 98.7%. In the second trial, the fresh Brazil nut oil showed a coefficient of digestibility of 97.0% while the Brazil nut oil heated for either 1 or 2 hrs. presented coefficients of digestibility of 98.1 and 98.5%, respectively. Corn oil, fresh and heated, resulted in similar digestibilities. None of the differences in digestibility observed in this trial were of practical significance.

Discussion

The Brazil nut has two components, fat and protein, which could make the production and industrialization of the fruit desirable for countries capable of growing it. The decorticated nut in its natural state contains 16.3% protein and 68.3% fat, both of which could be used in animal and human nutrition. In general, the chemical composition of the nut found in this study is similar to that described by other workers. The data show that the oil contains significant amounts of linoleic and oleic acids although the values for the former are higher and for the latter are lower than previously reported (4,9–11).

The biological trials indicated that the Brazil nut oil, as measured by growth and percentage digestibility in rats, is comparable to other vegetable oils and animal fats now in common use for human consumption, either fresh or heat-treated. Furthermore the rat-growth trials give no evidence of toxicity and indicate that the Brazil nut oil could be used as an edible oil. The highest level tested, 20% of the diet, produced good growth and did not lower the consumption of food. Its high linoleic acid content as reported here and also found by other workers (6,11) is an additional property to be desired in a good table oil. In view of the favorable characteristics of the oil, it is highly desirable that the protein quality of the Brazil nut press-cake be investigated for both human and animal diets.

REFERENCES

1. American Oil Chemists' Society, Official and Tentative Methods of Analysis, Chicago, 1957.
2. Association of Official Agricultural Chemists, Official Methods of Analysis, 7th ed., Washington, D.C., 1950, 910 pp.
3. Chaves, J.M., and Pechnik, E., Trabalhos e Pesquisas, *2*, 281–318 (1949).
4. Costa, D., and Mota, S., Cult. Med., 3 e 4, IX, 35 (1942). (Cited by Costa, D., O Hospital, 3a. Edicao, Julho 1945).
4. Hegsted, D.M., Mills, R.C., Elvehjem, C.A., and Hart, E.B., J. Biol. Chem., *138*, 459–466 (1941).
6. Hilditch, T.C., "The Chemical Constitution of Natural Fats, 2nd ed., New York, Wiley, 1941.
7. Manna, L., and Hauge, S.M., J. Biol. Chem., *202*, 91–96 (1953).
8. Markley, K.S., Botany, *11*, 91–125 (1957); ref. Chem. Abs., *51*, 17201a (1957).
9. Noriega, P.J., Rev. facultad farm. bioquim., Univ. nacl. mayor San Marcos, *11*, 232–241 (1949).
10. Pechnik, E., Borges, P., e Siqueira, R. de, Arch. Brasileiros de Nutricao, *7*, 7–42 (1950).
11. Schuette, H.A., Thomas, R.W., and Duthey, M., J. Am. Chem. Soc., *52*, 4114–4117 (1930); ref. Chem. Abs., *24*, 6046 (1930).
12. Squibb, R.L., Aguirre, A., Braham, J.E., Scrimshaw, N.S., and Bridgforth, E., J. Nutrition, *64*, 625–634 (1958).

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Composition of the Oil of Asphodelus Fistulosus (Piazi) Seeds

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The seed oil of *Asphodelus fistulosus (piazi)* contains 0.5% myristic, 5.7% palmitic, 3.6% stearic, 33.1% oleic, and 54.9% linoleic acids.

The 1.8% nonsaponifiable matter appeared to contain fucosterol and a yellow, unidentified substance.

ASPHODELUS FISTULOSUS (PIAZI), N.O. LILIACEAE, a weed grows abundantly along with wheat in the Indo-Pakistan subcontinent. It is a pest of the wheat crop, and efforts have been made to eliminate it. Annual collection of the weed seeds in wheat in West Pakistan has been reported to be 8,750 tons (1). This estimate is based on an assumption that the total harvested wheat contains 0.25% of the seeds.

Since eradication of the weed has not been accomplished, it is desirable to find a commercial use. Muhammad (1) reported that the seeds contain 21% of a drying oil and (2) that the protein value of the seeds was higher than that of several cereals. However composition of the oil was not determined. Information about the oil might lead to industrial applications. In addition to the work on oil composition reported here both the oil and the protein values of the seeds are being intensively studied at the West Regional Laboratories.

Experimental

The seeds were crushed in an iron pestle and mortar. The meal was extracted with petroleum ether (50–70°C.) in a Soxhlet apparatus. The solvent was distilled from the extract after drying over anhydrous sodium sulphate. The last traces were removed at 80–90°C.

Physical characteristics and chemical values of the oil were determined by the usual methods (3,4). They are recorded in Table I.

TABLE I

Physico-Chemical Characteristics of the Oil

Refractive index	= 1.4740 at 21.5°C.
Specific gravity	= 0.9230
Color (Lovibond)	= 20Y—1.0R
Saponification value	=185.4
Iodine value	=142
Acid value	= 2.07
R.M. value	= 0.86
Polenske value	= 0.45
Kirschner value	= 0.08
Hehner value	= 94.73%
Saturated acids (Bertram oxidation)	= 10.50%
Nonsaponifiable matter	= 1.9%

Resolution Into Various Acid Fractions

The oil was saponified with 0.5*N* alcoholic KOH solution under reflux for 4.5 hrs. The alcohol was then distilled under reduced pressure from the soap solution. The residual soap was diluted with water and extracted with diethyl ether to remove the nonsaponifiable matter. Fatty acids were obtained from the soap by the addition of dilute sulphuric acid.

The fatty acids were separated into "solid" and "liquid" fractions by Twitchell's lead salt-alcohol method as adapted by Hilditch (5), as shown in Table II. The acids were characterized through bromo-derivatives of the liquid acids and methyl esters of the "solid" acids.

TABLE II

Lead Salt Acid Separation

Values	Total acids	"Solid" acids	"Liquid" acids
Percentage	.....	10.1	89.9
Saponification value	219	213.5	202.3
Iodine value	148	1.1	153.6

Liquid Acids

Bromo-derivatives of the liquid acids were prepared according to Jamieson and Baughman (6). From the derivatives the amounts of C_{18} unsaturated acids were calculated.

Solid Acids

The solid acids were converted to their methyl esters according to Hilditch (7) and fractionated by distillation under reduced pressure.

By combining results of these analyses and calculations, the composition of the oil is indicated in Table III.

The nonsaponifiable matter in diethyl ether was concentrated under reduced pressure. The residue was crystallized from 95% alcohol. The m.p. of the crystals was noted to be 129°C. (uncorrected). Acetyl, benzoyl, bromo-, and digitonide derivatives of the sterol had 119°, 119.5°, 105–109°, and 234–237°C. (decomp.) as their melting points, respectively. From these tests the crystals above were inferred to be of fucosterol. The alcoholic mother liquor contained a yellow substance which was not identified.

TABLE III

Composition of Oil from *Asphodelus fistulosus*

Acid	% as Glyceride
Myristic	= 0.5
Palmitic	= 5.7
Stearic	= 3.6
Oleic	= 33.1
Linoleic	= 54.9
Nonsaponifiable matter	= 1.8
Total	= 99.6

Discussion

The bromo-derivatives indicated that oleic and linoleic acids were present in the liquid acids. Further, that the liquid acids were of the same carbon content was concluded from their saponification equivalents and the amounts of the crystallizable bromo-derivatives. Where the acids have the same carbon content, esterification and fractionation of the esters are nonconclusive. From the saponification values given in Table II, only C_{18} acids constitutue the liquid acids. Since a hexabromide derivative from the liquid acids was not obtained, it was inferred that linolenic acid was absent. Tetrabromide derivative (m.p. 112–113° C.) established the presence of linoleic acid. The rest of the liquid acids was taken as oleic acid.

REFERENCES

1. Muhammad, S., P. Jr. Sci., I, 35 (1949).
2. *Idem, ibid.*, 2, 29 (1950).
3. Official Methods of Analysis of the A.O.A.C., 8th ed., pp. 462–467 (1955).
4. Williams, K.A., "Oils, Fats, and Fatty Foods," 3rd ed., J. and A. Churchill Ltd., London, pp. 76–111 (1950).
5. Hilditch, T.P., "Chemical Constituents of Natural Fats," 3rd ed., Chapman and Hall Ltd., London, p. 574 (1956).
6. Baughman, W.F., and Jamieson, G.S., J. Am. Chem. Soc., pp. 154 and 1199 (1920).
7. Hilditch, T.P., "Chemical Constituents of Natural Fats," 3rd ed., Chapman and Hall Ltd., London, p. 581 (1956).

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• *Letter to the Editor*

The Preparation of Pure Methyl Linoleate

THE UREA ADDUCT METHOD (1) has been used for the preparation of large quantities of methyl linoleate from safflower seed oil. The yield was 21–24%, and the final product was contaminated with 1% of an impurity assumed to be methyl oleate.

In this laboratory the same method has been closely followed. Whereas Keppler *et al.* (1) used an alkali-refined safflower seed oil, we have used a "non break" sample containing 1.25% FFA. To neutralize these free fatty acids an equivalent amount of metallic sodium has been added in addition to the amount used in the previous method. Separation of methyl linoleate from 2,886 g. of methyl esters, isolated from 3,000 g. of safflower seed oil, was followed by gas liquid chromatographic analysis, using an eight-foot column packed with 20% diethylene glycol adipate polyester on Celite at 207°C.

Keppler *et al.* (1) rejected the mother liquor remaining after the fourth crystallization (Fraction IV, Table I), but we have found that these contained a further 500 g. of linoleate, essentially free of other fatty acid esters. Schlenk (2) has reported that the yield of the urea linoleate adduct can be increased by reducing the volume of the solvent. Therefore the 20 liters of mother liquor were concentrated at reduced pressure under nitrogen to 10 liters. Gas liquid chromatography and iodine value (3) determinations showed that no change in the methyl linoleate had occurred during the concentration. A further 1,500 g. of urea was added to the concentrated mother liquor, the mass was heated and allowed to stand over-night at room temperature. The urea adduct was filtered and washed with 2 liters of methanol.

The fourth crystallization produced 99.4% of lin-