Edisi Khusus Balitkabi No. 7 - 1996 ISSN 0854 - 8625

Risalah Seminar Nasional Prospek Pengembangan Agribisnis Kacang Tanah di Indonesia

Penyunting

Nasir Saleh
Koes Hartojo H
Heriyanto
Astanto Kasno
A. Ghozi Manshuri
dan
Achmad Winarto

Badan Penelitian dan Pengembangan Pertanian
Pusat Penelitian dan Pengembangan Tanaman Pangan
BALAI PENELITIAN TANAMAN KACANG-KACANGAN
DAN UMBI-UMBIAN
1996

Risalah Seminar Nasional Prospek Pengembangan Agribisnis Kacang Tanah di Indonesia, p.49-54

GROUNDNUT : A FOOD CROP

S.L. Dwivedi, S.N. Nigam, and G. Renard
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
ICRISAT Asia Center, Patancheru 502324, Andra Pradesh, India

SUMMARY

Groundnut (*Arachis hypogaea* L.) is growth in over 100 countries in the tropical and subtropical regions of the world. It is a rich source of oil, protein, minerals, and vitamine. Over the years there has been a significant change in groundnut utilization. While the domestic utilization of crushed (oil) groundnut decreased by 1-64%, the food uses increased by 11-71% in different regions. Peanut butter, roasted in-shell and shelled nuts, and freshly harvested in-shell boiled nuts are most commonly used food form of groundnut. A substantial amount of roasted groundnut seeds are used in the preparation of candies and confections in USA. There two product are also considered to be the major growth area in groundnut consumption in developing countries. The groundnut cake provides partially defeated flour, protein concentrates and protein isolates which are now used in the preparation of groundnut based-fortified foods. The various physical, sensory, chemical, and nutritional factors determine the quality of groundnut seeds. Aflatoxin content, presence of chemical residues in the seed, and high fat content have potential to limit the use of groundnut as a food in human diet. Options to minimize the adverse effects

been developed. ICGV 86564 in Srilangka, and ICGVs 89214, 88438, and 91098 in Cyprus have been released for commercial cultivation. Sweet testing valencia types with 3-4 seeded pods are available for use in breeding. Efforts ar on to reduce the duration of large seeded varieties but with improved seed quality to fit them in cropping pattern prevalent in Asian countries.

INTRODUCTION

GROUNDNUT (*Arachis hypogaea* L.), an annual legume and a native of south America, is currently grown in over 100 countries in the tropical and subtropical regions of the world. The world groundnut production has been increasing over the years. However this increase in production is largely confined to Asia. Current world groundnut production stands at 28.5 million metric tons from an area of 21.8 million ha (FAO, 1994). The leading groundnut producing countries in the world are India, China, USA, Indonesia, Nigeria, Sudan, Senegal, Zaire, Myanmar, Argentina, and Vietnam.

Groundnut is a rich source of oil (in g/100 g dry seed) (44-56%), protein (22-30%), minerals (in mg/100 g dry matter) such as phosphorus 9137-470), calcium 944-88), magnesium (157-200), and potassium (618-890) and vitamins (E, K, and B group). it also contains carbohydrates (5-14%) and ash (2-3%). The carbohydrates are sucrose, starch, raffinose, and stachyose. Groundnut seed skin, which represents 2-4% of the dry weight of the shelled nuts and contains 12-15% crude fiber, is comparable to cereal bran and fruit fibers. Like many other legumes, groundnut also contains antinutritional factors (such as trypsin, haemagglutinins, and goitrogens) that can adversely affect the nutritive value of the seed. These toxic factors are a group of unrelated chemical compounds with varying effects on the metabolic process. Their effect is considerably reduced when raw groundnut is roasted or boiled. They are, therefore, not considered to affect seriously the utilization of process groundnut food. The red skin of the seed contains tannins and related pigments that cause an undesirable color in the protein unless removed during processing. They may also be responsible for some of the bitterness associated with raw groundnuts. Foods containing groundnut are also causing allergy to some human beings. The symptoms of an allergic reaction may range from mild to deadly and include nausea, vomiting, diarrhea, oral and laryngeal edema, urticria, rhinitis, and anaphylactic shock (Taylor *et al.*, 1988). It is, therefore, important for individuals allergic to groundnut to avoid it in their diet.

Over the years there has been a significant change in groundnut utilization and trade. The domestic utilization of groundnut has increased considerably, thus affecting the availability of surplus for international trade. The volume of the international trade in groundnut (shelled seeds and oil) has decreased by 13-15% in recent years (FAO, 1993). The regionwise distribution of domestic utilization between crushed and food uses of groundnut in Americas (by 36%), Africa (by 17%), Asia (by 2%), the Near East (by 47%), Europe (by 64%) and 15% in Oceania. Groundnut trade characteristics have also changed since 1960s. While groundnut oil dominated the world trade in 1960's and early 1970's, it is now groundnut for food use which dominates the world groundnut trade (Fletcher *et.al.,* 1992).

In the following sections, the current trend in food uses of groundnut, the seed quality traits and their significance to nutrition and product stability and the possibility of tailoring new groundnut varieties with required quality traits are discussed.

UTILIZATION OF GROUNDNUT

Groundnut are utilized in several ways. The main uses are (i) cooking oil, (ii) peanut butter, (iii) roasted shelled nuts, (iv) in-shell roasted nuts, (v) in-shell boiled nuts, (vi) confections and candies, and (vii) groundnut-based fortified foods.

Groundnut oil is characterized by high level of triglycerides and low level of complex lipids. The triglycerides are composed of 80% unsaturated and 20% saturated fatty acid. The oil is used preliminary in cooking and for salad dressing, pastries, shortening, oleomarganrine, and mayonnaise. It is an excellent fat for pan frying or deep-fat frying, and may be reused many times for frying foods. Freshly refined groundnut oil has a smoking point of about 224.8° C, melting point of 0.6-2.2° C, refractive index of about 1.4682, iodine value of 90-94, free fatty acids content of 0.0137-0.0422%, peroxide value of 3.5-8.5 mm/kg, and saponification value of 188-191 (Woodroof, 1973). Whereas peanut butter, roasted in-shell and shelled nuts are the most commonly used from of groundnut all over the world, the freshly harvested groundnut boiled in a slight brine medium is popular in many countries. In the USA, a substantial amount of groundnut is used in the preparation
crunchy texture, and high protein content of the roasted groundnut seeds. They are also becoming popular in other countries. These two product ranges are considered to be the major growth area in groundnut consumption.

The protein-rich cake, that remains after oil extraction, has been recognized as a valuable supplement to develop groundnut-based fortified foods for human diets. The cake provides partially defeated groundnut flour, protein concentrates and protein isolates. The groundnut protein concentrates and protein isolates, on a dry weight basis, contain 60-70% and 90-95% protein, respectively. The overall effect of processing of groundnut to produce flour and protein concentrates and isolates is to increase the crude protein and, therefore, essential amino acids content by removing the carbohydrate fraction. Groundnut flour can be used in the preparation of groundnut- based fortified foods. Some of the popular groundnut protein-fortified foods in developing countries are pronutro, Indian multipurpose foods, arlac, bal Ahar, ladylac, nutreso, amama, paustik atta, tapioca macaroni, biscuit (provit, probisk, and uni-protein), bread, gonfa, epo-ogi, kisra, toe, gari, oncom, tofu (curd), souces, kuli kuli, coura-coura, groundnut supplemented chinese noodle, groundnut nougat, ice cream product containing groundnut protein isolates, groundnut bars, Yuba, miltone (peanut tonned milk), and chocolate flavored groundnut beverage (Natarajan, 1980; Ahmed, 1989; Singh, 1991; Singh, 1992; Beuchat *et.al.*, 1992). Such products are readily digestible, tasty, and nutritious. Because of the beneficial effect of increased fiber in diets, the groundnut seed skin may be used as a fiber supplement in selected food items.

Because of health consideration, low fat groundnut (with 50 to 80% of fat removed) are also becoming popular as snack food. They can also be used as ingredients in candies, cakes, and many other food products to restrict the calorie intake.

Several uses of the shell or the husk have been reported; fuel, soil conditioner, a filler in feeds and a source of furfural. It is also processed as a substitute for cork or hardboard, or composted with the aid of lignin-decomposing bacteria.

Description of seed quality characteristics and their significance in nutrition and product development

Various physical, sensory, chemical, and nutritional factors determine the quality of groundnut seed. The physical factors include consistency of seed mass and shape, integrity of seed testa, absence of foreign materials and immature seeds, integrity of the seed at the time of processing, and blanching efficiency. Seed mass and its uniformity in size and shape are important when in-shell roasted or shelled roasted nuts are consumed. Pod color, size, shape and texture, cleanliness and freedom from damage, and absence of blind nuts. Sensory factors include seed color, texture, flavor and wholesomeness. Texture plays an important role in food acceptance by the consumers.

Chemical and nutritional factors include oil and protein contents, amino acid and fatty acid composition, carbohydrates, minerals, and vitamins. Oil is composed of saturated and unsaturated fat. The degree of unsaturation is due to aleic and linoleic fatty acids in the oil. Together they account for 75-80% of the total fat in groundnut (Treadwell *et.al.*, 1983; Dwivedi *et.al.*, 1983). Although both are nutritionally important, a higher content in linoleic fatty acid is more desirable because of its hypocholesterolaemic effect (Young and Waller, 1972; Taira, 1985). Linoleic acid is also associated with reduced self-life of the products. Higher oleic (O)/linoleic (L) fatty acid ratio and lower iodine value (IV) ensure longer shelf-life of groundnut oil and its products (James and Young, 1983; Branch *et al.*, 1990). The IV measures the susceptibility of fatty acids to oxidation (rancidifivication). The nutritive value of groundnut protein is low because of its deficiency in lysine, threonine, methionin, and tryptophane content. Amino acids and monosacharides are the precursor of roasted groundnut flavor. Aspartic acid, glutamic acid, glutamic, aspergine, histidine, and phenylalanine are associate with the production of typical roasted flavor, while threonine, tyrosine, lysine, and unknown amino acids are associated with the production of a typical flavor in roasted seeds of groundnut (Newell *et al.*, 1967). roasted groundnuts have characteristic flavor attributes. Various disable (almond, coffee, fresh, nutty, popcorn, smoky,and sweet) and off-flavor (acrid, astringent, barnyard, beany, bite, medical, metallic, musty, onion, off-sweet, oily, rancid, raw, rotten, soapy, solvent, sour, stale, unclean,and woody). Roasted groundnut possess a firm and crisp texture; soft or mushy roasted groundnut are not liked by consumers.

Large elongated tan/rose tan colored seed with uniformity in size and shape are preferred for roasted salted nuts. While 2-seeded large, elongated, constricted, nonstriated, bright cream colored pods are preferred for in-shell roasted nuts, 3-4 seeded light gray colored smooth pods with tan or red seed coat color and prominent seed coat veins are preferred for in-shell boiled nuts. Although the seed size is not important for the production of peanut butter, varieties with high oil content (>50%) are preferred. Seeds of all sizes and shapes may be used in the preparation of candies. The chemical, nutritional, and sensory characteristic described earlier are applicable to all types of products prepared from groundnut seeds.

While the food uses of groundnut are increasing, certain quality factors have potential to limit its use as a food in human diet. These are aflatoxin content, presence of chemical residues in the seed, and light fat content. Failure to address these factor may adversely affect the utilization of groundnut as a food in human diet. Tolerance limit of aflatoxin contamination in groundnut ranges from 5-20 ppb. However, many groundnut importing countries are now demanding no measurable aflatoxin content in groundnut. Genetis resistance to preharvest infection and in-vitro seed colonization by *Aspergillus flavus*, and aflatoxin production, coupled with good crop husbandry, helps to minimizes aflatoxin contamination on groundnut. However, conventional methods are not sufficient to ensure complete freedom from this contamination. Current research on aflatoxin in USA is focused on understanding its biosynthetic pathway to identify the precursor, and enzyme that catalyses the conversion of this precursor in to aflatoxin B1. When the gene responsible for the enzyme is located, it could either be removed or altered using biotechnological tools to stop the production of aflatoxin in groundnut cultivars. Presence of chemical residues in the food is increasingly attracting consumer's concern. The edible grade groundnut in general is grown under high-input management, which also includes the use of pesticide. Excessive use of pesticide can adversely affect the quality of the product. It is, therefore, important to search for an alternative to chemical control. Until then, the pesticide use should be minimized by adopting integrated pest management practices in cultivation of groundnut.

Improved post-harvest technology should be applied for curing and drying the produce and the produce should by store in good storage conditions to avoid post-harvest aflatoxin contamination. Curing is the process during which the moisture content of the groundnut is reduced to a safe level to maintain quality. Groundnut at the time harvest have high moisture content that must be decreased down to 8- 10%. Certain physical and biochemical changes occur in addition to moisture loss during curing. It is, therefore, desirable to cure groundnut in a manner to preserve or enhance their quality. The rate of drying affects the milling quality of groundnut. Milling quality includes skin-slippage and splitting of seeds during the shelling. Fast drying as well as over drying of seeds below 8% moisture are reported to reduce the milling quality (Dickens and Beasley, 1963; Beasley and Dickens, 1963). Temperature is also associated with the flavor of the cured groundnut seeds. Temperature above 35°C result in off-flavor development in the seed. Groundnuts with 20-30% moisture content when exposed to high temperature results in more pronounced off-flavor (Beasley and Dickens, 1963).

Consumer's preference is changing towards low-calorie food and beverage because of health consideration. Although low fat groundnuts are available in the market, such nuts are costly because of the increased processed cost. Narrow genetic variability for oil content limits the scope for substantial reduction in oil through conventional breeding. Understanding the biochemical pathway and use of biotechnological technique might help us to substantially reduce the oil content in edible grade groundnut.

GENETIC ENHANCEMENT IN GROUNDNUT FOR FOOD USES AT ICRISAT

Because of considerable variation in food of groundnut, it is difficult to develop a "prefect" variety that will satisfy the needs of all the sectors of peanut industry. However, it is possible to develop a variety with minimum quality traits that are common irrespective of the end uses of groundnut. These are pod size and shape, seed color, seed mass and uniformity in size and shape within grades, good blanching ability, preferably low oil content and high O/L ratio (>1.6) Whereas genetic variation for pod and seed size and shape selection, the narrow variation for oil content and fatty acid composition (except for the two florida breeding lines with very high O/L ratio of 40) (Norden *et al.*, 1987) limits scope of selection in breeding population. since these high O/L ratio lines are not available to other breeders because of intellectual property right of the originating breeders' the effort at ICRISAT were made to enlarge the genetic variation for fatty acid composition by use induced mutagenesis. The mutants with an average O/L ratio of 3.5 to 4.0 have been isolated. They are now available for use in crop improvement program. Sweet tasting valencia types with 3-4 seeded pods, tan-rose or tan color seeds with relatively high protein and low oil contents have been identified for use in breeding. These are ICGs 335, 408, 1830, 1307, 6224 and 10900.

Excellent progress has been made in developing varieties with improved seed quality in deferent botanical types. When these varieties were evaluated for pod yield and seed quality traits under high input conditions at ICRISAT Asia Center (IAC) Patancheru, several of them showed potential pod yield of 4-5 t/ha^{-1} with an average 100 seed mass of 70-120 g, virginia extra-large market type seeds of 60-90%,oil content 50-54%, and O/L ratio of 1.6-2.0. Several of these varieties with high pod yield;d potential. Large seed size, and good seed quality were provided to cooperators in National Agricultural Research System (NARS) for wider testing. ICGV 86564 (Walawe) in Srilangka and ICGV 89214 (Kouklia), ICGV 88438 (Nikoklia), and ICGV 91098 (Gigas) in Cyprus have been recently released. Many varieties with high pod yield and good seed quality are in the advanced stage of evaluation in India, Korea, Nepal, Sudan, Vietnam, and Zimbabwe. Multilocation testing of these select group of varieties revealed unstability of seed mass and seed quality traits across locations (Dwivedi *et al.*, 1988; Dwivedi *et al.*, 1992; Dwivedi *et.al.,* 1993). The physiological and biochemical reason for such unstability of these quality traits in groundnut are not well understood. Although breeders have made good progress in combining the good seed quality traits with improved genetic background, most of the present day large seeded varieties in general are late maturing types. A better understanding of the physiological process involved in crop maturity and seed mass accumulation should help breeders to delink this association between maturity duration and seed mass.

REFERENCES

Ahmed, Esam M. 1989. World native uses of peanuts. Pages 159-170 in food uses of whole oil and protein seeds. American oil and Chemist Society, 1608 East Broadmore Drive, P.O. BOX 3489, Chapman. (Edmund W. Lusas, David R. Erickson, and Wai-Kit NIP, Eds).

Beasley, E.O. and J.W. Dickens. 1963. Engineering research in peanut curing. North Carolina State Univ. Agric. Expt. Sta. Technical Bulletins No. 155.

Beuchat, L.R., P. Chompreeda, V.V. Garcia, C. Cupadissakoon, V. Haruthaithanasan, R.R. del Rosar, and R.C. Mabesa. 1992. Some new groundnut products in Southeast Asia. Pages 249-255 in groundnut a global perspective; proceedings of an international workshop, 25-29 Nov 1991. ICRISAT Center, India (Nigam, S. N., Ed), Patancheru, AP 502324, India; International Crops Research Institute for the Semi- Arid Tropics.

Branch, W.D., T. Takayama, and M.S. Chinan. 1990. Fatty acid variation among U.S. runner-type peanut cultivars. J. Amer. Oil Chem. Soci., 67:591-593.

Dickens, J.W. and E.O. Beasley. 1963. The effect of curing treatment on some physical properties of peanuts. North Carolina state Collage Agric. Engr. Inform. Ciric. No. 16.

Dwivedi, S.L., K. Thendapani, and AAS.N. Nigam. 1988. Stability of seed mass in confectionery groundnut. International Arachis Newsletter, 3:14-16.

Dwivedi, S.L., G.V.S. Nagabhushanam, and R. Jambunathan. 1992. Perfromance of introduced confectionery lines for yield and quality characteristics at ICRISAT Center, India. International Arachis Newsletter, 12:8-9.

Dwivedi, S.L., S.N. Nigam, R. Jambunathan, K.L. Sahrawat, G.V.S. Nagabhushanam, and K. Raghunath. 1993. Effect of genotype and environment on oil content and oil quality parameters and their correlation in peanut (*Arachis* *hypogaea* L.). Peanut Sci. 20:84-89.

FAO. 1993. Trade Year Book: Export and import of total shelled groundnut and oil.47:213-214 and 249-250.

FAO. 1994. Production Year book: Groundnut area, production, and productivity. 48:108-109.

Fletcher, Michelle M. 1987. Evaluation of peanut flavor quality. pages 60-72 in peanut quality: its assurance and maintenance from the farm to end-product. Agricultural Experiment Station, Institute of Food and Agricultural Sciences, University of Florida, Gainesville (Esam M. Ahmed and Harold E. Pattes, Eds).

Fletcher, S.M., Fing, Zhang, and D.M. Carley. 1992. Groundnut production, utilization, and trade in the 1980s. Pages 17-32 in groundnut a global perspective: proceedings of an international workshop, 25-29 Nov 1991. ICRISAT Center, India; International Crops Research Institute for the Semi-Arid Tropics.

James, S.L.H., and C.T. Young. 1983. Comparison of fatty acid content of imported peanuts. J. Amer. Oil Chem. Soc. 60:945-947.

Natarajan, K.R. 1980. Peanut protein ingredients: Preparation, properties, and food uses. Advances in food research, 26:215-273.

Newell, J.A., M.E. Mason. and R.S. Matlock. 1967. Precursor of typical and typical roasted peanut flavor. J.Agric. Food Chem., 15:767-772.

Norden, A.J., D.W. Gorbert, D.A. Knauft, and C.T. Young. 1987. Variability in oil quality among peanut genotypes in the Florida breeding program. Peanut Sci. 14:7-11.

Singh, B. 1992. Aspects of groundnut utilization and possible environments of indigenous foods in some countries of semi-Arid Tropical Africa. Pages 257-263 in groundnut-a global perspective: proceedings of an international workshop, 25-29 Nov. 1991. ICRISAT Center, India (Nigam, S.N., Ed). Patancheru, AP 502324, India, International Crops Research Institute for the Semi-Arid Tropics.

Singh, B., and U. Singh. 1991. Peanut as a source of protein for human foods. Plant foods for human nutrition, 41:165-177.

Taira, H. 1985. Oil content and fatty acid composition of peanuts imported in Japan. J. Amer. Oil Chem., 62:699-702.

Taylor, S.L., J.A. Nordlee, S. Meier-Davis, and R.K. Bush. 1988. Significance, identification, and detection of allergenic peanut proteins. In proceedings of America Peanut Research and Education Society. Inc. 12-15 July 1988. Tulsa, Oklahoma, USA (J. Ronald Sholar, Ed). Volume 20:48 (Abstract).

Treadwell, K., C.T. Young, and J.C. Wynne. 1983. Evaluation of fatty acid content of forty peanut cultivars. Oleagineux, 38:381-385.

Woodroof, J.G. (Eds). 1973. Peanuts: Production, processing, Products. 2nd edn. The Avi Publishing Company, Inc. Westport, Connecticut, USA. Pages 247-257.

Young, C.T. and G.K. Waller. 1972. Rapid oleic/linoleic microanalytical procedure for peanuts. J. Agric. and Food Chem., 20:1116-1118.