Bambarra Groundnut
(Voandzeia subterranea Thouars)
Abstracts of World Literature 1900–78
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Abstracts of World Literature 1900-78

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INTRODUCTION

These abstracts of literature on the Bambarra groundnut have been compiled as an activity of the International Grain Legume Information Centre. The Centre is administered as a part of the Library and Documentation Centre of the International Institute of Tropical Agriculture, Ibadan and is supported by a grant from the International Development Research Centre, Ottawa, Canada.

Bambarra groundnut is a potentially important grain legume indigenous to Africa. It is cultivated in tropical and subtropical Africa from the Sahara to Natal. It features prominently in many traditional farming systems in Africa as an intercrop of cereals and root crops. It is also cultivated in parts of southeast Asia and Brazil. The seeds contain about 6% oil, 60% carbohydrates and 18% protein and are highly nutritious.

Bambarra groundnut was described by Linnaeus in 1763 and given the name Glycine subterranea. Du Petit Thouars in 1806 changed it to Voandzeia subterranea. Bambarra is the name of a district on the Upper Niger near Timbuktu in Mali while Voandzeia is believed to have been formed from the deformation of a Malagasy term "Voandjo" ("Voa" means seed and "anjo" means that which satisfies well). While the African origin of the crop is established, there is no agreement on the exact location; suggested locations include Mali, Madagascar and Angola.

The vernacular names of the crop include: Earth Nut, Ground Bean, Nyimo or Ndhluubu in Rhodesia, Njugo Bean in the Republic of South Africa, Epi roro, Okpa ibi and Gujiya by the Yoruba, Ibo and Hausa of Nigeria respectively, Nzama or Njama in Malawi, Kachang Menila, Kachang pol and Nela-Kadala in Malaya, Kachang bogor in Java, Guerte or gertere in Arabic, Haricot pistache, Pois arachide, Madagascar groundnut, and Stone groundnut.

This bibliography collates available information on the crop, mostly published and a few unpublished reports. It covers the period 1900-1978.

Collection of Materials: Requests were made to individuals and institutions working on this crop to supply literature. Manual searches of abstracting and indexing journals, bibliographies, were augmented by commissioned computer searches. The major bibliographical sources consulted are listed hereunder. Abstracts have been provided to documents available in the Centre. Some publications which could not be located were however included to make the bibliography as complete as possible. We are continuing to record new literature and we request persons working on Bambarra groundnuts to send us reprints and any available information for inclusion in future supplements.

Availability of Publication: Except those listed hereunder the publications in this bibliography are in the collection of the International Grain Legume Information Centre. Photocopying facilities are available; the current rate is 10 cents a page. Photocopies of a limited number of papers may be provided free of charge to active agricultural workers in developing countries. The following were not available at the Centre at the time of going to press: 015, 023, 038, 045, 054, 065, 075, 089, 100, 102, 106, 111, 114, 117-119, 122, 123, 125, 136, 142, 146, 147, 162-165, 180, 182, 195, 203, 223, 229, 234, 240, 241-260.

Arrangement: Entries are grouped by broad subject categories, and within each category are arranged alphabetically by author. The 260 entries in this bibliography are numbered in one sequence (to facilitate user access). An Author Index, and a Subject Index are provided.
Major bibliographical sources consulted

Abstracts of Tropical Agriculture, Vols. 4(4), 1975-1978
Experiment Station Record, Vols. 12-95, 1900-1946.
Food Science and Technology Abstracts, Vols. 1-10(6), 1969-1978.

Language Note: The original language of publication is indicated if it is not English.

Authorship: This bibliography is the joint effort of all the staff, temporary and permanent, of the International Grain Legume Information Centre. Mr. B.O. Adenaike was responsible for the final collation, editing and indexing.
Bambarra groundnut takes its name from a district on the Upper Niger near Timbuctoo. The plant is undoubtedly native to Africa, growing wild on the Upper Nile, both wild and cultivated in Senegambia, and cultivated from the Sahara to Natal. Although it has been introduced to India, Malaya, Brazil and Northern Australia where it gave a large yield, it is not cultivated on a large scale anywhere. The different forms, plant and seed characters, habit and uses are described. *Voandzeia* seeds have a very low oil content (4.53-6.0%). As the seeds mature only underground, earthing up is practised in the Transvaal with the object of burying the flowers which at times are all aerially borne. Differences between *Voandzeia* and *Arachis* seeds are discussed.

*Voandzeia subterranea* is a food plant of African origin which buries its pods underground like those of *Arachis*. Its cultivation in Africa is widespread and its distribution extends to Brazil, Madagascar and Malaysia. There are a number of races of the plant differing in shape of leaf, size, hardness and color of the seeds. The seeds are not oily but about half of their weight is starch and 20% is nitrogenous. There is no demand for them in Europe and no indication they would sell except as a substitute for split peas, but during World War, a substitute for coffee was made of them.

Central Africa is suggested as the probable centre of origin of Bambarra groundnut (*V. subterranea*) though found throughout Africa, in Madagascar and parts of tropical central America. The plant is a bunched herbaceous annual with subterranean habit. The morphology of the plant is discussed. The seeds contain 4-6% oil, considerably more protein than this and a starch content of 50-60%. The seeds are used as a pulse either when mature or in the young state.

Bambarra groundnut was found growing wild in northern Nigeria. The albuminoid, oil and starch contents are from 16-12%, 4.5-6.5% and 49-59%, respectively. It is eaten extensively in Nigeria. The foliage is not used for fodder, but the seeds when soaked are suitable for coffee.
for horses.


Observations on climatic and soil requirements, agronomy, productivity and chemical composition of the seed are reported for seven types of Bambarra groundnut, grown at the Lake Alaotra Agronomic Station. At Vohimena, yields of 1300-1500 kg/ha of nuts were obtained.


Information is given on morphology and habit; culture; resistance to adverse factors such as high temperatures, frost, shade, drought, water-logging and saline soils; uses; yield and quality of grain legumes including Arachis hypogaea, Cajanus cajan, Cowpea spp., Cicer arietinum, Glycine max, Lablab purpureus, Phaseolus lunatus, Vigna spp. and Voandzea subterranea. The variety name, local names, the station submitting the information and the country, are listed for each entry.


Reviews the literature on the botany, origin and nomenclature, wild and cultivated forms, cytology, chemical composition, environmental requirements, cultivation, diseases and pests, and uses of the Bambarra groundnut.


Gives information on the origin, distribution, common names, morphology, cultivation, chemical composition and ways of cooking Bambarra groundnut.


The leguminous Njugo bean (Voandzea subterranea), is a source of edible or industrial oil. In cultivation, the plant requires heat, a frost-free period of 3-4 months and a loose sandy loam soil with a fair amount of lime and organic matter. Earthing up at flowering time is essential. Harvesting is done by loosening the soil and pulling up the plant or by using a single furrow plough. Dehushed Njugo bean contains 10.3% water, 15.0% protein, 7.4% fat, 5.1% fibre, 59.1% carbohydrate, 3.1% ash, 0.8% P2O5, 1.1% K2O and 0.9% CaO. Collected analyses of the nuts, shells and leaves and of maize, wheat, groundnut kernels, cassava meat, and Indian polished rice are given. History, distribution and description of the bean are also reviewed.


Bambarra groundnut, Voandzea subterranea is illustrated on page 33 of the book. The seeds are 9.6 mm in diameter, and colour ranges from creamy to black, smooth and shiny.
A special characteristic of the seeds is the white hilum.


It is a small herb growing to 1 ft in height, with compound leaves of three leaflets. The flowers are underground, with pods usually containing one or two seeds, although one variety has three. The fruits are about 1/2" in diameter, rounded and wrinkled when dry. The seeds are about 1/8" in diameter, almost spherical, smooth and hard, and varying greatly in colour, being brown, black, white, yellow, red or variously mottled. It is ready for harvesting 4-5 months after planting. The seeds must be cooked before eating. They contain much less oil than the groundnut but they are a well-balanced food. Cakes fried in palm oil, with pepper and salt, keep better than boiled cakes.


The author places the centre of origin of Voandzeia in the Sudan, where the greatest variability is seen in the cultivated forms and where a spreading type differing from the cultivated bunch types can be found growing wild, subsontaneously or in cultivation. The state of knowledge on the geographical distribution, cytology of the plant and the morphology, anatomy, chemical composition and nutritive value of the seed is discussed.


On p. 869, mention is made of the similarity between the ground-bean or Bambara groundnut a crop much cultivated by the natives of tropical and sub-tropical Africa, and the groundnut or monkey nut.


Describes 18 legume species including Cajanus cajan, Dolichos niger [= Lablab purpureus], Macuna pruriens utilis, Voandzeia subterranea and Vigna.


Describes the habit, origin, distribution, morphology, chemical composition, cultivation, pests and diseases of Bambara groundnut.


Some of the more common concepts on the origin and distribution of Bambara groundnuts are discussed. The botany, chemical composition and agronomy of the plant, including cultivation, harvesting, threshing, storage, yield and usage are also discussed.
The importance of grain legumes in human nutrition is stressed. Vouandzeia subterranea and other legumes, including Arachis hypogaea, Cicer arietinum, Glycine max, Sphenostylis stenocarpa etc. are illustrated along with notes on popular names and botanical characteristics.

Bambarrá groundnut is a small, bunched annual herb with erect long-stalked, trifoliate leaves. It is widely found in Africa, especially in the semi-arid to subhumid southern fringes of the Sahara, in Eastern Africa from Sudan to Rhodesia, and in the Malagasy Republic. It grows in dry, poor soils and is drought-resistant. It has very low pest and disease susceptibility. Maximum yields of dry seed are about 2,000 kg/ha and average about 750 kg. Unripe seeds are eaten fresh, ripe seeds are used as pulse. It is high in protein, but unlike ordinary groundnuts, contain very little oil. Other legumes discussed include Kerstings' groundnut, Phaseolus sp., lablab, Parkia sp., Vigna sp., winged bean, Jack bean, African yam bean, Mexican yam bean and Mucuna sp.

Bambarrá groundnut is a most extensively cultivated crop in Africa with Nigeria being one of the major producers (100,000 t). The ripe seeds contain 20% protein, 4-7% fat and 50-60% carbohydrate. It may be intercropped with pearl millet or sorghum. It has few diseases and pests, and a chromosome number 2n=22. It is indigenous to Africa with a broad range of variation occurring in West Africa or East Africa and Madagascar. Other crops reviewed include cowpea, pigeon pea, peanuts, winged bean, lima beans, mung beans, African yam bean, velvet beans etc.

Bambarrá groundnut, together with Kersting's groundnut, is the third most important legume after groundnuts and cowpeas. It is confined to the hot drier regions between the desert and sub-humid savannah forest land on the southern fringe of the Sahara and in scattered areas in East Africa. Production of seeds in the lowland tropics is from 300-450 thousand t of which Niger alone producers 30,000 t on 40,750 ha and Nigeria 100,000 t. The botany and probable trend of evolution of the plant are also discussed. Seeds take up to 15 days to germinate in the cultivated forms and in the wild relative (var. spontanea) it is 31 days. Protein, fat and carbohydrate contents are 16-21, 4.5-6.5 and 50-60%, respectively. It may be planted as a mixed crop with cereals at spacings of 100-200 cm and as a sole crop at 15 x 30, 25 x 30, 20 x 50 or 40 x 40 cm. Superphosphate at 60 kg/ha at planting and ammonium sulphate at 40 kg/ha are economical. Stem and foliage rots are caused by Sclerotium rolfsii, Pythium sp. and Rhizoctonia solani; root rot by Phytophthora manihotis and foliage diseases by Sphaerotheca vouandzea, Cercospora congoenoe and Aecylachyta phaseolom.
Voandzia subterranea grew wild in the Sudan before the introduction of the groundnut (Arachis hypogaea). The morphology, selection and cultivation of the plant are described. The seeds have 19.31% crude protein, 7.48% crude fat, 4.74% cellulose, 3.88% minerals, 4.52% sugars and 44.58% starch. The chemical composition is compared with that of groundnut.

In Kwango, whole seeds are used by man as food in small quantities either immature or mature, and in other parts of Africa they are made into flour. Their possible use as a feed for livestock, poultry and fish is being studied.

Bamburra groundnut is an annual which resembles Arachis hypogaea both in cultivation and habit. It is widespread in tropical Africa and Madagascar. It is used mainly for human consumption. Chemical analyses shows it contains: 89.7% dry matter, 19.1% crude protein, 5.8% cellulose, 5.1% fat, 7.9% mineral matter, 0.15% Ca and 0.43% P.

Bamburra groundnut is an annual bearing numerous erect long-petioled trifoliate leaves which are produced from small short creeping stems, whilst the small yellowish coloured flowers are borne on these stems quite close to the ground. A well-drained, sandy loam soil is most appropriate for cultivation with a spacing of 2 ft to 2½ ft square. Two seeds are sown in each hole and the plants mature their small round single-seeded pods in 3-4 months from time of sowing. Yield of dried unshelled nuts is about 800-1000 lb/ac under suitable conditions and two or more crops can be obtained/annum. The usual local method of preparing the nuts for food is to boil them until they become soft and shell the beans afterwards. Uses of the plant include the employment of the nut for food, both for human consumption and for stock and leaves for fodder and green manure.
The principal pulses grown in tropical countries are *Vigna sinensis*, *Dolichos lablab* (= *Lablab purpureus*), *Phaseolus lunatus* and *Voandzeia subterranea*, but with the exception of *P. vulgaris* and *P. lunatus*, both grown in Madagascar, trade in these legumes with metropolitan France is small. Production statistics and various market prices, export standards, selection and breeding standards achieved to date, are reviewed.

A one page note on the origin, composition and agronomy, as well as varietal trial of Bambarra groundnut.

Bambarra groundnut is described under the following headings: origin, morphology, pest and diseases, extent of cultivation, place in rotational cropping, time of planting, type of culture, planting distance and depth, rhizobia, cultivars, fertilizers, yields, storage and future prospects.

A description of bambarra groundnuts, including an illustration, is given on page 169-170. Bambarra groundnut contains 10.2% moisture, 4.53% fat, 5.13% ash, 0.8% phosphorus, 19.20% nitrogenous substances and 49.91% starch.

The fruit of *V. subterranea* is sub-globular, 1-2 seeded and ripens underground. The fruits are edible and oily.

*Voandzeia* is one of the most important of the local African pulse crops and is found throughout Africa, Madagascar and parts of tropical America. The seed contains 4-6% oil, about 16% protein and 50-60% starch. The subterranean pod has a wrinkled surface and normally contains one, occasionally two, oval or almost spherical seed about 10 mm long. Colour variation of the testa is very marked, being white, red or black. Microscopic details of the testa and embryo are given.
Describes the history and cultivation of the groundnut sometimes called the Madagascar peanut. The coefficients of digestibility were protein 84.2, fat 100.0, nitrogen-free extract 84.3, and fibre 25.6%. Analysis of the unshelled nut was water 15.0, protein 17.9, fat 3.9, nitrogen-free extract 49.1, fibre 10.7 and ash 3.4%.

A01 DOCUMENTATION


Gives the history of the Nigerian Grain Legume Gene Bank and describes the species maintained as of 1970. These include Vigna sinensis, Cyamopsis psoraloides, Glycine max, Phaseolus radiatus (= Vigna radiata), P. lunatus, P. vulgaris, P. mungo (= Vigna mungo), Voandzeia subterranea, Dolichos lablab (= Lablab purpureus), Sphenostylis stenocarpa and Canavalia spp.


Information is given on the scope of the Tropical Grain Legume Bulletin, a newsletter which contains research notes by scientists or grain legume workers, a space for announcing and describing unique and useful grain legume germplasms and cultivars, and abstracts of current literature on tropical grain legumes, including cowpeas, Bambarra groundnuts, lima beans, pigeon peas, winged bean, etc.


Describes the beginning of what is intended to be a systematic field collection of cultivated and wild grain legumes throughout the lowland humid tropics. In Nigeria collections of Vigna unguiculata included 394 cultivated and 49 wild and weedy forms. Other species collected during 1972 were Sphenostylis stenocarpa (42), Voandzeia subterranea (22), Phaseolus lunatus (16), Cajanus cajan (5), Mucuna sloanei (5), Canavalia ensiformis (3), Kerstingiella geocarpa (2), and Lablab niger (= Lablab purpureus) (1).
In experimental sowings of Crotophyllum rotula, indigo, Bambarra groundnuts, Zephroidea candida and sword bean (Cosmopteris gladitata), only the last named germinated well under a cacao shade.

Bambarra groundnut belongs to the Leguminosae and is thus capable of using atmospheric nitrogen. Though similar to ordinary groundnuts, its development of leaves is less abundant giving a smaller amount of vegetable matter after harvest. It produces a bunch of upright leaves, and the leaves are developed close around the stem, at a very small depth in the soil. It is a good cover crop and its cultivation is the same as that of the ordinary groundnut. In sowing, 3-4 seeds are put into each pocket, at a depth of 1 in. Yields are usually better than those of groundnuts. It keeps well when nuts are dry and is not attacked by insects. Bambarra groundnut contains a little less phosphoric acid but a greater amount of potash than the ordinary groundnut which also has a greater N content. Uses include nut as food for man and stock, use of leaves for fodder, and as green manure.

Though it is also grown in East Africa, Bambarra groundnut (Voandzeia subterranea (L) Thou.) is most extensively cultivated in Africa with Nigeria (100,000 tonnes), Niger (30,000 t) and Ghana (20,000 t) estimated to be the main producers. The crop grows on very poor, sandy soils which are marginal for other pulses, as a mixed crop with millet or sorghum, or in pure stands, maturing in about four months. The fruits are developed in the soil, which is often earthed up to help the process.

Earthnut or Bambarra groundnut is a close relation of the groundnut possessing the same physical characteristics including the subterranean habit. Neither pests nor diseases have been found on the Bambarra groundnut so far and its storage in the form of unshelled pods is easy. It contains 20.8% proteins and 5.8% fat. Calorific, nicotine and aneurine values are also given.
The cultivated grain legumes of Ghana are in a descending order of importance cowpea, groundnut, Bambara groundnut and lime bean. Bambara groundnut is retailed but the amount available at any one time is always less than that of cowpea. It is indigenous to West Africa, adapted to the dry areas stretching as far North as the northern fringes of the Sudan savanna and is most drought tolerant. In the south, it is usually grown in pure stands and at high densities, but in the north it is grown mixed with millets, sorghum, yam etc. It grows well on a variety of soils, especially light and sandy loams, but it also does well on heavier soils. Bambara groundnut has very few pests and diseases, almost all of which attack under high rainfall conditions.

In Ghana, Bambara groundnut ranks second only to cowpeas in production and consumption as it is tolerant of poor soils and drought. It has been cultivated since ancient times, but interest in the crop is very recent. The present state of knowledge regarding the past and present cultivation of Bambara groundnut is reviewed.

Bambara groundnut (Voandzeia subterranea), a tropical-subtropical legume sensitive to frost and drought, grows best in a temperature range of from 15-30°C. Protein and oil content are 15 and 7%, respectively.

The principal crops grown include groundnuts, Bambara groundnuts, cowpeas, mung beans, chickpeas and some cereals, all of which are grown as pure stands on 65% of the area. Maize, sorghum and legumes are also often grown in mixture in two of the three areas studied.
With good management, yields are comparatively high. The crop appears singularly free of
disease but is attacked by Meloidogyne javanica and by Plectruchelus (Apion) varium and
Callosobruchus rhodesianus in storage.

047 KARIKARI, S.K. 1971. Economic importance of Bambarra groundnut. World Crops,

The value of Bambarra groundnut (Voandzeia subterranea) production in Africa is reviewed.
The crop is drought-resistant, comparatively free from pests and diseases and well adapted
to poor soils. It is important as a source of protein for human consumption and animal
feed and can be sown in sand as a means of erosion control.

p. 35.

It grows much the same way as the bunch type of groundnut and their cultivation methods are
the same. It cannot be eaten raw, contains 6% oil and a high content of carbohydrates and
proteins. It is grown for domestic consumption in some parts of Africa, the seed rate
being about 25 lb., and yield up to 800 lb./ac. of unshelled nuts after 4-5 months.

049 NIGERIA. INSTITUTE FOR AGRICULTURAL RESEARCH. 1969. Other legumes: Bambarra
groundnuts. In: Annual report of the Institute for Agricultural Research and
Special Services, Ahmadu Bello University, Zaria, Nigeria. 1967-1968.
p. 28, 29.

Bambarra groundnuts were shown to be second in importance only to cowpeas as cultivated
grain legumes in Northern Nigeria. Accessions 1862 and 1972 which were resistant to an
unidentified virus disease of this crop were recommended for extension, choice of seed
color being determined by local preference.

050 NYASALAND PROTECTORATE. DEPARTMENT OF AGRICULTURE. 1961. Bambarra
p. 41, 206.

Of four stations used for Bambarra groundnut varietal trials, the highest yield of 2340 lb
shelled nuts/ac was recorded at Chitedze. Time of sowing had a critical effect on yield
thus 14 Dec. 2040, 11 Jan. 430 and 8 Feb. 30 lb shelled nuts/ac. New records of diseases
include leaf spot caused by Cercospora amesiana and Pseudoplea trifolii, and wilt caused
by Sclerotium rolfsii [=Corticium rolfsii].

051 SAVILE, A.H. and WRIGHT, W.A. 1958. Notes on Kenya agriculture. 3. Oil
seeds, pulses, legumes and root crops. The East African Agricultural Journal,

Notes are given on climatic and soil requirements, cultivation and harvesting methods,
and main uses of groundnut (Arachis hypogaea), bonavist bean (Dolichos lablab [=Lablab
purpureus], lima bean, sword bean (Canavalia ensiformis), jack bean (C. gladiata), chickpea
cowpea (Vigna aytjang), pigeon pea, green gram (Vigna radiata), black gram (V. mungo),
Bambarra groundnut, etc. Spacings, sowing rates, yields/ac. and time to maturity are
(tabulated for each crop.)
A description of the botany, cultivation and the results of yield trials of Bambarra groundnut is given.

**B01 PLANTING DATE, PLANTING METHOD AND SPACING**


Almost 85% voandzou cultivation is concentrated in the Dosso department, Dogon Doutchi sector and 75% of the harvests are exported to coastal countries. Density trials set up in Tarna and Kala Pate during 1965-1967 gave a high density of 0.30x0.15m (222,000 plants/ha). Varietal work in 1964-1967 showed the varieties TV21, TV12, TV37, TV7 and TV83 to be the highest yielders. Groundnuts and cowpeas are also discussed.


Common and individual characteristics of groundnut (*Arachis hypogaea*) and Bambarra groundnut (*V. subterranea*) are discussed. Considerable attention is given to the phenomenon of subterranean fruit production common to both plants. In an experiment on the effect of hilling as practised with groundnut, *Voandzeia* plants all died. The author states that hilling creates conditions which favour disease attack.
B02 CROPPING SYSTEMS: INTERCROPPING AND ROTATIONAL CROPPING


In most parts of Ghana, Bambarra groundnut is a prominent intercrop legume. It is mostly intercropped with cereals and groundnuts.


The most important legumes in Upper Volta (apart from the groundnut Arachis hypogaea) are cowpeas (Vigna sinensis), Bambarra groundnut (Voandzeia subterranea) and to a lesser extent Parkia biglobosa and the haricot kissi (Phaseolus spp). Rotation is recommended for the promotion of legume cultivation.


Bambarra groundnut (Voandzeia subterranea) is one of the important food legumes of Nigeria predominantly grown in the more sandy soils of the northern fringes of the humid tropics in the derived savannah zone. It may be grown as a sole crop in rotation with maize, cowpeas, cassava or yam. As one moves northwards, the area of sole cropping increases.


The traditional and transitional cropping systems of Africa were discussed. The use of Bambarra groundnuts and other legumes, such as beans, cowpeas, groundnuts, pigeon peas, soybeans, lima beans and Sphenostylis sp. were also discussed.


In an experiment conducted over two years, tomato following a clear fallow gave the best yield followed by tomato after cowpea, tomato after Bambarra nut, and tomato after groundnut. Tomato after tomato had the highest number of nematodes followed by tomato after cowpea, tomato after Bambarra nut, tomato after fallow and tomato after groundnut.
The Magadi crop rotation system of Nyasaland is a 5-10 year rotation based on maize-beans-maize-groundnuts. The maize is often spaced 5ft and the groundnuts interplanted on mounds. The maize and bean crop that follows may be interplanted with cowpeas or Bambarra groundnuts.

**B03 CULTIVATION PRACTICES: WEED CONTROL AND HARVESTING**

The crops grown in this region are groundnuts, cowpeas, maize, sorghum, rice, eleusine, sesame, pigeon peas, Bambarra groundnuts, and Kidney beans. Results show that very high yields are obtained with non-selected varieties and primitive cultural methods.

Voandzou or Bambarra groundnut is a tropical and south African pulse crop of great importance in Nigeria. It is grown like groundnut.

Crops grown by various ethnic groups in the Cameroun include Bambarra groundnuts, cowpeas and groundnuts. Amongst the various tribes, there is varying emphasis on the crop grown.

Maize can be interplanted with groundnuts, beans or Bambarra nuts on ridges or occasionally alone with groundnuts on flat surfaces.

Cultivation systems of the various tribes of the Congo Basin are described. Among the crops discussed is the Bambarra groundnut, a crop which looks very much like the peanut and has the same subterranean habit of seed development. But differs in having only one seed/pod.
Although this crop is still grown regularly, very few plots are now cultivated as it has been largely replaced by groundnuts (*Arachis hypogaea*) with which it has similar methods of cultivation. The nuts are only consumed in appreciable amounts in south Buganda and Busoga and are either boiled or roasted. Two groups of cultivars are identified by color of the Kernels: the plain brown or black kernel type and the mottled type with brown as the dominant color.

Historical series on cultivated areas are unreliable, particularly on a breakdown of cultivated areas by component states of the Federation for crops such as locust bean, pigeon pea, Bambarra nut, oil bean, yam bean, sword bean, lima bean and chickpea, which are grown and consumed in some parts of Nigeria.

In the Eastern Province of Zambia, yields of Bambarra groundnuts (*Voandzeia subterranea*) probably average only 50-100 lb/ac. Under traditional farming systems, Bambarra nuts are grown in combination with other crops.

In Sukumaland, Tanzania, phased planting is practiced for Bambarra groundnuts because of the uncertainty of constant rainfall.

Bambarra groundnut *Voandzeia subterranea* is cultivated in many regions of Africa and Madagascar though on a small scale. Several varieties have a high yield potential. Other legumes discussed include *Lablab purpureus*, *tepary beans*, lima beans, pigeon peas and *Vigna sp.*
A series of field inoculation trials were carried out using local Rhizobium strains to determine for which legume species and on which soils the absence of specific rhizobia limited nodulation and yield. The species studied included groundnuts, Bambarra groundnuts, soybean and cowpeas.

In a cross-inoculation experiment using crushed nodules from groundnuts, cowpea, Bambarra groundnuts and soybeans, nodule bacteria from soybeans nodulated with all species. Groundnuts and Bambarra groundnuts nodulated with bacteria from all species except cowpeas and lima beans.

Many legumes including mung bean, Phaseolus aconitifolius, urd bean (Vigna mungo), Voandzeia subterranea etc. were found to belong to the cowpea inoculation group.

Bambarra groundnut roots were found to contain 3.93% total N, 2.10% total water soluble N, 0.97% Ca, 0.55% Mg, 1.52% K and 0.30% P. Net mineralization or immobilization of root N in Bambarra groundnut was 48.7% after 84 days of incubation in fallow soil. Other legumes studied included cowpeas, lima beans, pigeon peas and soybeans.

Bambarra groundnuts, whose pods develop underground, takes 36±5 days to flower. Its nodules are 2.81-7.5 mm in size, smooth and spherical, with a red or pinkish colour visible through the cortex. Nodule number ranges from 92-318.
Very good yields (up to 3000 lb/ac of shelled beans) were obtained at Chitedze from Bambarra groundnuts planted early on December 11th and allowed to grow for 146 days before wilting and harvesting. Plots in the same field planted on January 24th wilted and harvested after 118 days gave less than one-fifth of the yield of the early planted plots. Up to 65% of the beans broke from the haulm on lifting, and were left in the ground. Gleaning therefore is very important.

At Chitedze very good yields of from 1,747-3,373 lb/ac shelled seed were obtained from ground beans planted 11th December, which were able to grow for 146 days before lifting. Gleaning is a very important factor if maximum yield is to be obtained. Leaf spot of the ground bean was caused by Cercoospora canescens Ell. & Mart.

This is a report of the first technical meeting on improvement of production of vegetables and grain legumes including Bambarra groundnuts, cowpeas, groundnuts, soybeans, lima beans and pigeon peas, in Africa.

Ground bean or Bambarra groundnut, one of the commonest legumes grown in Africa, possesses subterranean fruits which can be boiled and eaten. Its use in rotational cropping is doubtful and apart from a small local market, the crop is of little economic value.
Stachyose was present in the highest amount in the soluble sugar fraction of dry Bambarra groundnut cotyledons, followed in descending order by raffinose, sucrose and verbascose. During germination in the dark, the stachyose and raffinose content decreased rapidly, but there was little change in the relatively small amount of verbascose present. The sucrose content increased rapidly during the first two weeks and decreased thereafter. Free glucose and fructose were present in the cotyledons after the 7th day and gradually increased in amount with time of germination. Free galactose and other galactose-containing oligosaccharides were not detected in either the dry or germinated Bambarra seeds. During germination, galactose was the only identifiable sugar, aside from traces of sucrose, glucose and fructose, in the extracted soluble sugar fraction in the embryonic axes of all ages when the tissue was incubated with D-[14C] galactose. With the cotyledons, however, most of the radioactivity was in glucose and fructose during the early period of germination and in sucrose later. A small fraction of radioactivity was lost as CO₂.

The distribution of the endodermis in etiolated and light-grown shoots was compared in Pisum sativum, P. jemaudi, Vicia faba, Lathyrus odoratus, L. latifolius, Lens esculenta, Phaseolus multiflorus, P. arachinoides, P. vulgaris, Glycine soja, Voandzeia subterranea, Arachis hypogaea and Acacia sp.

Self and cross pollination, both brought about by ants, occur to varying extents depending on the variety or strain. Cross pollination may be greater in varieties or strains with an open habit resembling that of the wild ancestor, but the bunched types are more likely to be self pollinated.

In a small-plot trial, 14 Bambarra groundnut cultivars were ringed with 5% DDT powder to prevent access by pollinating ants. Mean number of pods/plant for controlled and uncontrolled groups of the Bunch, Semi-bunch and Open cvs were 15.24, 8.36 and 7.13, respectively.

The flower of *Voandzeia subterranea* is typical of the Papilionaceae. Flowering starts 28 days after germination and, depending on the variety, may not cease before the end of the life of the plant. More flowers and pods are produced during the dry than the rainy season. Fertility coefficient, which is higher for bunch than open varieties, does not differ much in the two seasons although coefficients are slightly higher in the dry season. It is suggested that if water can be provided, the dry season would be better for the cultivation of Bambarra groundnut.


Flowers of Bambarra groundnut were positively geotropic, whether fertilized or not. The ovary developed only when it was on or beneath the surface of the soil. The pod developed first, during the first 30 days after fertilization; seed development took a further 10 days. There were always two ovules/pod; seeds were not mature until the parenchymatous lining of the shell had disappeared and brown patches had appeared on the sides of the shell.


The role of three species of ants, two of which were identified as *Pheidole megacephala* and *Monomorium pharaonis*, in the pollination and pod production of Bambarra groundnut was studied by comparing plots to which the ants had access with ones from which they were excluded by DDT treatment. Pod production was significantly higher in the presence of ants, while unburied discs were significantly more numerous in their absence; these results applied only to semi-bunched and open varieties. There were no significant differences between treatments when numbers of pods and discs were taken together. It was considered doubtful that the movement of ants in and out of the openings at the tip of the keel petal was the only means of pollination, although they are the only insects known to be associated with the plant.


This work attempts a general classification of cultivated Ghanaian varieties of Bambarra groundnuts. Seasonal effects on flowering and yield are also touched upon.


In *Voandzeia subterranea*, a post-floral movement of the peduncle leads to the burying of the fruiting head.

091 SMYTH, K.J.F. 1968. Flowering, pollination and pod formation in the Bambarra groundnut. *Ukiriguru Research Notes* No. 16

A one-page note on the occurrence of both self and cross pollinated varieties of Bambarra groundnut.
The parasitic plant *Aleatra vogelii* is stimulated to germinate by root exudates of host plants once the seed of the parasite has been sensitized by moist conditions at 28°C. Extracts were made of pot leachates from pot grown *Voandzeia*, *Vigna unguiculata*, *Phaseolus multiflorus* and sunflower. After chromatographic separation of the extract fraction, the activity of the extracts was tested with germinating sensitized *A. vogelii* seed. A number of stimulatory zones were discovered which are apparently common to all the hosts investigated.

**D00 CHEMICAL COMPOSITION**

On pages 87-90, *Voandzeia subterranea* Dupetit - Thouars is discussed. Chemical values of the seeds, mineral matter and the results of an analysis of the pods are presented. Physical and chemical properties of the oils are also given. The chemical composition of seeds from Nigeria, Africa, Mauritius, Madagascar, Congo Belge and the French and English colonies of Africa, as presented by various authors are tabulated.

Chemical composition, including both organic and mineral contents of Bambarra groundnuts, is given in tabular form. The chemical composition of Bambarra groundnuts from different sources are also compared.

Bambarra groundnut contains 19.05% protein of which 0.90% is tryptophane, and 1.95 mg vitamin PP/100 g of dry matter. Chemical values are also given for cowpeas, pigeon peas, *Lablab niger* (=*Lablab purpureus*), groundnuts, *Funkia* sp., Kersting's groundnuts, jack bean, *Phaseolus* sp. and *Sphenostylis stenocarpa*. The origin of the Bambarra groundnuts is recorded as Cameroon.

Sucrose was present in seeds of 31 species including groundnut, Bambarra groundnut, pea, cowpea, mung bean, adzuki bean, soya bean and broad bean at all ages and stages of their development. The raffinose family of oligosaccharides was present in most mature and dry seeds.
Analyses of a sample of Bambarra groundnut seeds gave the following results: moisture 13.1%, ash 2.4%, fat 6.2%, fibre 3.9%, albumino'fds (N x 6.25) 16.0%, starch 58.4%, and nutrient value 88.5%.

Two samples of Bambarra groundnut seeds were analyzed and compared with samples from the northern provinces of Nigeria and from Zanzibar. The nutrient ratio of the Sudan samples was 1:3.4 and were practically identical in composition but superior to the samples from the northern provinces of Nigeria and from Zambia which had nutrient ratios 1:4.5 and 1:3.9, respectively. No cyanogenetic glucosides or alkaloids were present in the seeds.

The geographical distribution and seed characters of Voandzeia, a native of tropical Africa, are discussed. When crushed, the seeds yield a white flour with a characteristic beany taste, but when boiled they taste like chestnuts. Chemical composition of the sample from Upper Ubangi is: water 9.8%, fat 6%, nitrogen 18.6%, starch 58.3%, cellulose 4% and ash 3.3%. The author remarks that Voandzeia is a natural foodstuff possessing all the chemical components of a complete food in balanced quantities.

Chemical composition of the African peanut (Voandzeia subterranea), Cajanus indica (= C. cajan) and several varieties of beans is reported.

Values for the water, ash, cellulose, fat, dry matter and nitrogen contents of green and ripe Bambarra groundnuts are 56.90, 13.30; 1.73, 3.54; 2.41, 4.37; 3.14, 6.94; 27.40, 55.81; and 8.42, 16.04%, respectively.

Analyses of the Bambarra groundnut (Voandzeia subterranea) and other data are quoted. The nuts, which are a favourite article of food in the Transvaal, are similar to peanuts but contain little fat.
Dry seeds of *Voandzea subterranea*, native of Madagascar and Indonesia, contain 9.8-12.5% H₂O, 2.45-4.00% ash, 0.038-0.112% Mg, 0.207-0.280% P, 6.0-6.9% sugars, 56.0-60.0% cellulose, 4.0-5.7% fat, and 3.0-5.0 mg vit. B₁/Kg. Paper and column chromatography showed the following amino acids to be present: aspartic acid 11.8%, threonine 3.8%, serine 5.8%, glutamic acid 17.7%, proline 5.3%, glycine 4.1%, alanine 4.7%, valine 5.5%, methionine 1.9%, isoleucine 4.5%, leucine 8.1%, tyrosine 3.8%, phenylalanine 5.8%, lysine 6.9%, histidine 3.1%, and arginine 7.6%; cystine and tryptophan were absent.

Tabulated information is given on the amino-acid composition of the seeds of a number of varieties of *Arachis hypogaea*, *Kerstingiella geocarpa*, *Glycine max*, *Phaseolus lunatus*, *P. vulgaris* and *Voandzea subterranea* from different parts of Africa. Percentages were found to be remarkably constant within the species. Amino acid values for Bambarra groundnut varieties ranged as follows: aspartic acid 11.5-12.1%, threonine 3.6-3.8%, serine 5.4-5.8%, glutamic acid 16.6-17.0%, proline 4.9-5.2%, glycine 3.9-4.3%, alanine 4.3-4.7%, valine 5.1-5.5%, cystine 0.9-1.1%, methionine 1.7-1.9%, isoleucine 4.2-4.6%, leucine 7.7-7.9%, tyrosine 3.3-3.7%, phenylalanine 5.3-5.9%, lysine 6.4-6.6%, histidine 2.8-3.3% and arginine 6.0-6.7%.

Amino acid values of Bambarra groundnut varieties collected from Cameroun and Madagascar ranged as follows: aspartic acid 11.5-12.1%, threonine 3.6-3.8%, serine 5.4-5.8%, glutamic acid 16.6-17.0%, proline 4.9-5.4%, glycine 3.9-4.3%, alanine 4.3-4.7%, valine 5.1-5.5%, cystine 0.9-1.1%, methionine 1.7-1.9%, isoleucine 4.2-4.6%, leucine 7.7-7.9%, tyrosine 3.3-3.7%, phenylalanine 5.3-5.9%, lysine 6.4-6.6%, histidine 2.8-3.3% and arginine 6.0-6.7%; and protein content was 19.9%. Chemical values are also given for *Arachis hypogaea*, *Cajanus sp.*, *Canavalia sp.*, *Dolichos sp.*, *Kerstingiella geocarpa*, *Mucuna sp.*, *Parkia sp.*, *Phaseolus sp.*, *Sphenostylis sp.* and *Vigna sp.*

The amino acid composition of cowpeas, jack beans, Bambarra groundnuts, *Lablab niger* (=*Lablab purpureus*) and some other legumes are presented.
Bambarra groundnut, *Voandzeia subterranea* contains 10.0% moisture, 21.1% protein, 53.5% carbohydrate, 6.5% fat and a high lysine content of 6.4 g/16 g N. It grows well in light soils, warm to hot climate and the seeds mature in 100-180 days.

Chemical values for six varieties of Bambarra groundnut (one from the Camerouns and five from Madagascar) ranged as follows: 18.4-21.5 protein N, 11.4-12.0 aspartic acid, 3.6-3.8 threonine 5.4-5.8 serine, 16.6-17.0 glutamic acid, 4.9-5.2 proline, 3.9-4.3 glycine, 4.3-4.7 alanine, 5.1-5.5 valine, 0.9-1.1 cystine, 1.7-1.9 methionine, 4.2-4.6 isoleucine, 7.7-7.9 leucine, 3.3-3.7 tyrosine, 5.3-5.9 phenylalanine, 6.4-6.6 lysine, 2.8-3.3 histidine, and 6.0-6.7% arginine. No significant varietal differences were found with respect to nutrition.

In Western Java, the beans are eaten by the natives and is known to them under the name Katjang begor (Buitenzorg Beans), because the plant was introduced by the Botanic Gardens at Buitenzorg. At the Laboratory of the Colonial Museum, the composition of *Voandzeia* was found to be: water 12.78%, oil 6.41%, nitrogenous matter 19.12%, starch 49.28%, cellulose 5.79% and ash 3.33%.

Oil contents of the seeds of *Cicer arietinum*, *Lena esculentum*, *Cajanus indicus* (=C. cajan), *Phaseolus mungo* (=*Vigna mungo*), *P. vulgaris*, *P. lunatus*, *Dolichos lablab* (=*Lablab purpureus*), *Vigna catjang*, *Canavalia ensiformis* and *Voandzeia subterranea* etc. were examined. Physical and chemical constants are reported, and the fatty acids were also studied. All the oils were non-drying in nature.
Bambarra groundnut is widely distributed throughout Africa. Analysis of a sample of seeds from N. Nigeria showed it to contain moisture 13.1, ash 2.4, fat 6.2, fibre 3.9, albuminoids 16.0 (total nitrogen 6.25), starch and other carbohydrates 58.4%, nutrient value of 88.5 and a nutrient ratio of 1: 4.5


Bambarra groundnut (100g wt) contains 11g H2O, 15.6-21.9g protein, 5.0-7.5g fat, 64g carbohydrates and fibre, 30-100 mg Ca, 100-280 mg P, 7mg Fe, 100mg Mg and 1.2g K.


Data are given on the chemical composition of the seeds of Vigna unguiculata and Voandzeia subterranea, and of the seeds and leaves of Cajanus indicus [=C. cajan].


Data on the chemical composition of six legumes, including Voandzeia subterranea eaten in Mozambique are presented. In Bambarra groundnut protein content is 19.24%, fat 7.84%, carbohydrates 69.28%, cellulose 5.50% and the Energy in calories/100g dry matter is 414. Mineral and vitamin composition are also listed. The other legumes are Cajanus cajan, Dolichos lablab (=lablab purpureus), Phaseolus lunatus, Mungo sp. and Vigna catjang.


The fat of Bambarra groundnut (V. subterranea) is made up of 34.2% linoleic acid, 24.4% oleic acid, 19.4% palmitic acid, 11.8% stearic acid, and 10.2% arachidic, behenic and lignoceric acids. It contains Ca 90.0, P 7.6, Fe 4.0, Vit A 30.0, ascorbic acid 1.0, thiamine 0.30, riboflavin 0.12 and niacin 2.1 mg/100g food. Essential amino acids content in mg/g N are: arginine 394, histidine 188, isoleucine 275, leucine 494, phenylalanine 350, lysine 400, tyrosine 2.9, cystine 180, methionine 113, threonine 219, tryptophan nil and valine 331. Values for its protein content are also given. Nutritive values for groundnut, soyabean, cowpea, lima bean, locust bean, pigeon pea, green gram, kidney bean and lablab niger (=lablab purpureus) are also given.


The seeds contain 3.39% total ash, 9.17% fatty oil, 49.25% starch, 4.77% cellulose, 17.51% proteins, 0.038% Ca, 0.224% P, 0.0027% Fe, 242 γ vit. B1, 160 γ vit. B2, 2 mg niacin, 12.43% water and an energy value of 350 cal./100g.

A sample of *Voandzeia subterranea* seeds from Eala, Belgium Congo contains 15.34% moisture, 3.36% ash, 5.90% oil, 3.17% cellulose, 20.65% nitrogenous matter, 41.93% amylaceous matter, 51.58% non-nitrogenous matter and a nutritive value of 178.7.


Chemical values for Bambarra groundnuts/100g edible portion are: water 10.0 ml, protein 18.0 g, fat 6.0 g, carbohydrate 55.0 g, Ca 90.0 mg, Fe 4.0 mg, aneurine 0.03 mg, riboflavin, nicotinic and ascorbic acids nil, and 346 calories.


This is the revised edition of the food tables first published in 1945 as No. 253. The chemical values for Bambarra groundnuts/100g edible portion are: water 10.0 ml, protein 18.0, fat 6.0 g, carbohydrate 60.0 g, fibre 3.3, Ca 65.0 mg, Fe 6.0 mg, thiamine 0.3 mg, riboflavin 0.1 mg, nicotinamide 2.0 mg and 367 calories. Values are also given for other crops including *Cicer arietinum*, cowpea (*Vigna* spp), *Parkia* spp., *Vigna mungo*, *Cajanus sajan*, *goa bean* (*Psophocarpus tetragonolobus*), groundnut (*Arachis hypogaea*), sword bean (*Canavalia ensiformis*) etc.


A sample of seeds of Bambarra groundnut obtained from Bambey, Senegal was analyzed for its oil content. Physical and chemical properties of the oils are given. It contains 6.8% oil, whose fatty acid component is made up of 19.4, 11.8, 24.4, 34.2, 5.3 and 4.9% palmitic, stearic, oleic, linoleic, arachidic and behenic acids, respectively.


Analyses are given of the principal foodstuffs of vegetable origin in the Dutch East Indies including *Arachis hypogaea*, *Glycine max*, *Phaseolus radiatus* (= *Vigna radiata*), *Vigna sinensis* and *Voandzea subterranea*.

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E00 BOTANY, TAXONOMY AND GEOGRAPHICAL DISTRIBUTION


Morphological and biological features of V. subterranea are described, with information on some local West African varieties which fall into various groups according to their seed colour. The seeds may be spotted, as in Kloglo Apelou Kienzoa, or of one colour, whether white as in Kloglo Oufoe, red as in Kloglo Kokore or black as in Kloglo Ble. The stems and leaves are fed to cattle, while the seeds are boiled or made into soup.


A choro-ecological hypothesis based on a critical study of non-organographic data at the generic level comprising new observations in areas such as palynology, dermatology, blastology and flavonoid chemistry was adopted in the classification of the Phaseoleae into three subtribes - Cajalinæ, Glycininæ and Phaseolinae. Voandzeia subterranea was classified under the Phaseolinae-Phaseolæstræ.


A brief botany of Bambarra groundnut, including its distribution and usefulness, is given. Used mainly for human consumption and livestock feed.


The pollen of Voandzeia subterranea was found to be similar to that of Vigna ampestris but could still be clearly distinguished.


The botany of the Bambarra groundnut is described. It was introduced into Brazil in the 17th century and later to the Philippines and Indonesia.
Bambarra groundnut (Voandzeia subterranea) has its probable centre of origin in Africa. It has been found in Madagascar, Southern Asia, on the banks of the Nile from Khartoum to Gondokoro and in Brazil.

This annotated list of plants included Bambarra groundnuts (Voandzeia subterranea), pigeon peas (Cajanus indicus = C. cajan) and dolichos bean (Lablab purpureus).

Bambarra groundnut, Voandzeia subterranea is a subtropical annual herb that grows well in moist and dry habitats. Diploid chromosome number of 22 and an African centre of diversity is recorded for it. It requires a pH of 4.3-6.3, annual precipitation (mm) 5-33 and an annual temperature of 19-27°C. Values for Cajanus cajan, Canavalia ensiformis, Dolichos lablab = Lablab purpureus, Glycine sp., Phaseolus sp., Psophocarpus tetragonolobus and Vigna sp. are also reported.

The botany of the subterranean Bambarra groundnut is described.

The botany of Bambarra groundnut is discussed.

Voandzeia subterranea Thou. is a widely cultivated tropical African crop of Madagascar origin. The botany of the crop is briefly described.

Bambarra groundnut, (Voandzeia subterranea) seeds have a low oil but a high starch and protein content. The botany of the crop is briefly described. West Africa is given as its
center of origin. Brief notes are also given on pigeon pea, some Phaseolus species, cluster bean, winged bean and the Kerstingia gecarpa.


The cultivation and botany of the Bambarra groundnut are discussed including its similarity with the ordinary groundnut (Arachis hypogaea). Some of the various common and native names of the crop are also given. Nitrogenous nodules were found on the small fibrous root in fair quantities.


The botany of the plant is described. The pods, which develop underground, are widely eaten. It is native to Africa where it is usually cultivated.


The book gives a botanical description with keys for the determination of genera and species of 126 genera and 450 species of Leguminosae with notes on their use, common names and geographical distribution. Among them are Voandzeia species.


Bambarra groundnut (Voandzeia subterranea) is second in importance to cowpea although not as widely distributed and there is little variation in the Northern Nigeria collection.


Voandzeia poissoni Chev. is a herbaceous tropical African bean eaten by natives of Dahomey. V. subterranea Thou. is an annual herb of uncertain origin, probably from tropical Africa. It is extensively cultivated, its fruits ripen in the ground like those of Arachis hypogaea L. and the seeds are consumed as food by the natives of Africa.
E01 HISTORY, ORIGIN AND EVOLUTION


Bambarra groundnut (Voandzeia subterranea) seeds are edible by man and Madagascar is regarded as the centre of origin.


Seeds of V. subterranea introduced into Argentina from Australia in 1951 germinated well. A morphological and histological description is given of this plant as well as notes on seed germination.


Voandzeia subterranea occurs both wild and in cultivation in Senegambia.


A survey was undertaken to determine the location of primitive cultivars of sorghum, millets, barley, wheat, African rice, cowpeas and Voandzeia, and when possible to obtain information on their genetic characteristics and the degree of genetic erosion present in these regions. Reports that wild or cultivated forms of Voandzeia are present in Botswana, Cameroon, Chad, Dahomey, Ethiopia, Ghana, Ivory Coast, Malawi, Mali, Nigeria, Rhodesia, Tanzania, Uganda, Upper Volta, Zaire and Zambia.


An account of the finding of Voandzeia subterranea and Kerstingiella geocarpa is given and reasons stated for the belief that they grow wild in North Eastern Nigeria-North Cameroon region. Notes on the seed-types and their germination are given.


New facts on the Bambarra groundnuts since Harm's work of 1912 are reported. The samples studied are from Yola Garoua, Oubangui and Adamawa, all in the Cameroun.

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On page 507, Bambarra ground-bean (*Voandzeia subterranea*) is said to be a native of N'Yemo and a good drought resister but small yielde.


Briefly described is the introduction and cultivation of Bambarra groundnut and its use as human food.


Wild Bambarra groundnut, *Voandzeia subterranea* subsp. *spontanea* can be found from the Jos Plateau and Yola (northern Nigeria) to Cameroun and possibly to the Central African Republic. It differs greatly from the subsp. *subterranea* which has a clustered habit with short nodes, in having diffuse growth and more scattered pods. Both have chromosome number 2n=22.


Morphological differences between *Kerstingella geosarqa* and *Voandzeia subterranea* are noted. The simultaneous discovery of the wild form of *Voandzeia subterranea* in August, 1909 by Dr. Dalziel in the Kilba country, north of Yola and close to the frontier of German Adamaua, and by C. Ledermann, near Garua in German Adamaua is also reported.


Briefly mentions the fact that *V. subterraneam* Thou. is a tropical African crop of Madagascar origin. Its young fruit is buried in the ground like those of *Arachis*, the seed is edible and the plant is largely cultivated.

ZEVEN, A.C. and ZHUROVSKY, P.M. 1975. *Voandzeia subterranea* Thouars. In: *Dictionary of cultivated plants and their centres of diversity, excluding ornaments, forest trees and lower plants*. Wageningen, Centre for Agricultural Publishing and Documentation, p. 120.

Bambarra groundnut (chromosome number 2n=22) occurs wild in Africa, and is distributed throughout Africa from where it later spread to America and Asia.
In 27 local varieties of Bambara groundnut, there was some association between the number of days from sowing to germination, earliness, internode length, petiole length, number of stems/plant, terminal leaf area, shell thickness, number of pods/plant, number of seeds/pod, seed size and yield of seeds/plant. Fifty-five coefficients show the degree of correlation between 11 agronomic characters. Yield was highly significantly and positively correlated with days to first germination and maturity, number of pods/plant, number of seeds/pod, and 100 seed weight, and negatively correlated with the other characters. Although yield is highly correlated with all 10 characters, earliness in germination and maturity, number of pods/plant, number of seeds/pod, number of stems/plant and seed size appear to be the best criteria for selection.

Agronomic parameters of 14 local cultivars of Bambara groundnut ranging in plant habit from bunch to semi-bunch, were correlated with yield. Days to maturity, number of pods/plant, number of seeds/pod and 100-seed weight were very highly correlated with yield, the coefficients in all 14 cvs. being greater than 0.8. Days to first germination, petiole length and number of stems/plant were highly correlated with yield, these correlations being greater than 0.7 but less than 0.8. In terminal leaf area and shell thickness, correlations of less than 0.5 were observed.

At Kataba valley substation in the Western Province, local cultivars far out-yielded imported varieties. At Sesheke, Bambara groundnuts gave practically no yield in the drought season. Leaf spot of Voandzeia caused by Phyllosticta sp. were recorded for the first time.

At Kataba, emergence and early growth of 20 selections of Bambara groundnut was good although infection by Ceratocystis leaf spot and Elatinoe (scab) together with a poor climate resulted in poor yields. At Lusitu, planting on the flat in the wet season gave good results probably because of good drainage. Other crops tested include lima bean, pigeon pea, mung bean, winged bean, velvet bean, cowpeas, groundnuts and soybeans.
Varietal characters and the cultivation of crops of secondary importance grown in Sudanese region of French Africa, are described. These crops include *Vigna sinensis*, *Dolichos lablab (=lablab purpureus), Voandzeia subterranea* etc. In some cases, mention is made of ways in which breeders could improve these crops.

**FO1 BREEDING AND SELECTION**


The varieties of *Voandzeia subterranea* in Ghana, including source and year of introduction and station where kept are reported in tabular form.


Seeds of a species of earthnut received from Mr. R. Echlin, of Gatton are being tested. The native African name of the seeds is "Masubla" and its usefulness as human food was proved after the nuts were used to sustain a native on a 100-mile journey. Available information on the crop contained in Bulletin No. 21 of the "Agricultural News" (Barbados) is presented.


The principal food crops grown in the Sahel, Sudan and Guinea (French Africa) are reviewed and the possibility of improving them through selection is examined. These crops include (*Vigna catjang* = *V. unguiculata cylindrica*), lima bean, hyacinth bean (*Dolichos lablab* = *lablab purpureus*), Kersting's groundnut (*Kerstingiella guiana*) and Bambarra groundnut (*Voandzeia subterranea*).


From observations on 27 types of Bambarra groundnut in the Legon collection (nine each with bunch, semi-bunch and open habit), it was concluded that the cultivated *Voandzeia subterranea var. subterranea* originated from the wild *V. subterranea var. spontanea* through a series of gradual changes, which are still taking place. These changes include change from open to bunch habit, change from outbreeding to inbreeding, and a reduction in shell thickness and in leaf area.
Seed yield of Bambarra groundnut is usually between 300 and 800 kg/ha.

In selection trials at Kiyaka Experimental station, the yields of varieties of Bambarra groundnuts, (Voandzeia subterranea) ranged from 1725 to 1792 kg of seed/ha. In cultivation trials, the highest yields were obtained from sowing at a depth of 3-6 cm.

From a red kernelled sample, chosen from some ten distinct types originally mass selected on kernel appearance ranging from cream to deep purple, some 120 single plant selections were made and progeny rowed. Within the progeny rows there was no variation in foliage, pod or kernel characters but there were obvious differences between the rows, which included variation in plant size and amount of anthocyanin intensity in leaves and stems. Other crops under the minor legumes section include chickpea, cowpea, lima beans and velvet beans.

Trial reports on groundbeans (Voandzeia subterranea), cowpeas, chickpeas and guar are given under the Minor legumes section (p. 111-113). Yields of seven varieties of groundbeans varied from 363-1196 lb/ac shelled beans. Mbawa D was the highest yielder and Mbawa A, the lowest.
Trial reports on groundbeans (Voandzeia subterranea), cowpeas, chickpeas and grams are given under the Minor legumes section (p. 119-122). The trial on groundbeans, conducted at Tuchila, gave extremely low yields despite a basal dressing of 200 lb/ac single superphosphate and 100 lb/ac sulphate of ammonia. Mean germination percentage was 63%, and Mbawa C was the highest yielder with 484 lb/ac.

Good yields were obtained from nine groundbean varieties tested, the mean yield being 1852 lb/ac. Barotseland selection was the highest yielder with 2797 lb/ac. This crop is extremely well adaptable and resistant to many pests and diseases. There is a wide range of seed coat colour enhancing the attractiveness of this large, round seeded legume, which appears ideal for canning. It is a popular food crop in Africa. Other crops reported include groundnuts, pigeon peas, jack beans, guar, soybeans, beans (Phaseolus spp.) dolichos, velvet beans and cowpeas.

Due to unfavourable weather conditions, yields of groundbeans (Voandzeia subterranea) were low, the highest yielding variety gave 978 lb/ac which was 41% of its yield in the previous season. The crop is a high yielding one and presents a good gene pool for selection towards the production of stable varieties. Other crops reported include velvet beans, beans (Phaseolus spp.) and soyabean.
Yield studies with nine groundbean varieties indicated no significant difference between established varieties and the selections from Tuchila and Mbawa (Malawi) but these were all significantly different from the Chitedze selection. The yields of all varieties were relatively low due to adverse environmental conditions. Yellow and tan seeded varieties are very stable but the purple seeded varieties tended to resegregate.

Seven selections of groundbeans, based on the color of the seed coat, were tested. Yield data indicated differences between types. Types with purple seed coats were relatively unstable and resegregated into a series of shades ranging from dark purple to light pink. Types with tan, red, brown and yellow (black eyed) seed coats were stable and bred true to type.

Yields of 25 varieties ranged from 596-1615 lb seeds/ac, the highest being for the local variety Kasholishoro.

**F02 CYTOLOGY AND CYTOGENETICS**

Observation on the meristem, radicle and morphology of the 22 chromosomes of two varieties of Bambarra groundnuts, one with red seeds and the other white, in Tchad are reported.

Lists the chromosome numbers in 36 tropical legume species which are used either as food and forage or as cover crops. The legumes include *Voandzeia subterranea*, *Phaseolus coccineus* Roxb. [= *Vigna unguiculata*], *P. radiatus* L. [= *Vigna radiata*], *Dolichos lablab* [= *Lablab purpureus*] and *Cajanus indicus* [= *C. cajan*], all of which have a chromosome number of 2n=22, and *Arachis hypogaea* L. var. Schwarz 21, 2n=40.

Voandzeia subterranea Thouars from the green house in Wageningen has a chromosome count of 2n=22. Information on chromosome numbers and source, of Cicer arietinum, Cajanus indicus (=C. cajan), Dolichos lablab (=Lablab purpureus), Glycine soja, Phaseolus calcaratus (Vigna umbellata), P. radiatus (=Vigna radiata), Sphenostylis holosericeae Harms and Arachis hypogaea, is tabulated.


Chromosome numbers of 37 plant species including grain legumes are reported. Bambara groundnut has a chromosome number of 2n=22. It is widely cultivated in Africa and its distribution extends to Senegal, Ivory Coast, Madagascar, Sudan and Chad.


Microscopic details of the testa and embryo of Voandzeia subterranea are given. True "pillar" cells are absent in V. subterranea.


The hypodermal layer of the testa of Voandzeia subterranea is one-layered, hour-glass shaped, 14-22 μ in height, 20 μ wide at the ends and 14 μ at the centre with smooth thickenings of anticlinal walls. The lumen is large and the intercellular spaces are lenticular. The testa (excluding hypodermis) is up to 300 μ thick with a thin cuticle. The epidermis is one layered, 100 μ in height, 8-14 μ thick and contains bands of thickenings. The parenchyma is many-layered and cells are somewhat flattened. Endosperm is usually scanty or absent. The "pillar" cells form a single layer in V. subterranea.
G00 INSECT PESTS AND CONTROL


Brief notes on the more important insect pests of vegetables in Malaya are given. Prodenia littura F. deposits large masses of eggs on the leaves of Bambarra groundnut, the larvae feeding together for a few days and then dispersing. Control measures recommended are picking off the egg masses by hand and spraying with lead arsenate while the larvae are still clustered together.


Apion sp. injured the developing pods of the earth nut (Voandzeia subterranea), in parts of Bukoba.


Apion (Piezotroachelus) ugandum, Wagn., is recorded as a very serious pest of Bambarra groundnut (Voandzeia subterranea), a most important food crop in the Bukoba district, Tanganyika Territory. The adults are found in the soil round the collar of the plants and oviposition takes place when the nuts or peas are well formed and beginning to harden.


Bambarra groundnuts (Voandzeia subterranea) were attacked by the jassid, Empoasca fabiata, Jac., and the crop is difficult to harvest owing to the slender peduncles which break when the plants are lifted with the result that most of the nuts are left in the soil.


About 60-60% of root nodules of groundnuts near Yangambi in the Congo (Zaire) were damaged by Dipteronous larvae of the genus Rivellia. Experiments with six species of legumes sown in alternate rows showed that Rivellia would attack cowpeas, Phaseolus aureus (=Vigna radiata), Voandzeia subterranea in addition to groundnuts, but neither larvae nor adults were found on Crotalaria longiflora or soybeans.


Apion (Piezotroachelus) ugandum, Wagn is reported on Bambarra groundnuts (Voandzeia subterranea).

Gives the results of a survey of methods used by farmers in Togo, Dahomey and Senegal for storing beans, groundnuts, sorghum millet, Kersting's groundnut and Bambarra groundnuts. Photographs of various rural storage structures are presented. Estimates of losses caused by insects are given and the effects of prices are discussed. Short-term and long-term recommendations for improvement are made.


Pests infesting stored products in Belgium included *Bruchus (Callosobruchus) maculatus* F., *B. tristis* and *B. refiriatus* var. *velutinus* Muls. and Rey in seeds of *Voandzeia subterranea*. An unidentified Chalcididae was found parasitizing *C. maculatus*.


Results from 1967 trials in various regions of West Africa confirmed those of 1966 with respect to the effective conservation of the germinating power of grains stored in carbon tetrachloride environment inside plastic bags.


Oviposition in *Callosobruchus subinnotatus* (Pic), a storage pest of Bambarra groundnuts, commences only when pods, in which a succession of generations develops are nearly dry. In laboratory culture, oviposition commenced within one day of emergence and a total developmental period of 6-7 weeks was recorded at room temperature. The adult beetle, with head extended is normally 4.5-5.5 mm long.


*Callosobruchus subinnotatus* (Pic), a storage pest of Bambarra groundnuts is widely distributed in the Kano, Zaria and Ibadan provinces of Nigeria. It produces several generations a year in dry pods only.

C. subinnotatus is a pest of stored seeds of the Bambarra groundnut, Voandzeia subterranea. Development was much slower on groundnuts than on Bambarra groundnuts.


A Bruchid from the seeds of Voandzeia subterranea in Ghana was provisionally identified as Bruchus vicinus var subinnotatus (F).


The beetle Bruchus vicinus var subinnotatus is a pest of Bambarra groundnut, from three to five insects being found in one seed.


The larvae of bruchids usually have a series of more or less closely related preferred food plants which include Bambarra groundnuts.

H00 PLANT PATHOLOGY


Late planting causes Ceroneoora on Bambarra groundnuts, and anthracnose and bacterial rot on cowpeas.


Disease incidence on Bambarra groundnuts is less than that of the common groundnut.
A one-page note on the important diseases and pests observed on Bambarra groundnut during the year which included *Cercospora* leaf spot, *Fusarium* wilt, virus rosette, nematode root knots and powdery mildew.

Morphological and anatomical studies of the development of the primary haustorium of the hemiparasite, *Alectra vogelii* on *Voandzeia subterranea* roots were discussed. Localized swelling of host root tissue occurs upon contact between parasite seedling and host, and several lateral roots originate in the swollen area.

**H01 FUNGI AND FUNGAL DISEASES**

An isolate of *Fusarium oxysporum* that caused wilt of the Bambarra groundnut (*Voandzeia subterranea*) in Tanzania was used to inoculate 44 different cultivars in numerous genera of plants. From host-plant reactions, the *Fusarium* from *Voandzeia* is thought to be a new forma specialis, *F. oxysporum* f. sp. *voandzeia*.

Bambarra groundnut (*V. subterranea*) has been widely affected by powdery mildew which the author names *Sphaerotheca voandzeiae*. The superficial hyphae measure about 7 μ in diameter and penetrate the epidermal cells. *Cercospora voandzeiae* causes a leaf spot of *V. subterranea*.

*Voandzeia subterranea* is attacked by *Phyllosticta voandzeiae* in Casamance and the French Sudan, and by *Corticium solani* in Casamance.
Bambarra groundnut is attacked by *Meliola vignae-gracilis* Hansf. & Deight, which forms a black mould-like coat on the leaf surfaces. *Rhizoctonia solani* may cause the destruction of all the above-ground parts of the plant in the wet season. *Phyllosticta* sp. also causes leaf spot in Bambarra.

An isolate of *Fusarium oxysporum* from Bambarra groundnut (*Voandzeia subterranea* Thouars) at Ukiriguru and another from cotton were tested for pathogenicity to three varieties of Bambarra groundnuts and one of cotton by root dip inoculation. Results showed that each isolate infected only the host species from which it originated and *Fusarium* wilt of *V. subterranea* is not caused by *Fusarium* sp. *vastiform*.

Symptoms of the wilt disease are described. Isolates UKP 218 and UKP 322 of *Fusarium* from the *Voandzeia* wilt were used in pot experiments to inoculate eight plants which included *Arachis hypogaea*, *Cajanus aajan*, *Cicer arietinum* cv CH/11, *Phaseolus vulgaris* cv ‘Selection 16’, *Vigna unguiculata* cv CP/17, and five cvs of *Voandzeia subterranea*. The isolates were pathogenic to *P. vulgaris*, *Vigna unguiculata* and *Voandzeia subterranea*. Only isolate UKP 218 infected *C. arietinum*. Results indicate a close affinity between *Voandzeia*-wilt *Fusarium*, and *Fusarium oxysporum f. sp. tracheiphilum*. Population of *V. subterranea* showed considerable variation in resistance to *Fusarium* wilt.

Late blight of Bambarra groundnut is caused by *Corticium solani*. The plants die before they reach maturity, the leaves and stems becoming dried out and brown. The disease is most common during the wet season in the forest zones and no control is economically practicable. A small but unimportant leaf spot is also caused by *Phyllosticta* sp.

*Voandzeia subterranea* is a host of the cowpea isolate of *Salerotiwn rolfsii*. Other hosts include cowpea, pigeon pea, groundnut, sword bean, soyabean, velvet bean, Lima bean and kidney bean.

*Phyllosticta voandzeia* nov. spec. forms ill-defined, irregular, circular, brownish-purple spots on living leaves of *Voandzeia subterranea*.
Among the diseases noticed was stem rot of *Voandzeia subterranea* caused by *Sclerotium rolfsii* Sacc. [=Corticium rolfsii].

Reports that the leaves of *Voandzeia subterranea* (‘mpandi’) on the Kampala plantations were attacked by an undescribed species of *Cercospora*.

A powdery mildew, mainly on the dorsal surface of the leaves, appeared on *Voandzeia subterranea* at Himayatsagar in 1963. The importance of this is stressed, in view of the attempts to use *V. subterranea* in the groundnut (*Arachis hypogaea*) breeding programme. Disease symptoms and morphology of the fungus are described.

The list of plant diseases include leaf spot on Bambarra groundnut (*Voandzeia subterranea*) caused by *Cercospora cainescens*.

**HO2 VIRUSES AND VIRAL DISEASES**

On pages 92-93, Bambarra groundnut viruses which caused a severe rosette disease of *Voandzeia subterranea* in Mwanza, Tanzania, are described.

In South Africa the host range of Alfalfa mosaic virus, White clover mosaic virus, Bean local chlorosis virus, isolated from *Crotalaria juncea*, *C. spectabilis* and *Phaseolus vulgaris*, respectively, includes *P. lunatus*, *Vigna mungo*, *V. sesquipedalis*, *V. unguiculata* (L) Walp and *Voandzeia subterranea* Thouars. The viruses are transmitted by mechanical sap inoculation and by *Aphis craccivora*. A bean mosaic virus strain isolated from *Phaseolus vulgaris* was also found on *V. subterranea*, *Vigna unguiculata* and *V. sesquipedalis* causing
a systematic chlorotic flecking on the young leaves of *Voandzeia subterranea* with the later ones developing a mottle with necrotic specks. Bean chlorotic ringspot virus was also isolated from *V. subterranea*.


An isolate of the cowpea mottle virus from Bambarra groundnut, *Voandzeia subterranea*, was carried in the seed of *V. subterranea* but not in that of cowpea. The *V. subterranea* isolate withstood dilution to 1/1000. An antiserum prepared to the cowpea isolate had precipitation end-points of 1/512 and 1/32 against the cowpea and *V. subterranea* isolates respectively.


Details of an isolate of cowpea mottle virus from Bambarra groundnut (*Voandzeia subterranea*) and a virus from cowpea called cowpea green mottle virus are given. Two seedborne viruses from cowpea were shown to be strains of cucumber mosaic virus and designated CMV-CSI and CMV-CS2.

**H03 NEMATODES AND NEMATODE DISEASES**


The paper lists all the root-knot-nematode-infected plants (including Bambarra groundnuts) found in the Federation in which specific identification of the parasites has been determined. Most of the records are of naturally occurring infections. *Meloidogyne javanica* attacked Bambarra groundnuts (*Voandzeia subterranea*) and the roots were almost totally covered with swellings. Heavy infestations of *M. javanica* were found in plants growing in apparently virgin situations.

Gives the nutritive values of cowpeas, dolichos and Bambarra groundnuts after cooking. The values for Bambarra groundnuts are: protein content 17.5%, growth value for rat 0.45 g/day, digestible N in vitro 21%, N retention 51% and a total nutritive value of 73%. Both cowpeas and Bambarra groundnut are very good sources of protein and are therefore valuable in nutrition programs to prevent Kwashiorkor.


Tables give the proximate composition, riboflavin and nicotinic acid/100 g and values of nine amino acids/16 g N of samples of Bambarra groundnuts (Voandzeia subterranea), hyacinth bean (Dolichos lablab = Lablab purpureus) and cowpeas (Vigna unguiculata) from Senegal. Protein content of cowpeas, lablab and Bambarra groundnuts is 23, 24.3 and 17.45%, respectively. The lipids in cowpea are about one-half to one-third those in Bambarra groundnuts. Proteins from all of these legumes are low in methionine (1.5, 0.65 and 0.95% for cowpeas, lablab and Bambarra groundnuts, respectively) and average lysine content is about 6.75, 6.95 and 8.2%, respectively. Autoclaving decreases nutritional value.


Nutritive values for groundnuts, including the Bambarra groundnuts are given.


The role of legumes and their botany, including cowpeas, pigeon peas, Bambarra groundnuts, chickpeas, broad bean, African locust bean, lima bean, green gram etc., in human nutrition are discussed. Bambarra groundnut is an annual crop maturing in 5-6 months after planting and its cultivation extends across tropical Africa and Madagascar. Together with chickpea, it has a fat content of about 4-6%. The nutritive value of the seeds, including amino acid content is tabulated.

V. subterranea contains an appreciable quantity of vitamin B1. In the raw state, it contained about half that of Phaseolus radiatus [=Vigna radiata] which, despite its higher vitamin content is eaten only reluctantly whereas V. subterranea is eaten with relish. V. subterranea also has a better protein, fat and carbohydrate ratio. Increased cultivation of the crop is advocated.


The paper mentions briefly that the important grain legumes consumed in Ghana in order of their popularity and extent of use are cowpea, Bambarra groundnut, yam bean, lima bean and chickpea. Of these, only cowpeas, Bambarra groundnuts and yam beans are used in appreciable quantities in the diet.


Bambarra groundnut (Voandzeia subterrana) has an extremely low content (less than 1% of the recommended dietary allowance [RDA]) of vitamins A and C, a low content (from 1-10% of RDA) of calcium and riboflavin, and a high content (from 10-100% of RDA) of calories, fibre, iron, niacin, phosphorus, protein and thiamine. Values are also given for adzuki bean, African locust bean, African yam bean, cowpea, ground bean, jack bean, lima bean, mungbean, peanut, pigeon pea, rice bean and sword bean.


In the Portuguese Oversea Territories there is generally a shortage of foodstuffs containing proteins and vitamins in appropriate quantities. In this respect Voandzeia can perhaps play a significant part. Together with Phaseolus, Vigna spp. and Arachis it belongs to the most often consumed leguminosae in Africa.


The biological values of cowpea, lablab, jack bean, groundnut and Bambarra groundnut are presented. The large, spherical ochre coloured seed of Bambarra groundnut which weighs 799.2 mg contains 2.33% total N, 12.00% moisture and 7.4% ash.
Lysine, methionine and tryptophan content, biological value and protein efficiency of groundnuts, haricot beans, lima beans, Bambarra groundnuts, lablab, pigeon pea, Kersting's groundnut, chickpea, cowpea and soybeans are compared. Values are from the F.A.O. tables of 1970.

The range of thiamine content and mean thiamine values of the jujube bean (*Voandzeia subterranea*) are 1.82-3.98 and 2.79 μg/g., respectively. The values for other legumes including groundnuts, soybeans, cowpeas, pigeonpeas, sword beans, lablab, kidney beans, lima beans, lentils, chickpeas, etc. are also given.

Notes that the proteins of peanuts, beans, peas, Bambarra nuts (*Voandzeia subterranea*), and green leaves are of high quality, and when these are consumed in sufficient quality there is little reason to expect the low consumption of animal proteins to cause trouble.

Bambarra groundnut, *Voandzeia subterranea* is solely reserved for domestic consumption in Madagascar. Other legumes discussed include groundnuts, soybeans, cowpeas, pigeon peas, mungbeans, urd and lablab.

The nutrient composition of 12 Ghanaian feeds was studied by chemical or microbiological determination of amino acids, B vitamins, Ca, P, gross energy, and the proximate principles. Digestibility coefficients for dry matter, energy, and protein were determined with adult male mice. The feeds included cowpeas and Bambarra nuts. Heating cowpeas and Bambarra nuts increased digestibility and protein utilization of the legumes which are generally low in Ca content.

Heating inhibited cowpea and Bambarra groundnut trypsin activity by 20.19 and 58.11%, respectively, and increased digestibility and protein utilization of the legumes.
The red-brown or nearly black seeds of *Voandzeia subterranea* are more palatable with less cooking than those which are pale in colour or mottled.

Chemical analyses of white Bambarra groundnut (*Voandzeia subterranea*) seeds from Legon gave 11.4% moisture, 424 calories of energy, 19.7% protein, 5.6% fat, 54.5% carbohydrate, 5.3% fibre, 3.5% ash, and mineral values of Ca, P and Fe/100 g edible portion were 108, 195 and 9.7 respectively. Corresponding values for red Bambarra groundnut seeds from Northern Ghana were: 5.5%, 430 calories 17.2%, 6.6%, 62.6%, 4.5%, 3.6% and 71, 185 and 9.4, respectively.

Canning of Bambarra groundnut is described under storage, sorting, soaking, blanching, filling, exhausting and processing. Bambarra groundnut should be dried to 13-15% moisture to ensure safe storage and the beans should be sorted by electronic machines according to size and colour. A soaking time of 24 h and the addition of sodium bicarbonate or "Kawe" to the soak-water if hard, and as a means of facilitating the softening of the beans are also suggested. A steam blanch of 115.6°C for 15 minutes and a water blanch of 93-99°C for 5-10 minutes are also suggested.

Summarises the various reports on the role of legumes, including cowpeas, *Voandzeia subterranea*, *Arachis hypogaea*, *Phaseolus lunatus*, *P. vulgaris*, *Sphenostylis stenocarpa*, *Canavalia ensiformis*, *Cajanus cajan* etc., in agriculture and human nutrition in various parts of Africa.
Notes that *Voandzeia subterranea* is an important African food crop of many varieties.

The seeds of *Voandzeia subterranea*, a widely cultivated legume of the South Guinea Savanna vegetation zone, are used as food by human beings and livestock. It ranks next to cowpeas as the most widely grown grain legume in Africa south of the Sahara. It is also a source of traditional religions artifact.

Results of agglutination tests with *Voandzeia subterranea*, *Phaseolus mungo* [=*Vigna mungo*], *P. maximus*, *Sphenostylis stenocarpa*, *Anachis hypogea* and some other crops are reported.

**SUPPLEMENT**

It is concluded that 750mm virus isolates from *Cassia, Voandzeia* and *Phaseolus lunatus* may be considered as host adapted strains of groundnut mottle virus.


Bambara groundnut, a crop indigenous to Africa, grows on the highly leached soils of Bukoga. Its cultivation is similar to that of groundnut, spacing 30cm x 30cm and its diseases and pests are not regarded as serious.


The first chapter summarizes agronomic, economic and nutritional data on groundnuts, pigeon peas, chickpeas, soybeans, Lablab purpureus, lentils, mung beans [Vigna radiata], Phaseolus lunatus, P. mungo [=Vigna mungo], P. vulgaris, peas, Vicia faba, cowpeas and Bambara groundnuts (Voandzeia subterranea). References are provided to sources of information on these and 15 other important grain legume species. The 2nd chapter identifies the insect genera and species that are important pests of grain legumes and the concluding chapter discusses the role of pest management in increasing production.


251 NIQUEUX, N. 1957. [Note on Voandzeia subterranea in the Chad]. Rapport de la service d'Agriculture du Tchad.


Tropical pulses discussed include the ground beans (*Voandzeia subterrina*), Kerstings groundnut, cowpeas, groundnuts, chickpeas, soybeans, lablab, *Phaseolus* sp., jack beans and pigeon peas. Botany and domestication, plant morphology, and pests and diseases of *V. subterrana* are discussed. *V. subterrana* has 2n=22 chromosomes.

The delineation of *Voandzeia* with *Phaseolus* shows that it cannot be maintained as a subsection since it comes close to the type *Vigna luteola* (Jacq.) Benth. and closest to *V. hosei* (Crab.) Backer which, incidentally is often geotropic. A proposal for the conservation of *Vigna* for *Voandzeia* is presented.
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