Groundnut Quality Characteristics

R. Jambunathan[1]

Abstract. *India is one of the world's second largest producer of groundnut, and the most important use of the Indian crop is for its oil content. Nearly 66% of the groundnut produced in the world is crushed for oil. At ICRISAT, screening groundnut germplasm accessions has demonstrated the large variation in their protein and oil contents. Storage stability of oil is an important factor, especially in developing countries, where storage conditions are not ideal. The concentration of oleic and linoleic acids in groundnut oil affects its stability.*

A variety of food uses of groundnut are known, and peanut butter is one of the most popular products in several countries. Low-fat groundnut is also receiving increased attention for use by calorie-conscious consumers. Flavor components of groundnut are very important in determining the acceptability of groundnut products, and this is a complex area, relating objective measurement to subjective evaluation. Protein quality and the functional properties of isolated groundnut protein have been extensively investigated, and a number of efforts have been made to utilize groundnut protein ingredients for human food. Groundnut protein is about 74% as high as the casein quality that is used as a reference for rat bioassay procedures.

Groundnut hulls form a sizeable proportion (about 25%) of total groundnut production. Various ways of using these hulls have been developed, particularly as a supplement to cattle feed, and attempts have been made to improve hull digestibility.

Introduction

Grain quality is a broad term which encompasses physical, chemical, and functional properties. The quality and properties of groundnut have been described in earlier publications (Cobb and Johnson 1973, Ahmed and Pattee 1987). The quality attributes that are important for end uses of groundnut vary among the developed and developing countries. In developed countries, groundnut is mainly used for making peanut butter and consumed as roasted groundnut or in confections, while in several developing countries, it is mainly

1. Principal Biochemist and Program Leader, Crop Quality Unit, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, A.P. 502 324, India.

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processed for its oil. The cake obtained after oil extraction is not utilized to the best advantage though it is a good protein source. Groundnut oil is relatively more stable than safflower and sunflower oil, which have higher content of polyunsaturated fatty acids and consequently groundnut oil has a longer shelf life. In this paper, a brief description on the quality of groundnut is given and, where available, data obtained on groundnut cultivars developed at ICRISAT are reported. The paper also indicates future research areas in groundnut.

Chemical Composition

Groundnut is primarily used for its oil and protein, which are major products of the crop. Rapid and reliable methods are available for the determination of protein content, and for the nondestructive determination of oil content using nuclear magnetic resonance spectrometry (Jambunathan et al. 1985). At ICRISAT, groundnut accessions grown in various parts of the world have been collected, cataloged, and stored for further use. We analyzed groundnut germplasm accessions and observed that their oil and protein contents varied considerably indicating the possibility of selecting germplasm accessions for higher oil or protein content (Fig. 1 and 2). It is important to ascertain if these characteristics are stable in the selected accessions before they are used in a breeding program.

Five groundnut cultivars developed at ICRISAT–ICGS 1 (ICGV 87119), ICGS 5 (ICGV 87121), ICGS 11 (ICGV 87123), ICGS 21 (ICGV 87124), and ICGS 44 (ICGV 87128)–and Kadiri 3 and J 11 as controls, were grown in the postrainy season 1985/86. They were analyzed for their proximate composition (Table 1). Among these cultivars, Kadiri 3 had the highest protein and lowest oil contents. Both Kadiri 3 and J 11 had lower seed masses than other cultivars. The amino acid composition of whole seed showed that the major

Table 1. Composition of selected groundnut cultivars, ICRISAT Center, postrainy season 1985/86[1].

Cultivar	Protein (%)	Oil (%)	Starch (%)	Soluble sugars (%)	Crude fiber (%)	Ash (%)	Moisture (%)	100-seed mass (g)
ICGS 1	24.9	48.3	11.8	4.6	2.2	2.3	7.3	56.2
ICGS 5	25.7	48.2	12.3	4.6	2.3	2.3	6.8	60.7
ICGS 11	25.0	48.3	11.8	4.6	2.2	2.3	6.7	57.3
ICGS 21	24.2	50.0	11.3	5.0	2.0	2.3	6.8	69.3
ICGS 44	25.4	49.1	12.2	4.4	2.1	2.2	7.1	65.1
Controls								
Kadiri 3 (Robut 33-1)	29.2	46.4	11.2	3.6	2.1	2.2	5.0	48.1
J 11	25.8	47.2	13.7	5.2	2.1	2.4	5.1	31.0
SE	±0.61	±0.44	±0.32	±0.19	±0.03	±0.03	±0.36	±4.71

1. Means of three determinations.

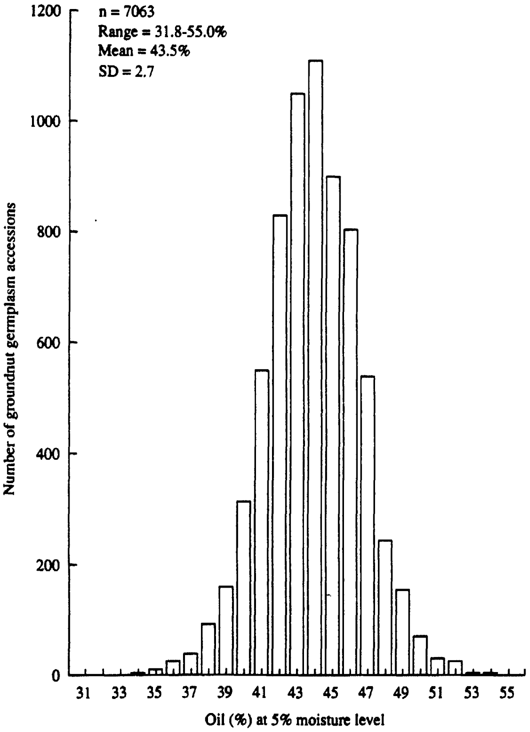

Figure 1. Distribution of oil content in ICRISAT groundnut accessions.
(Note: For easy comparison, all oil values have been expressed at a uniform moisture level of 5%).

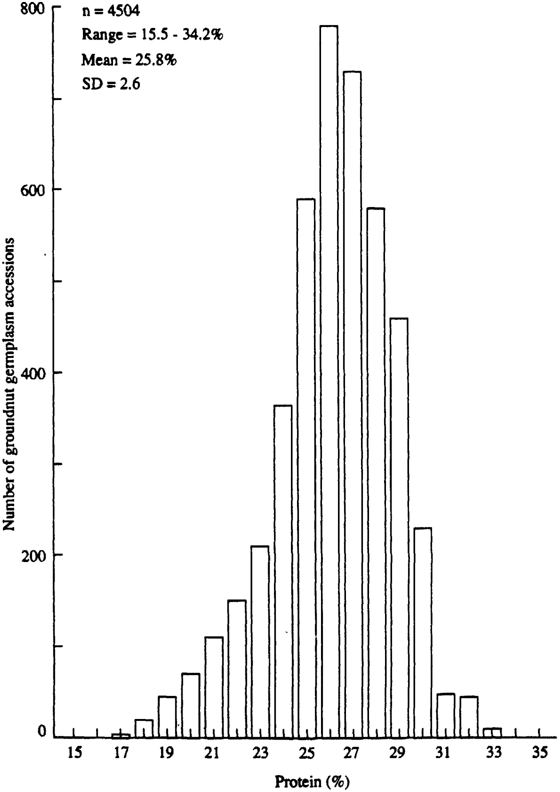

Figure 2. Distribution of percentage of protein content in ICRISAT groundnut germplasm accessions.

Table 2. Essential amino acid composition (g 100^{-1} g^{-1} protein) and protein contents of groundnut cultivars[1], ICRISAT Center, postrainy season 1985/86.

Amino acids	ICGS 1	ICGS 5	ICGS 11	ICGS 21	ICGS 44	Kadiri 3[2] (Robut 33-1)	SE	FAO/ WHO (1973) pattern
Lysine	3.98	4.03	4.07	4.06	4.09	3.81	±0.042	5.5
Threonine	3.23	3.09	3.32	3.10	3.14	2.90	±0.058	4.0
Valine	4.65	4.80	4.51	4.66	4.69	4.27	±0.076	5.0
Methionine + cystine	2.95	2.65	2.38	2.55	2.65	2.18	±0.107	3.5
Isoleucine	3.73	3.86	3.76	3.66	3.64	3.49	±0.051	4.0
Leucine	6.92	7.27	6.84	7.17	7.24	6.26	±0.155	7.0
Phenylalanine + tyrosine	10.17	10.49	9.77	10.10	10.32	9.90	±0.108	6.0
Protein content (%)	49.60	49.10	49.70	49.80	49.00	52.20	±0.479	-

1. Means of duplicate determinations.
2. Control.

deficient amino acids were methionine and cystine, lysine, threonine, and valine when compared with the FAO/WHO (1973) provisional amino acid scoring pattern (Table 2).

Rat bioassay of ICRISAT cultivars was carried out and the digestibility of groundnut protein was comparable to that of the reference protein, casein (Table 3). It was interesting to note that the protein of one cultivar, ICGS 21, was even more digestibile than casein. However, in all the cultivars, the biological values and net protein utilization were much lower than casein. The protein efficiency ratio was determined by feeding these cultivars to rats for a period of 4 weeks. Results indicated that the average protein value of these cultivars was about 74% of the casein value.

Table 3. Biological evaluation of selected groundnut cultivars, ICRISAT Center, postrainy season 1985/86[1].

Cultivar	Biological value (%)	True protein digestibiilty (%)	Net protein utilization (%)	Protein efficiency ratio
ICGS 1[2]	53.5	96.3	51.5	2.41
ICGS 5	52.7	95.4	50.3	2.42
ICGS 11	51.5	98.2	50.7	2.35
ICGS 21	56.6	99.2	56.1	2.33
ICGS 44	47.7	96.4	46.0	2.28
SE	±1.69	±0.55	±1.83	±0.026
Casein (standard)	76.0	96.4	73.3	3.24
SE	±0.57	±1.05	±1.12	±0.07

1. Means of five determinations.
2. Means of four determinations.

Table 4. Fatty acid composition of hexane extracts of groundnut cultivars, postrainy season 1985/86[1].

Fatty acid (%)	ICGS 1	ICGS 5	ICGS 11	ICGS 21	ICGS 44	Control Kadiri 3	SE
Palmitic	12.1	11.9	12.1	11.3	11.9	12.1	±0.13
Stearic	2.3	2.1	2.3	2.8	2.71	2.9	±0.13
Oleic	36.7	37.2	36.8	42.9	38.9	38.9	±0.95
Linoleic	40.5	40.5	40.6	35.1	38.4	38.0	±0.88
Arachidic	1.4	1.3	1.4	1.4	1.5	1.5	±0.03
Eicosenoic	1.4	1.4	1.4	1.3	1.4	1.4	±0.02
Behenic	3.2	3.1	3.0	2.9	3.0	2.8	±0.04
Lignoceric	1.8	1.7	1.8	1.5	1.7	1.8	±0.04
O/L ratio	0.91	0.92	0.91	1.23	1.01	1.03	±0.05

1. Means of three replicates.

Oil Quality

The stability or shelf life of oil is important in both developing and developed countries, but deserves more attention in developing countries where storage conditions are not optimum. A major influence on oil storage stability is its fatty acid composition, especially the proportion of unsaturated to saturated fatty acids. The fatty acid composition of ICRISAT cultivars showed that the oleic (O) to linoleic acid (L) ratio (O:L) varied between 0.91 and 1.23, and the highest ratio was obtained for ICGS 21 whose ratio was significantly higher than the rest (Table 4). For groundnut, an O:L ratio of 1.6 and above is desirable for longer shelf life. A minimum O:L ratio of 1.6 has been recommended for groundnut by food processing industry purchasers in the UK (Hildebrand 1987, personal communication).

Flavor Quality

The flavor of roasted groundnut plays a very important role in its acceptance by consumers and other users. This is a complex area as more than 300 compounds have been detected in roasted groundnut (Ahmed and Young 1982). It is important to standardize the tests used to evaluate the acceptability of roasted groundnut by conducting sensory evaluation and relating the findings to the presence or absence of various volatile compounds, and the concentrations in which they are present. Recent studies indicate that hexanal concentration is one of the eight compounds that gave an objectionable flavor to groundnut and it was correlated with a professional flavor profile panelists' evaluation (Young and Hovis 1990). Characterization of flavor compounds by gas chromatography would enable breeders to identify those cultivars that have a good flavor profile for further development. Sugars in groundnut also play an important role as precursors in the production of the typical roasted groundnut flavor.

Groundnut Utilization

A variety of food uses of groundnut are known, and peanut butter is one of the most popular products in several countries. However, except for peanut butter and roasted groundnuts, the desired confectionery quality parameters have yet to be clearly defined for selecting groundnuts suited to individual end uses in developing countries. For example, when groundnut pods are boiled in salt water and the boiled seeds consumed, various factors are involved in the process. The water permeability of the shell and the ease of uptake of salt water by the seed may play a role in influencing cooking time. This is one of several areas where additional information is needed to define quality characteristics that are required to make the best end products.

Some interest has been evinced in the introduction of a low-fat groundnut which is now being sold under the 'Weight Watchers®' label (Anon 1988). Low-fat groundnut is made by a commercial process that squeezes out about 50% of the oil from raw groundnuts which then regain their shape after being squeezed. The groundnuts are then soaked in hot water, and roasted in oil for 5 min. The water steaming out of the kernels prevents roasting oil from entering them resulting in a crunchy groundnut with 50% less fat than normal. This low-fat groundnut is gaining in popularity among health-conscious consumers.

Groundnut has been used to improve the protein content and quality of several cereal-based food products in India, Kenya, Malawi, Nigeria, Senegal, and Zimbabwe (Natarajan 1980). In India alone, there have been several agriculture-based products with groundnut as the protein-enriching medium. While using groundnut protein in food products, it is important to understand the characteristics and functional properties of this protein so that the product is acceptable to consumers when used as an ingredient in a food system. The important functional properties of protein ingredients are solubility, viscosity, emulsification, elasticity, adhesion, water and fat absorption, foam formation and stability, gel formation, and fiber formation (Natarajan 1980). It is a challenging task to relate functional properties with end products, as there do not seem to be any generally accepted tests for evaluating the several functional properties of protein.

Groundnut Hull

Of the several million tonnes of groundnut that are produced in the world each year, hulls form about 25% of the total mass produced, and their utilization thus becomes very important. At present the majority of groundnut hulls are either burned, dumped in forest areas or left to deteriorate naturally (Kerr et al. 1986). However, there have been some efforts to use groundnut hulls in cattle feed, as a carrier of insecticide, in the manufacture of logs and production of pulp, and as a fiber component in human diet (Kerr et al. 1986). One of the major potential uses of groundnut hull is as a component in cattle feed. Hull digestibility is quite low; research efforts are being directed to improve it. Hulls contain more than 60% fiber. Inoculation and biodegradation of hulls have been tried but these efforts have not been successful. A combination of chemical and biological pretreatments may offer hope to increase hull digestibility by ruminants (Kerr et al. 1986).

Future Research Needs

In developing countries, the method of oil extraction has to be made more efficient and hygienic, so that the groundnut cake available after oil extraction can be profitably used as a supplement to weaning food and in other processed cereal foods where additional protein would be advantageous. The concentration of aflatoxin should be determined before groundnut cake is used in any formulation or diet; if there is any contamination of the cake at all, it should not be used, because the end product will be toxic.

There is a need to identify the important flavor components that are either desirable or objectionable to consumers. The factors that contribute to a good confectionery type groundnut, and appropriate screening methodologies for these factors need further development. Market and consumer demands should dictate the development and setting of standards.

Blanching quality is important because of the energy involved in removing the seed coat. An economic laboratory method to screen germplasm and breeding material for blanching quality is needed if commercial varieties or genotypes with better blanching quality are to be developed. For this purpose, the relationship between the laboratory and commercial blanching methods must be established.

The physical, chemical, and functional properties of groundnut that relate to specific end products have to be determined and refined to facilitate screening breeding material for such properties. Also, methods have to be developed so that hulls and other by-products can be better utilized.

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