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The Nutritive Value of the Brazil Nut Oil

LUIZ G. ELIAS [1] and RICARDO BRESSANI, Institute of Nutrition of Central America and Panama (INCAP), Guatemala, Central America

The chemical composition of the decorticated Brazil nut in the natural and fat-free state was determined, and the results confirm that this seed contains significant amounts of oil and protein. In three growth experiments carried out in rats, the Brazil nut oil had a nutritive value comparable to that of butterfat and the common table oils, olive oil, cottonseed oil, and corn oil. The use of levels of the Brazil nut oil up to 20% of the diet did not reduce growth or food consumption of rats. Heat treatment of the oil up to 120 min. at 140°C. did not reduce its nutritive value. The coefficient of digestibility of the Brazil nut oil was similar to that of the other oils, fresh and heated. The digestibility of the Brazil nut oil averaged 98% and was not affected by the heat treatment. The data indicate that Brazil nut oil is comparable to other animal and vegetable fats and oils in common use for human consumption.

ONE OF THE GREAT number of seeds in the Latin American countries that offers unexploited possibilities for development and use (8) is the fruit of the tree *Bertholletia excelsa,* known as the Brazil nut. Available chemical analyses of this nut (9) indicate that it contains oil and protein in amounts that have practical significance for both animal and human nutrition.

Pechnik *et al.* (10) classified the oil as a semi-drying type from studies for its density, refractive index, saponification, and iodine number, and similar findings were reported by Noriega (9). The digestibility of the oil was found to be 97.7% (10). Hilditch (6) and Schuette *et al.* (11) investigated the fatty acid composition of Brazil nut oil and showed that the concentration of oleic acid varied between 48 and 58% while the linoleic acid content varied from 23 to 30%. Chaves and Pechnik (3) showed that the carotene in Brazil nut oil is relatively stable. Costa and Mota (4) indicated that, for the extraction of the oil, screw-pressing is very efficient and more practical than solvent extraction because with the latter the oil retains traces of the solvent and the fat-soluble vitamins are completely removed from the meal.

The present study was undertaken to determine whether the oil is of a sufficiently good nutritive value to recommend its industrial production on a large scale as a table oil. This, in turn, might make the press cake available for use in animal and human nutrition.

Materials and Methods

The nuts used for the extraction of the oil were obtained from Belem, Pará, Brazil.[2] The decorticated nut was analyzed for its proximate composition by A.O.A.C. methods (2), and the oil was obtained from it by solvent extraction with petroleum ether in a 3-liter Soxhlet extractor and by pressure. The solvent-extracted oil was purified by filtration with Celite [3] after removal of the solvent by vacuum. The pressure-extracted oil was obtained with a Carver laboratory press, using 10,000 p.s.i. pressure, and was also purified with Celite. Approximately 85% yields were obtained by using pressure and 90–95% by using the solvent method. The purified oil had a clear yellowish color. The pressure and solvent-extracted oils were analyzed for their iodine value, unsaponifiable matter, and color by the American Oil Chemists' Society Methods and Analysis (1) while the fatty acids were calculated from the areas under their gas-liquid chromatographic curves, using a Barber-Colman Model 20, tritium detector.

Nutritive value was assessed by rat-growth trials and digestibility studies, using albino rats of the Wistar strain. In all experiments the animals were distributed among the experimental diets by weight and sex and were placed in individual all-wire cages with raised screen bottoms. Food and water were provided *ad libitum,* and growth and food consumption were noted every 7 days for a total of 28 days.

The first of the three growth trials with rats was designed to test the nutritive value of the solvent-extracted oil. Brazil nut oil was tested at 5, 10, and 20% levels in a basal ration composed of vitamin-free casein [4] 25%, alphacel 1.80%, mineral mixture [5] 4.00%, L-cystine 0.20%, cod liver oil [6] 2.00%, and cornstarch to 100%. Five ml. of a vitamin solution (7) per 100 g. were also added. Each ration was fed to groups of six female rats. An additional group of rats was fed the basal diet with 20% olive oil.

The second growth trial was similar to the first except that the pressure-extracted oil was used at three levels: 5, 10, and 20% of the ration. Three groups of rats fed 5, 10, and 20% olive oil and three groups fed 5, 10, and 20% lard served as controls. Each group was composed of three males and two females.

The third growth trial consisted of feeding groups of four female rats the 10% level of Brazil nut oil, either fresh or heated for 60 and 120 min. at a temperature varying from 139 to 142°C. In this case the control groups received a diet with 10% corn oil, fresh or heated for 60 min. at the same temperature as the Brazil nut oil. The basal ration was the same as in the previous trials.

Six experimental groups were included in the first of two digestibility trials. One group each was fed the Brazil nut oil, olive oil, cottonseed oil, corn oil, and butterfat added at the 15% level in the following basal ration: vitamin-free casein 25%, cornstarch 52%, Torula yeast 1%, mineral salt 7%, and folic acid and B_{12} 0.1 mg. each per 100 g. of diet. A sixth group was fed the fat-free basal diet to obtain an estimate of endogenous fat excretion. The feces were collected in the last 5 days of a 12-day feeding period.

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[1] International Cooperation Administration fellow and Research Assistant. INCAP Publication I-150.

[2] Obtained through the courtesy of Frank Lowenstein.

[3] Johns-Manville.

[4] Nutritional Biochemicals Corporation, Cleveland, O.

[5] Hegsted Mineral Mixture (5), Nutritional Biochemicals Corporation, Cleveland, O.

[6] 1,800 U.S.P. units of vitamin A and 175 U.S.P. units of vitamin D per gram from Mead-Johnson, Evansville, Ind.

The fat content of the diets and of the dry feces was determined by A.O.A.C. methods (2). True fat digestibility was then calculated.

The second digestibility trial was carried out in a similar fashion except that the animals used were those from the third growth experiment, and the fat analysis of the feces was done by the method described by Squibb *et al.* (12).

Results

The high oil content of the decorticated Brazil nut in the natural state and the high protein content in the fat-free meal are shown in Table I. Some physical and chemical properties of the solvent-extracted and pressure-extracted oil are given in Table II. The differences in composition are not marked except in the color of the oil, which is higher for the solvent-extracted material. The results of the two rat-growth trials are shown in Table III. There was a progressive increase in weight gain with increasing amounts of the oil fed. The rats fed 20% olive oil gained weight at the same rate as those fed 20% Brazil nut oil. There was no large difference in the average food consumed in the five experimental groups.

TABLE I

Proximate Composition of the Brazil Nut

Nutrient	Decorticated Brazil nut, %	Brazil nut flour, %
Moisture	2.00	15.60
Protein (N x 6.25)	16.30	44.80
Ether extract	68.30	0.44
Crude fiber	2.60	7.80
Ash	3.61	7.36

TABLE II

Some Properties of Crude Brazil Nut Oil

	Solvent-extracted oil	Pressure-extracted oil
Iodine value (Wijs)	98.1	99.6
Unsaponifiable	0.61%	0.54%
Lovibond color	35 yellow/3.39 red	3 yellow/0.47 red
Fatty acids[a]		
Myristic	0.10%	0.05%
Palmitic	16.60	13.85
Palmitoleic	0.30	0.45
Stearic	10.35	10.25
Oleic	31.00	30.50
Linoleic	41.65	44.90
Total	100.00%	100.00%

[a] Estimated from the areas under gas-liquid chromatographic curves.

TABLE III

The Effect of Different Levels of the Brazil Nut Oil on the Growth of Young Rats

Type of oil	Percentage in diet	Average final weight, g.	Average weight gain, g.	Average food consumed, g.
First trial (6 rats per group)[a]				
Brazil nut oil[b]	5	153	97	338
Brazil nut oil	10	167	111	326
Brazil nut oil	15	172	116	319
Brazil nut oil	20	179	123	306
Olive oil	20	182	124	316
Second trial (5 rats per group)[a]				
Brazil nut oil[c]	5	190	134	347
Brazil nut oil	10	218	162	358
Brazil nut oil	20	215	159	333
Olive oil	5	193	137	356
Olive oil	10	191	135	345
Olive oil	20	213	157	346
Lard	5	199	143	349
Lard	10	179	123	292
Lard	20	218	162	328

[a] Average initial wt. 56 g. [b] Solvent-extracted oil. [c] Pressure-extracted oil.

TABLE IV

Effect of 10% Fresh or Heated Brazil Nut and Corn Oils on the Growth of Rats[a]

Type of oil	Treatment	Average initial weight, g.	Average weight gain, g.	Average food consumed, g.
Brazil nut oil	Fresh	54	141	344
Brazil nut oil	Heated (1 hr.)[b]	54	134	334
Brazil nut oil	Heated (2 hrs.)[b]	54	131	334
Corn oil	Fresh	55	116	298
Corn oil	Heated (1 hr.)[b]	55	133	329

[a] Four rats per group. [b] 139–142°C.

TABLE V

The Digestibility of Brazil Nut Oil and Some Other Natural Fats

	First Trial				
	Brazil nut oil	Olive oil	Corn oil	Cottonseed oil	Butterfat
% of fat	15	15	15	15	15
Digestibility % range	98.0–99.6	98.2–99.1	98.4–99.8	98.3–100.0	92.0–99.3
Average, 6 rats	98.8	98.9	99.0	99.4	97.5
	Second Trial				
	Fresh Brazil nut oil	Heated Brazil nut oil (1 hr.)	Heated Brazil nut oil (2 hr.)	Fresh corn oil	Heated corn oil (1 hr.)
% of fat	10	10	10	10	10
Digestibility % range	94.8–98.3	95.5–99.6	96.0–100.0	96.1–98.0	96.5–100.0
Average, 4 rats	97.0	98.1	98.5	97.1	98.1

In the second trial, growth with the 10 and 20% levels of Brazil nut oil was about equal to and slightly higher than at the 5% level. Olive oil and lard resulted in growth similar to that with Brazil nut oil at all three levels tested, and food consumption was similar in all experimental groups.

In the third growth trial, as shown in Table IV, differences were not observed in either the growth or food consumption of rats fed fresh as compared with heated Brazil nut oil. Compared with fresh and heated corn oil used as standards, the Brazil nut oil resulted in slightly higher weight gains. Food consumption was also similar in all experimental groups.

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.

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