Chapter **18**

Peanuts and Human Nutrition

By H. H. MOTTERN[1]

Peanuts are an excellent food because of their high-energy value and their content of good quality protein. Being both high in calories and containing 25% protein, they are an excellent food for growing youths requiring both. A two-ounce portion of peanuts contains 316 calories. The same amount of peanut butter contains 319 calories. This increase is due to added hydrogenated oil. Peanuts as human food occupy a unique position in the United States. In contrast with other countries where they are considered principally as a source of edible oil, in the United States only a fraction of the crop is pressed for oil and this only from the lower quality nuts. United States produces 70% of the soybeans grown in the world but eats only 3% of those grown in United States. By contrast, United States produces only 7% of the world's supply of peanuts but we eat nearly 60% of those we produce and use the remaining for oil and feed. Peanuts are native to South America but they have been consumed as food for centuries in other countries such as China and those in Africa. Peanuts were introduced into the United States by slaves but were not extensively grown until after the Civil War. First uses were on the farm for fattening farm animals such as hogs, turkeys, and chickens. Peanut production and commercial uses for food manufacture expanded rapidly after about 1900 as equipment was developed for many phases of peanut processing such as roasting, blanching, and preparation of peanut butter.

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The three most important food uses of shelled peanuts in United States are: (1) peanut butter, 460 million pounds annually; (2) salted peanuts, 200 million pounds annually; and (3) confectionery uses, 160 million pounds annually.

Composition. Shells constitute 27% of the weight of raw peanuts and 33% of unshelled roasted peanuts. The composition of roasted peanuts and peanut butter is compared with pecans in Table 1. The oil content, although high, is still not as high as that of pecans.

Table 1. Composition of peanuts, peanut butter, and pecans. (From USDA Agricultural Handbook 8, 1963)

	Peanuts, roasted & salted	Peanut butter	Pecans, raw
Moisture	1.6%	1.7%	3.4%
Calories per 100 g	585	589	687
Protein	26.0%	25.2%	9.2%
Fat	49.8%	50.6%	71.2%
Total carbohydrates	18.8%	18.8%	14.6%
Fiber	2.4%	1.8%	2.3%
Ash	3.8%	3.7%	1.6%
Minerals and vitamins as mg per 100 g			
Calcium	74	59	73
Phosphorus	401	380	289
Iron	2.1	1.9	2.4
Sodium	418	605	trace
Potassium	674	627	603
Vitamin A	—	—	130 I.U.
Thiamine	0.32	0.12	0.86
Riboflavin	0.13	0.12	0.13
Niacin	17.2	14.7	9
Ascorbic acid	—	—	2

A review of peanut composition in relation to processing and utilization was published by Hoffpauir (2).

Protein. Peanuts are most valuable in human nutrition for their protein content. The essential amino acid content of peanut protein compared with soy, cottonseed, and F.A.O. ideal is shown in Table 2, from the paper by Milner (3).

Table 2. Essential amino acids in some oilseed proteins expressed as g per 16 g N.

Amino Acid	Ideal	Peanut	Soybean	Cottonseed
Lysine	4.2	3.0[a]	6.8	4.1
Tryptophan	1.4	1.0[a]	1.4	1.2[a]
Phenylalanine	2.8	5.1	5.3	4.7
Methionine	2.2	1.0[a]	1.7[a]	1.6[a]
Threonine	2.8	2.6[a]	3.9	4.7
Leucine	4.8	6.7	8.0	6.6
Isoleucine	4.2	4.6	6.0	3.7
Valine	4.2	4.4	5.3	5.3

[a]Indicates a deficiency.

It is seen that peanut protein is deficient in four of the essential amino acids. This means that it is well to supplement it with other proteins or amino acids when it is the sole source of protein in the diet as in infant food. Or, if enough peanut protein is consumed to provide the necessary level of tryptophan, then peanut protein is deficient in only one essential amino acid, namely, methionine which can be provided cheaply with the synthetic product. In the United States we ordinarily obtain sufficient animal protein to more than balance out the deficiencies of certain amino acids in peanut protein. The storage proteins of peanuts are globulins. In unheated flour prepared by direct solvent extraction, they are mostly soluble in water at near neutral pH. Pominski *et al.* (5) describes a pilot-plant method of preparing peanut protein isolate which should be adaptable to commercial operation. The protein is extracted with dilute sodium hydroxide and precipitated by addition of sulfur dioxide.

Peanut oil. Peanuts are crushed commercially by screw pressing and prepress-solvent extraction. Very few oil plants operate exclusively on peanuts in the United States. Low quality peanuts, the germ from peanut butter operation, pick outs from nuts for roasting, salting, and confectionary uses are extracted for oil. This is also true for Segregation 2 and Segregation 3 classes, that are purchased on bid from Commodity Credit Corporation. The yield from screw pressing is not sufficient to make the operation attractive if a prepress solvent plant is conveniently located. Plants that operate exclusively on the solvent process shy away from extracting peanut oil because extraction of the high oil content leaves a meal that disintegrates easily. The powdery material tends to jam in equipment and interferes with drainage in the extractor, and produces a micella that is difficult to clarify. Filtration-extraction has been used in the laboratory (1). Only one or two plants have been set up for this process in the U. S.

Composition of peanut oil. There are variations in oil content of peanuts and in the composition of the oil from different varieties of peanuts. Although the oil is low in saturated fats (14 to 20%), the unsaturated fat is mainly oleic acid (43 to 65%) with 20 to 37% polyunsaturated linoleic acid. Peanut oil therefore has a polyunsaturated to saturated oil ratio of only slightly over one instead of the 2:1 considered desirable for reduction of blood serum cholesterol. Oil from Spanish type peanuts contains 53% oleates, 25% linoleates (2 double bonds) and 22% saturated glycerides. Oil from Virginia types contains 60% oleates, 22% linoleates, and 18% saturated glycerides (10).

Figure 1.

Ad for peanut butter appearing in 1911 Park and Tilford Catalog. (Courtesy Park and Tilford and Schenley Affiliated Brands Corporation.)

Peanut butter. About 55% of shelled peanuts in United States are used to make some 500 million pounds of peanut butter annually. Until about 1900, peanuts were consumed mostly roasted in the shell. The use as peanut butter had been prac-

ticed on a small scale, using crude equipment, for 20 years before the first patent was obtained by John H. Kellogg of Battle Creek, Michigan (8). Kellogg produced a "nut-meal" and a "nut-butter" by his process. He stated that the nut butter had a slightly nutty flavor and is used as a substitute for butter either for table use or in cooking. A rather complete list of expired peanut butter patents is included in the list of references (8).

Peanut butter was first used as a food for invalids because of its high nutritive value, easy digestibility, and palatability. It was first prepared and served in sanitariums. A physician in St. Louis was the first to manufacture peanut butter commercially. As a "diet food," it was priced too high for general use and consequently its preparation in the home using simple equipment was recommended. Because of the widely expanding use in the home it became a staple food and commercial production was encouraged. It was first used in sandwiches but uses in candies and cookies quickly developed.

It appears that peanut butter was slow to "catch on" in the beginning. Beech-Nut Packing Company was the first to popularize commercially prepared peanut butter and offer it on a national scale as exemplified in the accompanying reproduction of an ad appearing in the 1911 Park and Tilford Catalog. More rapid growth occurred after 1940 as research was conducted to improve the quality of peanut butter by selection and blending of varieties, control of roasting, improved methods of grinding to small particle size, stabilization to prevent oil separation, improving spreadability, extending shelf life and by developing uses for peanut butter in cookies and candies. Woodruff (10), p. 128, states that in 1940 only 25% of available edible peanuts were used to make peanut butter. By 1950 the proportion had risen to about one half and by 1964 it was 63%.

Originally, peanut butter was made by grinding dry roasted peanuts and adding salt if desired. Available equipment did a mediocre job of grinding and a few weeks after packing, oil separated which had to be stirred back into the ground paste. Such peanut butter is sometimes sold at "old fashioned peanut butter," and can be purchased in some supermakets. Many improvements have been made, such as the addition of a small amount of hydrogenated fat or of monoglycerides to prevent separation of the oil. Other materials have been added such as sugar, dextrose, corn sirup, glycerin, lecithin, and antioxidants. Peanut butters now on the market vary less in flavor and consistency since standards were proposed and adopted. Sara Roberson, *et al.,* (6) examined 18 brands of commercial peanut butter and found the following variations in composition of smooth type peanut butter: moisture, 0.69 to 2.69%; oil, 44.4 to 54.4%; and protein, 19.45 to 26.44%. The average composition of these were: moisture, 1.28%; oil 50.0%; and protein 23.04%.

Standards of identity. When standards for peanut butter were proposed by the Food and Drug Administration, there was a wave of protest by a few misinformed individuals who presumed to represent consumers' interests. It was stated by them that peanut butter should consist entirely of ground peanuts and maybe a little salt. While it is true that peanut butter was first made that way, it would never have reached the tremendous state of popularity it enjoys today if manufacturers had not catered to consumer wants and produced a product in which the oil emulsion was stabilized. The situation is best summarized in the hearing examiner's finding of fact as stated in Federal Register, July 8, 1965, p. 8626:

"Available information reveals that the majority of peanut butter consumers demand a peanut butter to which has been added salt and a sweetener plus ingredients

for the purpose of reducing separation of the oil and increasing its palatability. The major production of peanut butter manufacturers is directed toward meeting this demand. A number of manufacturers distribute a type of peanut butter very high in peanut ingredient and correspondingly low in nonpeanut ingredients. There is no basis for concluding that establishing the definition and standard of identity set out in this order will cause manufacturers to cease distribution of this so-called old-fashioned peanut butter. With complete ingredient labeling as required, those consumers who prefer peanut butter without sweetening or stabilizing ingredient can choose it."

The standards were set so that the weight of added ingredients do not in the aggregate exceed 10% of the weight of the finished food. Not more than 3% hydrogenated vegetable oil of any edible oils may be added as well as peanut oil to adjust the oil content, but in any case the total fat content shall not exceed 55%. The standards were finally adopted after much discussion.

Although most of the thiamine in peanuts is lost in the roasting process under the standards of identity, it is not permissible that thiamine be restored by addition of the synthetic product.

Commercial production of peanut butter on a large scale was confined for many years to the United States. Recently, Canada and Mexico have increased production but production is still lagging in European countries. Even developing countries that grow peanuts and need the protein do not eat any quantity of peanut butter. Historically, in developing countries that grow peanuts, they have been used as a much needed source of cooking oil and the cake fed to cattle or used as fertilizer. The quality of nuts produced has not always been the best or the best quality was separated for export. In addition, equipment for roasting and technological know-how for making a good quality stable peanut butter free of rancidity was lacking.

Peanut butter is preferably made from a blend of types so that composition can be uniformly controlled. Peanuts are roasted to the degree of roast desired by the particular manufacturer. Temperatures may vary from 320° F. to 350° F. and time from 6 minutes to much longer depending on the initial moisture of the peanuts, the temperature, the rate of air flow and the degree of roast to be attained. It is necessary to cool the nuts quickly by aeration to prevent continued roasting when the maximum temperature has been reached. The roasted nuts are blanched and broken into halves by rubbing on brush plates or rubber-ribbed rollers to free the testae which are blown off. The germs are mostly broken off and are screened out. They have a slight bitter taste and are thought to contribute to development of rancidity in peanut butter. The roasted splits are finely ground in mills such as Morehouse carborundum mills used for grinding mustard.

Stabilization of the oil dispersion in peanut butter is possibly the clue to the increased acceptability of the product. This permits sufficiently long shelf life to enable large manufacturers to nationally advertize and distribute the product. Initially, hydrogenated fat, either peanut or other vegetable oil, was used. But methods of agitation during cooling to obtain desirable crystal structure of the hydrogenated oil are also important. Fineness of grind, rate of cooling and agitation during cooling to obtain small fat crystals are important factors. More recently mono- and di-glycerides have been used. These are surfactants and although they are high-melting saturated fats, a smaller quantity can be used. This makes a peanut butter with less waxy feel in the mouth and therefore better flavor because of the quick flavor release and clearing up of the oily character on the palate. The difference is very noticeable on tasting pea-

nut butter alone but less noticeable when the peanut butter is used in a sandwich or mixed with other ingredients. Simpler equipment for mixing with less working during cooling can be used when mono- and di-glycerides are added. The product with added glycerides is softer and spreads more easily. The use of monoglycerides as a stabilizer of the oil emulsion in peanut butter in place of hardened oils was proposed many years before receiving recent extended adoption. The acceptance of monoglycerides was brought about mainly by the realization that a greater production rate could be obtained with less investment in expensive cooling equipment and also with greater flexibility of operation in regard to filling temperatures. Monoglycerides are used at a level of 1.5 to 2.0% in peanut butter of 50-51% fat and at a filling temperature of 108-112° F.

Peanuts in candies and cookies. About 60% of the nuts used in candies are peanuts. Besides the old favorite, peanut brittle, there are peanut clusters coated with chocolate, and peanut rolls with a soft nugget-like center surrounded by a layer of roasted peanuts and covered with chocolate coating. This latter is the largest use of shelled peanuts in candy. The makeup of peanut candy varies widely, some containing as many as 10 ingredients. Peanuts are used in more than 50 kinds of candies.

An example of how modern engineering and technology has affected peanut processing is given by the present method of making peanut brittle. Formerly, the process was a batch operation in which roasted peanuts were stirred into a kettle of hot melted caramelized sugar. Then the mixture was spread on a cooling table and after cooling, broken by hand and hand packed. The modern method is to continuously caramelize the sugar in a swept surface evaporator such as that manufactured by Baker-Perkins, then continuously add raw peanuts to the discharge flow of hot caramelized sugar allowing the heat of the caramel to roast the peanuts. The hot melt is evenly spread by rolls onto a long Teflon-coated conveyor belt that passes through a cooling tunnel. At the end of the tunnel the sheet breaks off and the pieces are immediately packed.

In order to obtain an extended shelf life for peanut candies and build up an inventory during the slack summer season in anticipation of the Christmas trade, it is imperative that the peanuts used show minimum evidence of developing rancidity. Although not infallible, low free fatty acid and peroxide values in the peanuts used are the best criteria for satisfactory long storage of peanut candies.

Roasted peanuts. Of the 820 million pounds of peanuts consumed annually about 200 million pounds are roasted and salted. While consumption of peanut butter has increased within the last 10-20 years, the consumption of salted nuts has remained constant. This is likely due to competition with other snack items.

The composition and therefore the nutritive value of salted peanuts is similar to that given earlier for peanut butter. Peanuts are not as readily digestible because teeth do not grind as fine as peanut butter machines. Eating of salted peanuts is contraindicated in cases of diverticulitis because the undigested pieces cause irritation. Flatulence may be produced for this reason or because of allergic reactions or presence of poorly digested carbohydrates.

Partially defatted peanuts were developed by the Southern Regional Research Laboratory in 1965 (9). Peanuts are hydraulically pressed to remove up to 80% of the oil. The distorted, pressed peanuts are immersed in hot water whereupon they resume their original shape. The expanded peanuts contain up to 35% moisture. They are roasted and salted or flavored. Variations can be made in oil content, method of roasting, and

flavoring. This product is now produced commercially by four companies, and others are conducting research to produce their own particular variation of the product. Partially defatted peanuts contain about half the calories per pound depending upon the extent the oil is removed. Removing the oil decreases the calories to about half and therefore increases the percentage of protein.

A few years ago dry roasted salted and flavored peanuts were introduced. Because of the lack of oil on the surface many customers mistakenly conclude they contain appreciably less oil than oil-roasted peanuts. The lower oil content is insignificant being around two percent. There is this much variation in oil content of different lots of peanuts of the same variety.

Peanut flour. Peanut flour is an excellent source of good protein. The potential for use of peanut flour in beverages and bakery products is good because of its ready acceptability to the palate. Edible peanut flour of high quality could be made from some lower priced peanuts now being sold to crushers. This grade of peanuts falls into the classes known as Segregation 2 and some of Segregation 1, which are pressed for oil and the cake now used for feed. To produce a fine quality flour the nuts would need to be upgraded by removing certain defects such as trash and discolored and shriveled nuts. To produce a white flour the testae would need to be removed although for some uses the light cream color of the flour made from unblanced peanuts might not be objectionable.

It is estimated that there are about 300,000 tons of peanuts of suitable quality for flour available each year at a low price. These are sold on bid by Commodity Credit Corporation for oil extraction at a price of 6 to 8 cents per pound. After extracting the oil which sells for about 13 cents per pound, the press-cake is sold for feed at 4 cents per pound. Such peanuts could be an economical source for production of edible peanut flour. Variations in quality and in location from year to year make unattractive an operation based solely on surplus peanuts, but existing extraction plants operating seasonally on other edible oil products could produce edible peanut flour once they were set up to make a food grade product. Production of peanut flour in some developing countries is feasible in that peanuts are produced cheaply in these countries in huge quantities as a source of oil. There may be an acceptability problem in that peanuts may not be considered an edible product in these countries.

A suggested specification for edible peanut flour from U.S. production is as follows: Peanut flour shall be prepared from sound shelled nuts free of musty odor and extraneous matter. Testae may or may not be removed as required. The flour shall be light tan in color if made with testae included and white or near white when testae are removed. It shall be free of sour, musty, burnt, or unpleasant odors or flavors and coarse or gritty particles. Edible peanut flour shall conform to the following analysis:

Moisture, max.	9%
Protein (N x 6.25) min. on dry basis	55%
Available lysine g per 16 g N	2.5
Ash, max.	4.5
Acid insoluble ash, max.	0.2
Fat, dry basis, max.	2.0
Free fatty acid of extracted fat, max.	2.0

Crude fiber, dry basis, max.	5.0
Aflatoxin micrograms per Kg, max.	Within allowable tolerance
Total bacterial count, per gram, max.	50,000
E. coli, max. per gram	10
Salmonella	None

Note that the above are merely suggested specifications based on information available at the present time. Further experience gained from practical manufacturing conditions may necessitate alterations before an exact specification can be written.

Other peanut foods. Peanut beverages for infant feeding have been developed in India (3, 4, 7). In the work described by Shurpalekar, *et al.* (7), the process for a spray-dried food formulation is given. The product contains 26% protein derived from peanut protein isolate and full fat soy flour. The spray-dried product reconstitutes readily in water into an acceptable beverage. The finely divided peanut flour obtained by air classification would appear to be cheaper to prepare than the isolate and perhaps just as satisfactory. UNICEF has sponsored a project in India to add peanut protein isolate to water buffalo milk which contains 9% fat.

As evidence of the high energy and nutritive value of peanuts the use by astronauts can be cited. The Pillsbury Company under contract developed rod-shaped sticks one-half inch in diameter and 4 inches long with a peanut butter base. They contain peanut butter, sugar, corn sirup, starch, sodium caseinate, glycerine, oat flour, and gelatin. They are individually wrapped and are now offered in supermarkets. It is a very tasty product.

Peanuts in various forms are good foods for young and old on widely different occasions at home, around the world and in space.

MV:8-26-69

LMV:9-29-69

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