Review Article

ARACHIS HYPOGAEA MINE OF ESSENTIAL NUTRIENTS AND PHYTONUTRIENTS

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ABSTRACT

Arachis hypogaea belonging to legume family Fabaceae is found all over world. It is a rich source of niacin, protein, lipids, fatty acids, folate, fiber, magnesium, vitamin E, manganese, phosphorus, stilbenephytoalexins, stilbenoids, p-coumaric acid and phytosterols like β-Sitosterol, stigmesterol and campesterol. *Arachis hypogaea* is a good example of symbiotic association for nitrogen fixation. Peanuts are the host of fungi *Aspergillus flavus* and *Aspergillus parasiticus* are of particular agricultural significance due to their ability to produce carcinogenic aflatoxins.

Keywords: *Arachis hypogaea*, Polyphenols, Stilbenoids, Symbiotic association, *Aspergillus*.

INTRODUCTION

Arachis hypogaea, is a species in the legume family Fabaceae.[1] *Arachis* have seed containing pods, which mature underground. *Arachis hypogaea* is found all over world but mostly in Brazil, Bolivia, America.[2] Arachis hypogaea have two varieties, one is wild and other is cultivated.[3,4] The peanut was probably first cultivated in the valleys of Peru.[5] Peanut seeds are used diet in Africa and parts of Asia.[6,7]

Scientific Classification[1]

Kingdom : Plantae

Order : Fabales

Family : Fabaceae

Subfamily : Faboideae

Tribe : Aeschynomeneae

Genus : *Arachis*

Species : *hypogaea*

Morphology

Arachis hypogaea is a species in the bean family. It is an annual herbaceous plant growing 30 to 50 cm (1.0 to 1.6 ft) tall. The leaves are opposite, pinnate with four leaflets (two opposite pairs; no terminal leaflet), each leaflet 1 to 7 cm (⅜ to 2¾ in) long and 1 to 3 cm (⅜ to 1 inch) broad. The flowers are a typical peaflower in shape, 2 to 4 cm (0.8 to 1.6 in) (¾ to 1½ in) across, yellow with reddish veining. *Hypogaea* means "under the earth", after pollination, the flower stalk elongates causing it to bend until the ovary touches the ground. Continued stalk growth then pushes the ovary underground where the mature fruit develops into a legume pod, the peanut – a classical example of geocarpy. Pods are 3 to 7 cm (1.2 to 2.8 in) long, containing 1 to 4 seeds.[8]

Common names

Peanuts are known as earthnuts, ground nuts, goober peas, monkey nuts, pygmy nuts and pig nuts.[9-11]

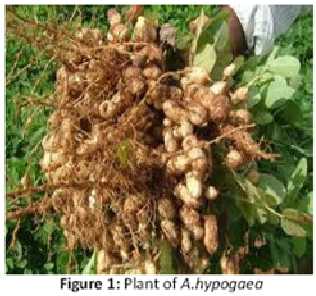


Figure 1: Plant of *A.hypogaea*

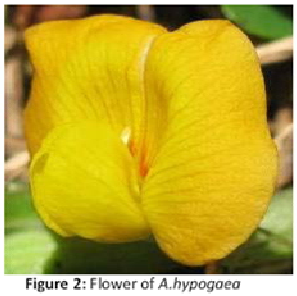


Figure 2: Flower of *A.hypogaea*


Figure 3: Fruits of *A. hypogaea*


Figure 4: Leaves of *A.hypogaea*

Symbiotic association in *Arachis hypogea*

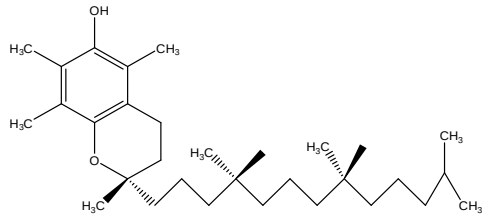
Arachis hypogaea is a well know species for symbiotic association occurs with rhizobia bacteria found in it which cause nitrogen fixation[1]. The mechanism of nitrogen fixation regulated by nitrogenase enzyme is present in these bacteria. [12] The effect of pesticides on nitrogen transformations in soils and effect on nitrogen transformations in wetland soils were reviewed by researcher.[12,13] For identification of the effect on nitrogenase activity for nitrogen fixation, residues of endosulfan were analyzed. The nitrogenase activity was continued but with increasing concentration of endosulfan, this activity gets completely stopped. Also different residual concentrations were used to determine the impact of higher concentrations of endosulfan on

Arachis hypogea. It is observed that the inhibitory effect was observed at (250 ppm) a very low concentration.[12,13]

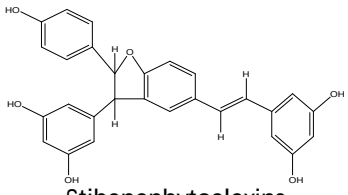
Peanuts are host of fungi *Aspergillus flavus* and *Aspergillus parasiticus* are of particular agricultural significance due to their ability to produce carcinogenic aflatoxins[20,21]. The peanut plant can resist fungal attacks by promptly producing stilbene-derived phytoalexins.[13-18]

Chemical constituents and Pharmacological activities of *Arachis hypogaea*

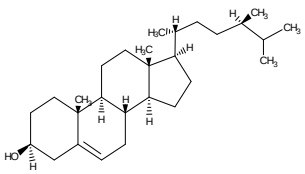
Peanuts are rich in nutrients, providing over 30 essential nutrients and phytonutrients. Peanuts are a good source of niacin[19], protein, lipids, and fatty acids.[6] folate, fiber, magnesium, vitamin E, manganese and phosphorus[20] stilbenephytoalexins[18,21-25] stilbenoids,[25-27, 58-64] p-coumaric acid. [28] They are also naturally free of trans-fats and sodium, and contain about 25% protein.[20] Peanuts are a significant source of resveratrol, a chemical associated with but not proven to cause a reduction in risk of cardiovascular disease and cancer.[29] The average amount of resveratrol in one ounce of commonly eaten peanuts is 73 µg.[30] Peanuts are a source of coenzyme Q10, as are oily fish, beef, soybeans and spinach.[31] They are a potential source of many micronutrients and bioactive constituents. Which are responsible for nutritional and physicochemical properties [32,33] Phytosterols are generally dominated by the chemically defined group 4-desmethylsterols, which have the same structural base as cholesterol but with one or two extra carbon atoms in the side chain. Whereas about 250 types of phytosterols are actually reported in the literature, nutrition research has focused mostly upon the unsaturated β-sitosterol, campesterol, and stigmasterol. Phytostanols, a fully saturated subgroup of phytosterols, are less abundant in nature than phytosterols and are not found in peanut kernels.[35-37]



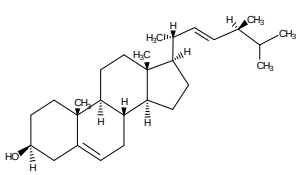
Vitamine E



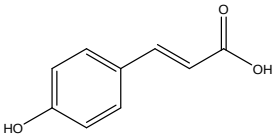
Stibenephytoalexins



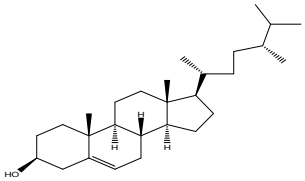
β-Sitsterol



Stigmesterol



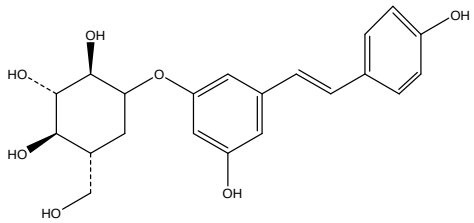
p-Coumaric acid



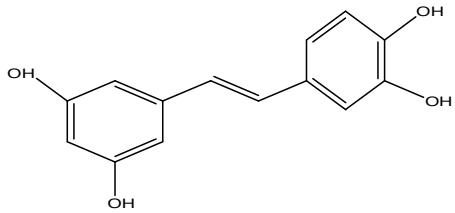
Campesterol

The results of the phytochemical screening carried out on the seeds of *Arachis hypogea* (Groundnut) showed the presence of useful phytonutrients. The results showed that *A. hypogea* showed the lowest yield of alkaloid (0.25%), saponin content (0.25%), flavonoids (0.18%) and tannins.[43]

Phenylpropanoid derivatives mainly stilbenes and flavonoids are found in this genus. These compounds are involved in a defense mechanism against physical injuries and microbial contamination. Indeed, the correlation between the concentration of several compounds and their effects on injuries or contamination has been fully reported.[65-74] The stilbenes that have been reported for several varieties from *A. hypogaea* in different organs from the plant, such as leaves, roots, and seeds, seem to be derived from trans-resveratrol, such as piceid,[37-39] isopentadienylresveratrol (IPD)[16] piceatannol, arachidin-1 arachidin-2, arachidin-3,[41-43] and trans-SB-1.[44]



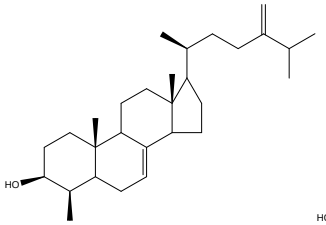
Piceid



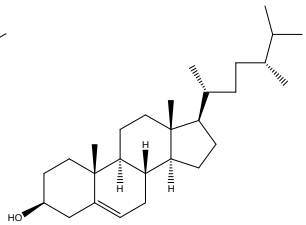
Piceatannol

Four new stilbene derivatives, termed arahypins, have been isolated from peanut seeds challenged by an *Aspergillus caelatus* strain, along with two known stilbenoids that have not been previously reported in peanuts. The structures of these new putative phytoalexins were determined by analysis of NMR, MS, and UV data. Together with other known peanut stilbenoids that were also produced in the challenged seeds, these new compounds may play a defensive role against invasive fungi.[45] *Arachis hypogaea* L. leaf aqueous extracts have received a long reputation in china as an abirritative remedy to ease various sleep disorders [46,47] and clinically validated by modernistic medical approaches[48,49]. However, many those researches only focus on the clinical effects, and relevant studies on their deep effect mechanisms are still lacking.

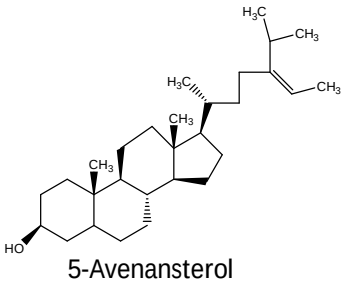
4-Desmethylsterols, the main component of the phytosterol fraction, have been analyzed during the development of Tunisian peanut kernels (Arachis hypogaea L.), Trabelsia (AraT) and Chounfakhi (AraC), which are monocultivar species, and Arbi (AraA), which is a wild species, by gas chromatography-mass spectrometry. Immature wild peanut (AraA) showed the highest contents of β-sitosterol (554.8 mg/100 g of oil), campesterol (228.6 mg/100 g of oil), and 5-avenasterol (39.0 mg/100 g of oil) followed by peanut cultivar AraC with β-sitosterol, campesterol, and 5-avenasterol averages of 267.7, 92.1, and 28.6 mg/ 100 g of oil, respectively, and similarly for AraT 309.1, 108.4, and 27.4 mg/100 g of oil, respectively, were found. These results suggest that, in immature stages, phytosterol contents can be important regulator factors for the functional quality of peanut oil for the agro-industry chain from plant to nutraceuticals.[45]



4-desmethylsterols



Campesterol



5-Avenansterol

The biochemical composition and some phytochemicals in the seeds of 4 groundnut (*Arachis hypogaea* L.) varieties viz., Golden, Barri 2000, Mongphalla and Mongphalli 334 cultivated in arid zones of Pakistan, were determined. The biochemical analysis included ash, crude fat, total nitrogen, proteins and sugar contents. A statistically significant difference ($p<0.05$) was observed among the varieties regarding the ash, crude fat, water soluble proteins, salt soluble proteins and sugar contents. The four groundnut varieties were also found to be significantly different ($p<0.05$) on the basis of phytochemicals analysed including tannins (822±3.78 to 903±4.45 mg/100g), saponins (438±2.12 to 480±2.30 mg/100g), non-protein nitrogen (1.33±0.03 to 1.56±0.02 mg/100g), hydrogen cyanide (40.80±0.32 to 42.82±0.75 mg/100g), total phenolic acids (218±2.11 to 256±2.02 mg/100g), total phosphorus (700±3.62 to 889±3.84 mg/100g) and phytic acid (572±4.37 to 714±3.74 mg/100g). The results obtained from the present studies could be a source of valuable information and a guideline for the food scientists, researchers and even the nut consumers not only in Pakistan but all over the world.[50]

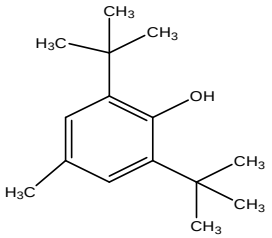
Eight medicinal plants were tested for their antimicrobial and antioxidant activities. Different extraction methods were also tested for their effects on the bioactivities of the medicinal plants. The plant were *Herba Polygonis Hydropiperis* (*Laliaocao*), *Folium Murraya Koenigii* (*Jialiye*), *Rhizoma Arachis Hypogea* (*Huashenggen*), *Herba Houttuyniae* (*Yuxingcao*), *Epipremnum pinnatum* (*Pashulong*), *Rhizoma Typhonium Flagelliforme* (*Laoshuyu*), *Cortex Magnoliae Officinalis* (*Houpo*) and *Rhizoma Imperatae* (*Baimaogen*) Extracts of *Cortex Magnoliae Officinalis* had the strongest activities against *M. Smegmatis*, *C. albicans*, *B. subtilis* and *S. aureus*. *Arachis hypogaea* demonstrated moderate antioxidant activity than other tested medicinal plants.[51]

Arachis hypogaea was screened for potential antibacterial activity against *Staphylococcus aureus*, *Staphylococcus epidermidis*, and *Staphylococcus subflava*. Antibacterial activity of aqueous and alcoholic extracts of *Arachs hypogaea* was performed by agar disc diffusion method and agar well diffusion method. The alcoholic extracts were more active than aqueous extracts. The most susceptible bacterium was *S. aureus*. The *in vitro* susceptibility testing of the studied *Staphylococcus* strains was done against standard antibiotics.[52]

A new pigmented, optically active, low molecular weight metabolite has been isolated from *Arachis hypogaea* challenged by four species of *Aspergillus*. The structure of the new compound, termed SB-1, was elucidated by analysis of 1H NMR, 13C NMR, and mass spectrometric data. The SB-1 molecule bears prenylated benzenoid and but-2-enolide moieties and represents an unusual class of compounds. The closest known analogue to SB-1 was isolated from heartwood of *Pericopsis elata*. Both *A. hypogaea* and *P. elata* belong to the family Leguminosae. The new metabolite was accumulated in different peanut genotypes challenged by five Aspergillus species and may be an important representative of a new class of peanut phytoalexins. SB-1 production often exceeds production of major known stilbenes.[53]

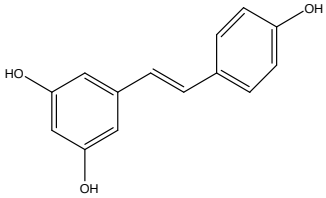
Peanut is a potent plant to be induced to synthesize bioactive stilbenoids. These stilbenoids and butylatedhydroxytoluene (BHT) were subjected to antioxidant characterization by various measures, all have exhibited varied potencies of antioxidant activity. In particular, retardation of absorbance increase at 234 nm as formation of the conjugated diene hydroperoxides in a real pork oil system, supplement of Ara-1 at 100 *i*M has shown equivalent or even greater activity than did BHT. When the media were supplemented with Res, Ara-1, Ara-3, and IPD at 15 *i*M for cultivation of mouse macrophage RAW 264.7 cells activated by lipopolysaccharide (LPS), the LPS-induced extracellular production of prostaglandin E2 (PGE2) and nitric oxide (NO) was significantly inhibited by Ara-1 ($p < 0.001$), Res ($p < 0.001$), Ara-3 ($p < 0.01$), and IPD ($p < 0.01$). It is noteworthy and of merit that all test stilbenoids have exhibited potent antioxidant and anti-inflammatory

activities and varied as affected by number of hydroxyl groups and isopentenyl or isopentadienyl moiety.[54]



Butylatedhydroxytoluene

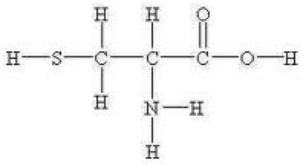
Both resveratrol and piceatannol are recognized as important ingredients in functional foods due to their beneficial health effects. However, unlike resveratrol, the piceatannol concentration in plants is very low. Thus, calluses of peanuts, an easily obtainable source, were chosen as the material to induce piceatannol production under controlled conditions. To induce resveratrol and piceatannol, calluses were exposed to the ultraviolet (UV) irradiation. Significant quantities of resveratrol and piceatannol were produced by calluses upon UV irradiation in both static and suspension culture conditions. In suspension culture, the amounts of induced piceatannol and resveratrol were somewhat lower. The quantities of induced piceatannol and resveratrol reached a maximum at 18 h after UV irradiation treatment in static culture. In contrast, the levels of resveratrol and piceatannol remained almost constant throughout the experiments in suspension culture. The piceatannol produced by calluses in all studies was much higher than the values reported in the literature, whereas the resveratrol produced was comparable to reported values.[55]



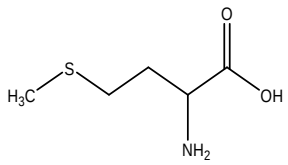
Resveratrol

Immunochemical activity of the *Arachis hypgaea* lectin has been equated, in spite of its different hapten combining requirements, with that of the human anti- T (Thomsen-Friedenreich) antibody population which is of importance in cancer immunology. The NN and MM antigens had about 50% of maximal activity toward the *Arachis* lectin. The slower appearance of T antigen upon graded desialation of MM antigen is likely due to the higher concentration of NeuAc and difference in some of its linkages on intact MM as compared to NN antigen.[56]

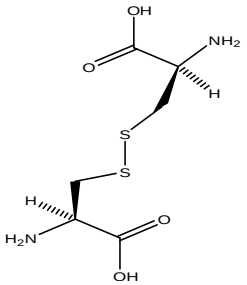
Peanut agglutinin was purified by affinity chromatography on Sepharose-c-aminocaproyl-B-D galactopyranosyl amine. The purified lectin obtained in a yield of 150 mg/IOO g of defatted peanut was homogeneous on polyacrylamide gel electrophoresis, ultracentrifugation. and gel filtration. The intrinsic sedimentation coefficient and the intrinsic diffusion coefficient were estimated at pH 7.4. The molecular weight of the agglutinin, determined by sedimentation and diffusion and by gel filtration, was found to be 110,000. Disc gel electrophoresis and gel filtration, both in the presence of sodium dodecylsulfate, gave a single component of M, = 27,500 suggesting that the lectin is a tetramer composed of four subunits. Four alanine residues per 110,000 g were found by NH,-terminal analysis and the sequence of the five NH,-terminal amino acids was: Ala-Glu-Ser-Val-Thr. Each cycle in a sequenator gave a single amino acid, suggesting that the four subunits are identical. Peanut agglutinin does not contain covalently bound sugar; it is devoid of cysteine and cystine, low in methionine, histidine, and tryptophan, but rich in acidic and hydroxyamino acids. Desialylated glycoproteins also reacted with the lectin to form precipitin bands in ouchterlony double diffusion in agar. Extracts of peanut (*Arachis hypogaea*) have been known for some time to agglutinate neuraminidase-treated human red blood cells. The agglutinin was designated “anti-T agglutinin” since it gave the same immunological reaction as the anti-T antibody of mammalian sera which is responsible for T-polyagglutination occurring in several bacterial and viral infections. In fact peanut extracts have been used for clinical determination of T-polyagglutinability, but no attempt has been made to obtain the lectin in pure, homogeneous form. Since the agglutinating activity of peanut extracts could be inhibited by galactose and by lactose, we tried to purify the lectin by affinity chromatography on a column of sepharose-c-aminocaproyl-p-galactopyranos-lamine previously prepared by us for the isolation of soybean agglutinin. Peanut agglutinin thus purified was obtained in a homogeneous form. In this paper we describe the procedure for the purification of peanut agglutinin as well as some of the physicochemical and biological properties of the purified lectin.[57]



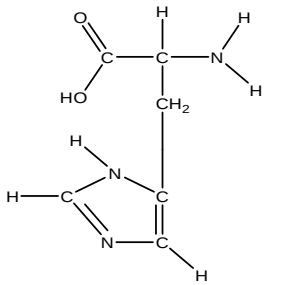
Cysteine



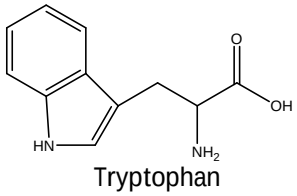
Methionine



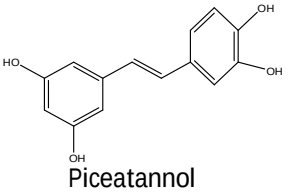
Cystine



Histidine



Tryptophan



Piceatannol

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