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REVIEW

PHENETHYLAMINE AND RELATED COMPOUNDS IN PLANTS

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Key Word Index—Algae; Fungi; Spermatophyta; food plants; phenethylamine; tyramine; dopamine; mescaline; adrenaline; ephedrine; derivatives; review.

Abstract—A comprehensive and up-to-date listing is provided of the distribution of phenethylamines in the Plant Kingdom. Such a listing is of importance because of their considerable physiological activity in higher animals. Their distribution in plants is also of some taxonomic interest.

Phenethylamine and *p*-hydroxyphenethylamine (tyramine) are found in many families throughout the plant kingdom. These amines and their derivatives may occur at quite high levels in certain species; for instance noradrenaline is found in *Portulaca oleracea* at 13 μmol/g fr. wt [1]. The range of structures is particularly

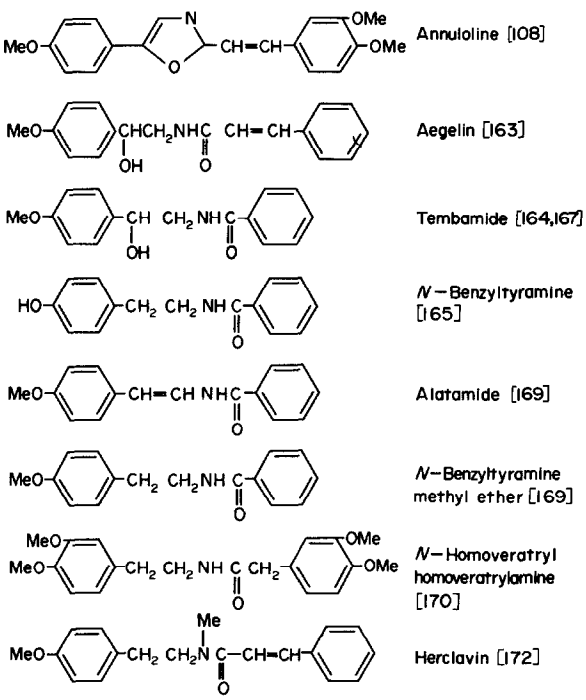


Fig. 1. Structures of phenethylamine conjugates.

wide in some plant families, notably in the Cactaceae and in the Leguminosae. It is likely that the distribution of these amines will be useful in chemotaxonomic studies [2–5]. In some cases, especially in the Rutaceae, these occur as conjugates with aromatic acids (denoted * in the Table, see Fig. 1). The biosynthesis of the phenethylamines in higher plants has been reviewed recently [6].

One reason for the importance of these compounds is due to their physiological activity in higher animals. The hormone adrenaline (epinephrine) and the transmitters in the sympathetic nervous system (noradrenaline, dopamine) are hydroxylated phenethylamines, collectively known as the catecholamines. Ingestion of these and related amines in food, especially by patients using monoamine oxidase inhibitors as anti-depressants, can induce significant physiological effects [7]. Potential food plants are marked + in the Table.

Mescaline, found in several cacti, is a powerful hallucinogen [8], and dietary phenethylamine may precipitate migraines [9]. Ephedrine is used in medicine for its properties as a hypertensive and bronchodilator. Synephrine, which is a stimulant and decongestant occurs in tangerines at levels which are high enough to be physiologically effective [10]. Hordenine is a diuretic and is a remedy for diarrhoea and dysentery [11], probably due to its antiseptic properties [12, 13]. Moreover the excretion of some of these amines is important in the diagnosis of certain diseases (e.g. phaeochromocytoma) and knowledge of their presence in food is needed for this reason.

No essential metabolic function for the phenethylamines in plants is established, though they are the precursors of a series of tetrahydroisoquinoline alkaloids found especially in the cacti. Like the uncommon amino acids [14] the phenethylamines may benefit the plant which produces them by acting as deterrents to insect predators and foraging animals and for this reason they may be of agricultural significance. Hordenine is a feeding repellent for grasshoppers [15], and the presence of phenethylamines in *Acacia* used as herbage may cause locomotor ataxia in sheep [17]. Moreover resistance of sugarbeet to the fungus *Cercospora beticola* may be related to the presence of dopamine [16].

The reliability of the methods used in characterizing the amines varies considerably. Early workers depended on elemental analysis and mp of the amines, with or without derivatization. Identification now often depends on PC or TLC R_f values, using as chromogenic reagent

Algae	*Ceramium rubrum*	Pe	[18]
	Cystoclonium purpureum	Pe	[18]
	Desmarestia aculeata	Pe	[18]
	Dumontia incrassata	Pe	[18]
	Monostroma fuscum	Dop	[19]
	Phyllophora nervosa (D.C.) Grev.	Hord	[20]
	Polyides rotundus	Pe	[18]
	Polysiphonia urceolata	Pe	[18]
Fungi	*Boletus edulis* Bull.	Pe; Tyr	[21]
	Boletus luteus L.	Pe	[22]
	Boletus zelleri Murr.	Tyr; Me–Tyr; Hord	[23]
	Claviceps purpurea (Fr) Tulasne	Pe; Tyr	[24–27]
	Coprinus atramentarius Bull.	Pe; Tyr	[28]
	Coprinus comatus Gray	Tyr	[29]
	Coprinus micaceus Bull.	Pe	[30]
	Fomes pini (Thore. ex Fr.) Overh.	Hord	[23]
	Inocybe patouillardi Bres.	Pe	[31]
	Marasmius peronatus Fr.	Pe	[32]
	Nematoloma fasciculare	Pe	[32]
	Phallus impudicus L.	Pe; Tyr	[33]
	Phlegmacium mellioleus	Pe	[32]
	Pholiota mutabilis	Pe	[32]
	Polyporus berkeleyi Fr.	Hord	[34]
	Polyporus sulphureus Bull. ex Fr.	Pe	[35]
	Polyporus spp.	Tyr; Me–Tyr; Hord	[23]
Amaryllidaceae	*Amaryllis vittata* Ait.	Tyr; Me–Tyr; Oct; Syn	[5]
	Crinum yuccaeflorum Salisb.	Tyr	[36]
	Crinum sp.	Tyr	[5]
	Eucharis grandiflora Planch.	Syn	[5]
	Haemanthus katharinae Baker	Tyr; Me–Tyr; Syn	[5]
	Hymenocallis americana Roem.	Tyr	[5]
	Pancratium maritimum L.	Tyr; Me–Tyr; Hord	[37, 38]
	Ungernia ferganica Vved.	Hord	[39]
	Ungernia trisphaera Bnge.	Hord	[40]
	Ungernia victoris Vved.	Hord	[41]
Anacardiaceae	*Schinus terebinthifolius* Raddi	Tyr	[5]
Araceae	*Arum maculatum* L.	Pe	[42]
	Colocasia antiquorum Schott. +	Tyr	[5]
Asclepiadaceae	*Vincetoxicum officinale*	Pe	[32]
Berberidaceae	*Nandina domestica* Thunb.	Tyr; Hord	[5]
Bignoniaceae	*Jacaranda acutifolia* Humb. & Bonpl.	Tyr	[5]
	Pyrostegia ignea Presl.	Tyr	[5]
Cactaceae	*Ariocarpus agavoides* (Castañeda) E. F. Anderson	Hord; 4-OH 3-MeO diMe–Pe; 3,4-diMeO Me–Pe	[43]
	Ariocarpus fissuratus (Eng.) Schumann	Me–Tyr; Hord; 3,4-diMeO Me–Pe	[44]
	Ariocarpus kotschoubeyanus (Lem.) Schumann	Me–Tyr; Hord	[45]
	Ariocarpus retusus Scheid.	Me–Tyr; Hord; 3,4-diMeO Me–Pe; 4-MeO Me-Pe	[46]
	Ariocarpus scapharostrus Bödeker	Me–Tyr; Hord; 3,4-diMeO Me–Pe; 3,4-diMeO diMe–Pe	[47]
	Ariocarpus trigonus (Web.) Schumann	Me–Tyr; Hord; 3,4-diMeO Me–Pe	[48]
	Azureocereus ayacuchensis Johns.	Tyr	[49]
	Carnegiea gigantea (Eng.) Br. & R.	Dop; 3-MeO 4-OH Pe; 3,4-diMeO Pe	[50, 51]
	Cereus aethiops Haworth	Tyr; Hord; Cand	[52]
	Cereus alacriportanus Pfeiff.	Hord	[53]
	Cereus forbesii O.	Tyr	[53]
	Cereus glaucus SD.	Tyr; Hord	[53]
	Cereus peruvianus (L.) Mill.	Tyr; Hord	[54]
	Cereus peruvianus-monstruosus DC.	Tyr	[53]
	Coryphantha bumamma (Ehrenberg) Br. & R.	Hord; 3,4-diMeO Me–Pe; 4-MeO Me–Pe	[55]
	Coryphantha calipensis H. Bravo	Me–Tyr; Hord; Normac; 3,4-diMeO Me Pe; 3,4-diMeO β-MeO Me–Pe; 3,4-diMeO β-MeO diMe–Pe	[55]
	Coryphantha cornifera (DC) Lem.	Me–Tyr; Hord; Syn; 4-MeO Pe; 4-MeO β-OH Pe; 3,4-diMeO Me–Pe	[56]
	Coryphantha cornifera (DC.) Br. & R. var *echinus* (Engelm.) Br. & R.	Me–Tyr; Hord; Syn; β-MeO Syn; 4-MeO Me–Pe;	[56]

Cactaceae (continued)	3,4-diMeO Me–Pe; Macrom; 4-MeO β-OH Pe	
Coryphantha durangensis (Rünge) Br. & R.	Me–Tyr; Hord; Syn; 3,4-diMeO Me–Pe	[56]
Coryphantha elephantidens Lem.	Me-Tyr; Hord; Syn; 3,4-diMeO Me–Pe; Macrom; 4-MeO β-OH Pe	[56]
Coryphantha greenwoodii H. Bravo	Hord; Normac; β-MeO Syn; 3,4-diMeO β-MeO Me–Pe; 3,4-diMeO Me–Pe; 3,4-diMeO diMe–Pe; 3,4-diMeO β-MeO diMe–Pe	[55]
Coryphantha macromeris var *runyonii* (Br. & R.) L. Benson	Me–Tyr; Tyr; Hord; Syn; Metaneph; Me–Metaneph; 4-MeO Me–Pe; 3,4-diMeO Me–Pe; Macrom; Normac; *N*-Formyl Normac	[57]
Coryphantha ottonis (Pfeif.) Lem.	Me–Tyr; Hord; Syn; 4-MeO Pe	[56]
Coryphantha pectinata (Engelm.) B. & R.	Me–Tyr; Hord; Syn; β-MeO Syn; 4-MeO Me–Pe; 3,4-diMeO Me–Pe; Macrom; 4-MeO β-OH Pe	[56]
Coryphantha poselgeriana (Dietr.) Br. & R.	Me–Tyr; Hord; Syn; 4-MeO Pe	[56]
Coryphantha radians (DC.) Br. & R.	Me–Tyr; Hord	[55]
Coryphantha ramillosa Cutak	Me–Tyr; Hord; Syn; β-MeO Syn; 4-MeO Me–Pe	[58]
Coryphantha vivipera (Nutt.) Eng.	Hord	[55]
Dolichothele longimamma (DC.) Br. & R.	4-MeO β-OH Me–Pe	[59]
Dolichothele sphaerica (Dietrich) Br. & R.	Me–Pe; Me–Tyr; Syn; β-MeO Syn; β-EtO Syn	[60]
Dolichothele surculosa (Boed.) F. Buxb.	Me–Pe; Me–Tyr; Hord; Syn	[61]
Echinocereus merkeri Hildm.	Hord; 3-MeO 4-OH Pe; 3,4-diMeO Pe; 3,4-diMeO Me–Pe; 3,4-diMeO diMe–Pe	[62]
Echinopsis eyriesii G. (Turpin) Zucc.	Hord	[53]
Echinopsis rhodotricha Schumann	Tyr; Hord	[63]
Gymnocactus aguirreanus Glass & Foster	Me–Pe; Me–Tyr; Hord	[64]
Gymnocactus beguinii (Web.) Backbg	Me–Pe; Me–Tyr; Hord	[64]
Gymnocactus horripilus (Lem.) Backbg.	Me–Pe; Hord	[64]
Gymnocactus knuthianus (Boed.) Backbg.	Me–Pe	[64]
Gymnocactus mandragora (Fric.) Backbg.	Me–Pe; Me–Tyr	[64]
Gymnocactus roseanus (Boëd.) Glass & Foster	Me–Pe; Me–Tyr; Hord	[64]
Gymnocactus viereckii (Werd.) Backbg.	Me–Pe	[64]
Gymnocalycium gibbosum (Haw.) Pfeiff	Mesc	[65]
Gymnocalycium leeanum (Hook.) Br. & R.	Tyr; Me–Tyr; Hord	[54]
Gymnocalycium schickendantzii (Weber) Br. & R.	Hord; Cand	[52]
Helianthocereus huascha (Weber) Br. & R.	Hord	[53]
Helianthocereus pasacana (Weber) Backbg.	Hord	[53]
Helianthocererus poco Backbg.	Hord	[53]
Lophophora diffusa (Croizat) Bravo.	Mesc	[3]
Lophophora williamsii (Lem.) Coult. = *Anhalonium lewinii* Hennings	Tyr; Me–Tyr; Hord; Cand; Dop; Epinine; 3, 4-diMeO Pe; 4-OH 3-MeO Pe; 3,4-diOH 5-MeO Pe; 3-MeO 4-OH Me–Pe; 5-OH 3,4-diMeO Pe; 4-OH 3,5-diMeO Pe; 3-OH 4,5-diMeO Me–Pe; 3-OH 4,5-diMeO diMe–Pe; Mesc; *N*-Me–Mesc; *N*-Formyl Mesc; *N*-Acetyl Mesc	[3, 13, 66–72]

Cactaceae (continued)

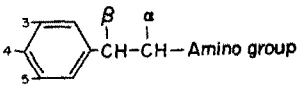
Mammillaria elongata DC.	Tyr; Me-Tyr; Hord; Syn; β-MeO Syn	[73]
Mammillaria heyderi Muehl.	3,4-diMeO Me–Pe	[43]
Notocactus ottonis (Lehm.) Berg. ex Backbg. & Knuth	Hord	[54]
Obregonia denegrii Frič	Tyr; Me-Tyr; Hord	[43]
Opuntia aurantiaca Lindley	Hord	[54]
Opuntia clavata Eng.	Tyr; Me-Tyr; Hord	[74]
Opuntia maldonadensis Arech.	Hord	[54]
Opuntia vulgaris Mill.	Hord	[54]
Pachycereus pectenaboriginum (Eng.) Br. & R.	3-OH 4-MeO Pe	[63]
Pelecyphora aselliformis Ehrenberg	Hord; 3,4-diMeO Pe; Me–Mesc; 3,4-diMeO Me–Pe; 3-OH 4,5-diMeO diMe–Pe; Mesc	[43, 63, 75]
Pelecyphora pseudopectinata Backbg.	Hord	[43]
Solisia pectinata Br. & R.	Me–Tyr; Hord	[43]
Stetsonia coryne (SD.) Br. & R.	Tyr; Mesc; Me–Tyr; Coryn; 3-MeO 4-OH Pe; 3,4-diMeO Pe	[63]
Trichocereus bridgesii (SD.) Br. & R.	Tyr; 3,4-diMeO Pe; 3-MeO 4-OH Pe; Mesc	[53]
Trichocereus camarguensis Card.	Me–Tyr; Tyr; 3,4-diMeO Pe; 3-MeO 4-OH Pe;	[53]
Trichocereus candicans (Gill) Br. & R.	Hord; Cand	[53]
Trichocereus chilensis (Colla) Br. & R.	Cand	[76]
Trichocereus courantii (Schu.) Backbg.	Tyr; Me–Tyr; 3-MeO 4-OH Pe; 3-MeO 4-OH Me–Pe; 3,4-diMeO Pe	[63]
Trichocereus cuzcoensis Br. & R.	Tyr; 3-MeO 4-OH Pe; 3-OH 4,5-diMeO pe; 5-OH 3,4-diMeO Pe; Mesc	[63, 72]
Trichocereus fulvilanus Ritt.	Tyr; Me–Tyr; Mesc	[63]
Trichocereus knuthianus Backbg.	Tyr; 3-MeO 4-OH Pe	[63]
Trichocereus lamprochlorus (Lem.) Backbg.	Hord; Cand	[53, 77]
Trichocereus macrogonus (SD.) Ricc.	Tyr; Mesc; 3,4-diMeO Pe; 3-MeO 4-OH Pe	[53]
Trichocereus manguinii Backby.	Tyr; Me–Tyr; Hord; 3-MeO 4-OH Pe	[63]
Trichocereus pachanoi Br. & R.	Tyr; Hord; 5-OH 3,4-diMeO Pe; 4-OH 3,5-diMeO Pe; 3,4-diMeO Pe; 3-MeO 4-OH Pe; Mesc	[53, 68, 78]
Trichocereus peruvianus Br. & R.	Tyr; 3-MeO 4-OH Pe	[53]
Trichocereus purpureopilosus Wgt.	Me–Tyr; Tyr	[63]
Trichocereus santiaguensis (Speg.) Backbg.	Tyr; Hord	[63]
Trichocereus schickendantzii (Web.) Br. & R.	Me–Tyr; Hord	[53]
Trichocereus skottsbergii Backbg.	Me–Tyr; Hord	[63]
Trichocereus spachianus (Lem.) Ricc.	Hord; Cand	[53]
Trichocereus strigosus (SD.) Br. & R.	Hord	[63]
Trichocereus taquimbalensis Card.	Hord; 3-MeO 4-OH Pe; 3,4-diMeO Pe; Mesc	[63]
Trichocereus terscheckii (Parm.) Br. & R.	Mesc; Trich	[53, 79]
Trichocereus thelegonoides (Speg.) Br. & R.	Hord	[63]
Trichocereus thelegonus (Web.) Br. & R.	Me–Tyr; Hord	[63]
Trichocereus tunariensis Card.	Tyr; Hord	[63]
Trichocereus validus (Manv.) Backbg.	Mesc	[63]
Trichocereus werdermannianus Backbg.	Tyr; 3,4-diMeO Pe; 3-MeO 4-OH Pe; 3,5-diMeO 4-OH Pe; Mesc	[53]
Turbinocarpus pseudomacrochele (Backbg.) F. Buxb. & Backbg.	Hord	[43]

Cactaceae (continued)			
	Wigginsia erinacea (Haw.) D. M. Porter	Hord	[54]
	Wigginsia macrocantha (Arech.) D. M. Porter	Hord	[54]
	Wigginsia tephracantha (Link & Otto) D. M. Porter	Hord	[54]
Cannabinaceae	*Cannabis sativa* L.	Hord	[80]
Caprifoliaceae	*Lonicera maackii* Maxim.	Pe	[42]
	Sambucus canadensis L.	Tyr	[5]
	Virburnum lantana L.	Pe	[42]
	Virburnum odoratissimum Ker.	Tyr	[5]
Celastraceae	*Catha edulis* Forsk.	Eph; NorψEph	[81]
Chenopodiaceae	*Anabasis jaxartica* (Bge.) Benth.	Me–Tyr	[82]
	Arthrophytum leptocladum M. Pop.	Me–Pe	[83]
	Beta vulgaris L. +	Dop	[16, 84]
	Halostachys caspica	Halos	[85]
	Haloxylon salicornicum (Moq.-Tand.) Boiss.	Tyr; Me–Tyr; Syn	[86]
	Spinacia oleracea L. +	Dop; Tyr	[87, 88]
Compositae	*Aster linariifolius* L.	Tyr	[5]
	Silybum marianum (L.) Gaertn.	Tyr	[89, 90]
Cornaceae	*Cornus alba* L. ssp *tatarica*	Pe	[32]
	Cornus sanguinea L.	Pe	[32]
Cruciferae	*Capsella bursapastoris* (L.) Medic.	Tyr	[91]
Cyperaceae	*Cyperus papyrus* L.	Tyr; Oct	[5]
	Cyperus rotundus L.	Oct	[5]
	Mariscus jamaicensis Crantz.	Tyr	[5]
Ericaceae	*Erica lusitanica* Rud.	4-MeO Pe	[92]
Euphorbiaceae	*Croton humilis* L.	Me–Tyr; Me–Homotyr	[93]
	Securinega virosa Baill.	Hord	[94]
Geraniaceae	*Erodium cicutarium* L.	Tyr	[95]
Gnetaceae	*Ephedra alata* Decne	Eph; ψEph	[96–98]
	Ephedra alenda (Stapf.) Andreanszky	ψEph	[97]
	Ephedra altissima Desf.	Eph; ψEph	[97]
	Ephedra americana Humb. & Bonpl.	Eph	[97]
	Ephedra andina Poepp.	Eph	[98]
	Ephedra californica S. Wats.	Eph; ψEph	[97]
	Ephedra distachya L.	Eph; ψEph	[97–99]
	Ephedra equisetina Bunge	Eph; ψEph	[97]
	Ephedra fragilis Desf.	Eph; ψEph	[97, 100]
	Ephedra gerardiana Wall.	Eph; ψEph	[97, 100, 101]
	Ephedra gracilis R. Phil.	Eph; ψEph	[97]
	Ephedra helvetica C. A. Mey.	Eph; ψEph	[97]
	Ephedra intermedia Schrenk & C. A. Mey.	Eph; ψEph	[97, 98, 101]
	Ephedra monosperma S. G. Gmel.	Eph; ψEph	[97]
	Ephedra monostachya L.	Eph; ψEph	[97]
	Ephedra nebrodensis Tineo	Eph; ψEph	[97, 101, 102]
	Ephedra nevadensis Wats.	Eph	[100]
	Ephedra pachyclada Boiss.	Eph; ψEph	[98, 100]
	Ephedra procera C. A. Mey.	Eph; ψEph	[97, 98, 103]
	Ephedra sinica Stapf.	Eph; ψEph; Me–Eph; Me–ψEph	[96–98]
	Ephedra triandra Tul.	Eph	[97]
	Ephedra trifurca Torr.	Eph; ψEph	[97]
	Ephedra tweediana C. A. Mey.	Eph	[97]
	Ephedra viridis Coville	Eph; ψEph	[97]
	Ephedra vulgaris L. C. Rich.	Eph; ψEph; Noreph; Me–Eph	[97]
Gramineae	*Hordeum murinum* L.	Hord	[104]
	Hordeum vulgare L. +	Tyr; Me–Tyr; Hord; Cand	[105, 106]
	Lolium multiflorum Lam.	Annuloline*; Oct	[107, 108]
	Panicum miliaceum L. +	Tyr; Me–Tyr; Hord	[109–112]
	Phalaris arundinacea L.	Hord	[113]
	Sorghum vulgare Pers. +	Hord	[109, 114]
	Triticum vulgare Vill. +	Me–Tyr; Hord	[106, 114]
	Zea mays L. +	Tyr	[115]
Juglandaceae	*Juglans nigra* L. +	Tyr	[5]
Labiatae	*Lamium album* L.	Tyr	[116]
Lauraceae	*Ocotea pretiosa*	Pe	[117]
	Persea americana Mill. +	Tyr; Dop	[88]
Leguminosae	*Acacia accola* Maiden & Betche	Pe; Me–Pe	[118]
	Acacia acinacea Lindl	Pe	[119]
	Acacia adunca	Me–Pe	[120]
	Acacia augustissima	Me–Pe	[17]

Leguminosae (continued)			
	Acacia berlandieri	Me–Pe; Tyr; Me–Tyr; Hord	[121, 122]
	Acacia buxifolia Cunn.	Pe	[119]
	Acacia cardiophylla	Pe	[118]
	Acacia constricta	Me–Pe	[17]
	Acacia cultriformis Cunn.	Pe	[123]
	Acacia floribunda Sieb.	Pe	[123]
	Acacia greggii	Me–Pe; Tyr	[17]
	Acacia harpophylla	Pe; Hord	[120]
	Acacia holoserica	Hord	[120]
	Acacia kettlewelliae Maiden	Pe; Me–Pe	[118, 120]
	Acacia longifolia Willd.	Pe	[123]
	Acacia lunata Sieb.	Pe	[123]
	Acacia podalyriaefolia Cunn.	Pe	[118, 123]
	Acacia praetervisa Domin.	Pe; Me–Pe	[118]
	Acacia pravissima F.v.M.	Pe	[123]
	Acacia prominens Cunn.	Pe; Me–Pe	[123, 124]
	Acacia prunosa Cunn.	Pe	[123]
	Acacia rigidula	Me–Pe; Me–Tyr	[17]
	Acacia roemeriana	Me–Pe; Tyr; Me–Tyr	[17]
	Acacia schottii	Me–Pe	[17]
	Acacia spectabilis Cunn.	Pe	[118]
	Acacia spriorbis Labill.	Hord	[123, 125]
	Acacia suaveolens Willd.	Pe	[123]
	Acacia texensis	Me–Pe; Tyr	[17]
	Acacia verticillata Willd.	Pe	[119]
	Albizzia adianthifolia (Schumack) W. F. Wight	Pe	[126]
	Albizzia julibrissin Durazz.	Noradr	[127]
	Alhagi pseudalhagi (Bieb.) Desv.	Pe; Me–Pe; Me–Tyr; Hord, Me–Mesc; Coryn; 3-MeO 4-OH triMe–Pe	[2, 128]
	Calliandra haematocephala Hassk.	Tyr	[5]
	Cassia alata L.	Tyr	[5]
	Cassia marilandica L.	Me–Pe	[17]
	Cytisus scoparius (L.) Link.	Tyr; Dop; Me–Dop; Epinine	[129]
	Dalea frutescens	Me–Pe	[17]
	Desmodium cephalotes Wall.	Pe; Tyr; Hord; Cand	[130]
	Desmodium gangeticum DC.	Me–Tyr; Pe; Hord; Cand	[131, 132]
	Desmodium gyrans DC.	Pe	[133]
	Desmodium tiliaefolium (G.) Don.	Tyr; di-MeO Pe; 3,4-diMeO diMe–Pe; 3,4-diMeO β OH Me–Pe	[134]
	Desmodium triflorum DC.	Pe; Tyr; Hord; Coryn	[11]
	Entada pursaetha DC.	Dop 3-*O*-glucoside	[135]
	Erythrina cristagalli L.	Tyr	[5]
	Gleditsia triacanthos L.	Me-Pe; Tyr	[17]
	Mimosa pudica L.	Noradr	[127]
	Phaseolus multiflorus Lam. +	Noradr	[127]
	Phaseolus radiatus L. +	Tyr	[136]
	Pisum sativum L. +	Tyr; Noradr	[127, 137]
	Prosopis alba Gris.	Tyr; Pe	[138]
	Prosopis glandulosa	Tyr; Me–Tyr	[17]
	Samanea saman Merr.	Noradr	[127]
	Trifolium alexandrinum L.	Tyr	[139]
	Vicia faba L. +	Epinine	[140]
Liliaceae	*Chlorophytum capense* Kuntze.	Tyr	[5]
	Cordyline terminalis Kunth.	Tyr	[5]
	Eremurus regelii Vved.	Hord	[141]
	Liriope spicata Lour.	Tyr; Oct	[5]
Loranthaceae	*Phoradendron* sp.	Tyr	[5]
	Phoradendron argentinum Urb.	Tyr	[142]
	Phoradendron flavescens Nutt.	Pe; Tyr; Hord	[143, 144]
	Phoradendron hieronymi Trel.	Tyr	[142]
	Phoradendron wattii Kr. & Urb.	Tyr	[145]
	Phoradendron liga (Gill.) Eichl.	Tyr	[142]
	Phoradendron villosum	Tyr	[146]
	Phyrgilanthus flagellaris (Cham. & Schlecht) Eichl.	Tyr	[142]
	Psittacanthus cuneifolius (Ruiz & Pav.) Blume.	Tyr	[142]
	Viscum album L	Pe; Tyr (?)	[144, 146, 147]

Magnoliaceae	*Magnolia* spp.	Tyr; Sal; Cand	[148–151]
	Michelia alba	Sal	[151]
Malvaceae	*Sida* sp.	Eph	[152]
	Sida cordifolia L.	Pe; Eph; ψEph	[153]
Moraceae	*Ficus bengalensis* L.	Syn	[5]
Musaceae	*Musa paradisiaca* L. +	Pe; Tyr; Noradr; Dop	[5, 88, 154, 155]
Nyctaginaceae	*Hermidium alipes* S. Watson	Dop	[156]
Orchidaceae	*Cattleya* spp.	Tyr	[157]
Papaveraceae	*Chelidonium majus* L.	Tyr	[158]
	Roemeria refracta DC.	Eph; ψEph	[159]
Passifloraceae	*Passiflora quadrangularis* L. +	Noradr	[127]
Piperaceae	*Piper amalago* L.	Dop	[145]
Plumbaginaceae	*Limonium vulgare* Mill.	Tyr	[160]
Portulacaceae	*Portulaca oleracea* L. +	Dop; Noradr	[1]
Rosaceae	*Crataegus* (3 spp.)	Pe	[42]
	Crataegus (8 spp.)	Pe	[32]
	Malus sp. +	Pe	[42]
	Prunus amygdalus Batsch. +	Pe	[161]
	Prunus domestica L. +	Tyr; Noradr	[88]
	Prunus padus L. +	Pe	[42]
	Pyrus communis L. +	Pe	[32]
	Rubus idaeus L. +	Tyr	[162]
	Sorbaria sorbifolia A. Br.	Pe	[32]
	Sorbus aucuparia L.	Pe	[32]
	Spiraea bracteata Zabel	Pe	[42]
Rutaceae	*Aegle marmelos* Corn.	Aegelin*; Tembamide*	[163, 164]
	Casimiroa edulis Llave & Lex. +	*N*-Benzyltyramine*	[165]
	Citrus limon Burm. +	Tyr; Me–Tyr; Syn; Oct	[10, 166]
	Citrus medica L. × *sinensis* Osbeck.	Tyr; Syn; Oct	[10]
	Citrus reshni Hort. ex. Tan. +	Tyr; Me–Tyr; Syn; Oct	[166]
	Citrus reticulata Blanco +	Tyr; Me–Tyr; Hord; Oct; Syn	[5]
	Citrus reticulata Blanco × *sinensis* Osbeck +	Tyr; Oct; Syn	[10]
	Citrus sinensis Osbeck +	Tyr; Me–Tyr; Syn; Noradr	[5, 88]
	Fagara spp.	Cand; Coryn; Tembamide*	[4, 167]
	Phellodendron amurense Rupr.	Cand	[168]
	Pleiospermium alatum (Wight & Arn.) Swingle	Alatamide*; *N*-benzyl 4-MeO Tyr*; *N*-Homoveratroyl-homoveratrylamine*	[169, 170]
	Teclea simplicifolia	4-MeO diMe–Pe	[171]
	Zanthoxylum clava-herculis L.	Herclavin*; Cand	[172, 173]
Saxifragaceae	*Philadelphus delavayi*	Pe	[32]
Solanaceae	*Aconitum napellus* L.	Eph; Tyr; Dop; Noradr	[174–176]
	Aconitum nasutum	*N*-Me–Adr	[177]
	Aconitum paniculatum Lam.	Noradr	[176]
	Atropa belladonna L.	Pe	[42]
	Capsicum frutescens L.	Oct.	[5]
	Nicotiana tabacum L.	Pe; Tyr	[178–180]
	Lycopersicon esculentum Mill. +	Tyr	[5]
	Solanum melongena L. +	Tyr	[88]
	Solanum tuberosum L. +	Dop; Noradr; Tyr	[88, 181]
Taxaceae	*Taxus baccata* L.	Eph	[182]
Theaceae	*Thea sinensis* L. +	Pe	[183]
Verbenaceae	*Stachytarpheta jamaicensis* Vahl.	Dop	[145]

ninhydrin, fluorescamine or dansyl chloride for the free amino groups, Dragendorff's reagent for methylated amino groups, and *o*-dianidisine, tetra-azotized benzidine, Pauly's, Gibb's or Folin's reagent for the hydroxylated amines. The amines may be separated by GC even without prior derivatization and R_f may be used as a means of identification. The most reliable structural assignments are based on additional physical data, including MS, IR and PMR.



Structures and abbreviations for the amines cited in the Table.

		3	4	5	β	α	Group
Phenethylamine	Pe	H	H	H	H	H	$-NH_2$
Me Phenethylamine	Me–Pe	H	H	H	H	H	–NHMe
DiMePhenethylamine	diMe–Pe	H	H	H	H	H	$-N(Me)_2$
Phenethylamine trimethylammonium hydroxide	triMe–Pe	H	H	H	H	H	$-N(Me)_3^+$
Tyramine	Tyr	H	OH	H	H	H	$-NH_2$
Me Tyramine	Me–Tyr	H	OH	H	H	H	–NHMe
Hordenine (anhaline)	Hord	H	OH	H	H	H	$-N(Me)_2$
Candicine	Cand	H	OH	H	H	H	$-N(Me)_3^+$
Dopamine	Dop	OH	OH	H	H	H	$-NH_2$
Epinine	Epinine	OH	OH	H	H	H	–NHMe
Coryneine	Coryn	OH	OH	H	H	H	$-N(Me)_3^+$
Salicifoline	Sal	OH	OMe	H	H	H	$-N(Me)_3^+$
Mescaline	Mesc	OMe	OMe	OMe	H	H	$-NH_2$
Me Mescaline	Me–Mesc	OMe	OMe	OMe	H	H	–NHMe
Trichocereine	Trich	OMe	OMe	OMe	H	H	$-N(Me)_2$
Halostachine	Halos	H	H	H	OH	H	–NHMe
Octopamine	Oct	H	OH	H	OH	H	$-NH_2$
Synephrine (oxedrine)	Syn	H	OH	H	OH	H	–NHMe
β-*O*-Methylsynephrine	βMe–Syn	H	OH	H	OMe	H	–NHMe
Noradrenaline (norepinephrine)	Noradr	OH	OH	H	OH	H	$-NH_2$
Adrenaline (epinephrine)	Adr	OH	OH	H	OH	H	–NHMe
Metanephrine	Metaneph	OMe	OH	H	OH	H	–NHMe
N-Methylmetanephrine	Me–Metaneph	OMe	OH	H	OH	H	$-N(Me)_2$
Normacromerine	Normac	OMe	OMe	H	OH	H	–NHMe
Macromerine	Macrom	OMe	OMe	H	OH	H	$-N(Me)_2$
Norephedrine Norpseudoephedrine* (cathine)	Noreph Norψeph	H	H	H	OH	Me	$-NH_2$
Ephedrine Pseudoephedrine*	Eph ψEph	H	H	H	OH	Me	–NHMe
Methylephedrine Methylpseudoephedrine*	Me–Eph Me–ψEph	H	H	H	OH	Me	$-N(Me)_2$

* Stereoisomers.

REFERENCES

1. Feng, P. C., Haynes, L. J. and Magnus, K. E. (1961) *Nature* **191**, 1108.
2. Ghosal, S., Srivastava, R. S., Bhattacharya, S. K. and Debnath, P. K. (1974) *Planta Med.* **26**, 318.
3. Todd, J. S. (1969) *Lloydia* **32**, 395.
4. Fish, F. and Waterman, P. G. (1972) *Phytochemistry* **11**, 3007.
5. Wheaton, T. A. and Stewart, I. (1970) *Lloydia* **33**, 244.
6. Smith, T. A. (1976) *Progress in Phytochemistry* 4, 27.
7. Strong, F. M. (1966) *Toxicants Occurring Naturally in Foods* Publ. 1354 p. 94, Nat. Acad. Sciences. Nat. Res. Council.
8. Kapadia, G. J. and Fayez, M. B. E. (1970) *J. Pharm. Sci.* **59**, 1699.
9. Chaytor, J. P., Crathorne, B. and Saxby, M. J. (1975) *J. Sci. Fd Agric.* **26**, 593.
10. Stewart, I. and Wheaton, T. A. (1964) *Florida State Hort. Soc. Proc.* **77**, 318.
11. Ghosal, S., Srivastava, R. S., Bhattacharya, S. K. and Debnath, P. K. (1972) *Planta. Med.* **23**, 321.
12. McCleary, J. A., Sypherd, P. S. and Walkington, D. L. (1960) *Econ. Botany* **14**, 247.
13. Rao, G. S. (1970) *J. Pharm. Pharmac.* **22**, 544.
14. Bell, E. A. (1976) *FEBS Letters* **64**, 29.
15. Harley, K. L. S. and Thorsteinson, A. J. (1967) *Can. J. Zoo.* **45**, 305.
16. Hecker, R. J., Maag, G. W. and Payne, M. G. (1970) *J. Am. Soc. Sugar Beet Technol.* **16**, 52.
17. Camp, B. J. and Norvell, M. J. (1966) *Econ. Botany* **20**, 274.
18. Steiner, M. and Hartmann, T. (1968) *Planta* **79**, 113.
19. Tocher, R. D. and Tocher, C. (1969) *Abstr. XI Int. Bot. Congr.*, p. 219.
20. Güven, K. C., Bora, A. and Sunam, G. (1970) *Phytochemistry* **9**, 1893.
21. Reuter, C. (1912) *Hoppe-Seyler's Z. Physiol. Chem.* **78**, 167.
22. Keil, W. and Bartmann, H. (1935) *Biochem. Z.* **280**, 58.
23. Lee, T. M., West, L. G., McLaughlin, J. L., Brady, L. R., Lowe, J. L. and Smith, A. H. (1975) *Lloydia* **38**, 450.
24. Burmann, J. (1912) *Schweiz Wsche Chem. Pharm.* p. 85.
25. Steiner, M. and Kamienski, E. S. (1955) *Naturwissenschaften* **42**, 345.
26. Kordts, D. and Voigt, R. (1961) *Scientia. Pharm.* **29**, 81.
27. Steiner, M. (1966) *Arbeitsgemeinschaft Forsch Landes Nordrhein-Westfalen* **161**, 7.
28. List, P. H. and Reith, H. (1960) *Arzneimitt.-Forsch.* **10**, 34.
29. List, P. H. (1958) *Arch. Pharm.* **291**, 502.
30. List, P. H. and Hetzel, H. (1960) *Planta Med.* **8**, 105.
31. List, P. H. and Müller, H. (1959) *Arch. Pharm.* **292**, 777.
32. Stein von Kamienski, E. (1957) *Planta* **50**, 315.
33. List, P. H. and Reinhard, C. (1962) *Arch. Pharm.* **295**, 564.
34. West, L. G., Johnson, I. T. and McLaughlin, J. L. (1975) *Lloydia* **37**, 633.
35. List, P. H. and Menssen, H. G. (1959) *Arch. Pharm.* **292**, 260.
36. Fowden, L. and Done, J. (1954) *J. Exp. Botany* **5**, 305.

37. Sandberg, F. and Michel, K.-H. (1963) *Lloydia* **26**, 78.
38. Sandberg, F. and Michel, K.-H. (1968) *Acta Pharm. Suec.* **5**, 61.
39. Israilov, E., Abduazimov, X. A. and Yunusov, S. U. (1965) *Dok. Akad. Nauk Uz. SSR* **22**, 18. (*Chem. Abstr.* **63**, 7346e).
40. Allayarov, K. and Abduazimov, K. A. (1970) *Problem. Osven. Pustyn-Akad. Nauk Turk. SSR* (1) 83.
41. Volodina, A. D., Dobronravova, E. K. and Shakirov, T. T. (1970) *Khim. Prir. Soed.* **6**, 450 (*Chem. Abstr.* **74**, 897a).
42. Hartmann, T., Ilert, H.-I. and Steiner, M. (1972) *Z. Pflanzenphysiol.* **68**, 11.
43. Bruhn, J. G. and Bruhn, C. (1973) *Econ. Botany* **27**, 241.
44. Norquist, D. G. and McLaughlin, J. L. (1970) *J. Pharm. Sci.* **59**, 1840.
45. Neal, J. M., Sato, P. T., Johnson, C. L. and McLaughlin, J. L. (1971) *J. Pharm. Sci.* **60**, 477.
46. Neal, J. M. and McLaughlin, J. L. (1970) *Lloydia* **33**, 395.
47. Bruhn, J. G. (1975) *Phytochemistry* **14**, 2509.
48. Speir, W. W., Mihranian, V. and McLaughlin, J. L. (1970) *Lloydia* **33**, 15.
49. Lee, T. M., McLaughlin, J. L. and Earle W. H. (1975) *Lloydia* **38**, 366.
50. Steelink, C., Yeung, M. and Caldwell, R. L. (1967) *Phytochemistry* **6**, 1435.
51. Agurell, S., Bruhn, J. G. and Sheth, K. (1972) *Biochemie und Physiologie der Alkaloide* (Mothes, K., Schreiber, K. and Schütte, H. R., eds.), p. 275. Akademie-Verlag, Berlin.
52. Ruiz, S. O., Neme, G., Nieto, M. and D'Arcangelo, A. T. (1973) *An. Asoc. Quim. Argent.* **61**, 41. (*Chem. Abstr.* **79**, 15842).
53. Agurell, S. (1969) *Lloydia* **32**, 206.
54. Vries, J. X. de, Moyna, P., Diaz, V., Agurell, S. and Bruhn, J. G. (1971) *Rev. Latino Americana Quim.* **2**, 21.
55. Bruhn, J. G., Agurell, S. and Lindgren, J. E. (1975) *Acta Pharm. Suec.* **12**, 199.
56. Hornemann, K. M. K., Neal, J. M. and McLaughlin, J. L. (1972) *J. Pharm. Sci.* **61**, 41.
57. Keller, W. J., McLaughlin, J. L. and Brady, L. R. (1973) *J. Pharm. Sci.* **62**, 408.
58. Sato, P. T., Neal, J. M., Brady, L. R. and McLaughlin, J. L. (1973) *J. Pharm. Sci.* **62**, 411.
59. Ranieri, R. L. and McLaughlin, J. L. (1976) *J. Org. Chem.* **41**, 319.
60. Dingerdissen, J. J. and McLaughlin, J. L. (1973) *J. Pharm. Sci.* **62**, 1663.
61. Dingerdissen, J. J. and McLaughlin, J. L. (1973) *Lloydia* **36**, 419.
62. McFarlane, I. J. and Slaytor, M. (1972) *Phytochemistry* **11**, 235.
63. Agurell, S., Bruhn, J. G., Lundström, J. and Svensson, U. (1971) *Lloydia* **34**, 183.
64. West, G. L., Vanderveen, R. L. and McLaughlin, J. L. (1974) *Phytochemistry* **13**, 665.
65. Ducloux, E. H. (1930) *Rev. Fac. Cienc. Quim.* **6**, 75. (*Chem. Abs.* **24**, 4077).
66. McLaughlin, J. L. and Paul, A. G. (1966) *Lloydia* **29**, 315.
67. Kapadia, G. J. and Fales, H. M. (1968) *Chem. Commun.* 1688.
68. Agurell, S. and Lundström, J. (1968) *Chem. Commun.* 1638.
69. Lundström, J. and Agurell, S. (1968) *J. Chromatog.* **36**, 105.
70. Lundström, J. (1971) *Acta Pharm. Suec.* **8**, 485.
71. Lundström, J. (1971) *Acta Chem. Scand.* **25**, 3489.
72. Lindgren, J. E., Agurell, S., Lundström, J. and Svensson, U. (1971) *FEBS Letters* **13**, 21.
73. West, L. G. and McLaughlin, J. L. (1973) *Lloydia* **36**, 346.
74. Vanderveen, R. L., West, L. G. and McLaughlin, J. L. (1974) *Phytochemistry* **13**, 866.
75. Neal, J. M., Sato, P. T., Howald, W. N. and McLaughlin, J. L. (1972) *Science* **176**, 1131.
76. Cortes, M., Garbarino, J. A. and Cassels, B. K. (1972) *Phytochemistry* **11**, 849.
77. Reti, L. (1950) (Cited by) *Fortschr. Chemie Org. Natur.* **6**, 242.
78. Crosby, D. M. and McLaughlin, J. L. (1973) *Lloydia* **36**, 416.
79. Reti, L. and Castrillón, J. A. (1951) *J. Am. Chem. Soc.* **73**, 1767.
80. El-Feraly, F. S. and Turner, C. E. (1975) *Phytochemistry* **14**, 2304.
81. Ristić, S. and Thomas, A. (1962) *Arch. Pharm.* **295**, 524.
82. Platonova, T. F., Kuzovkov, A. D. and Massagetov, P. S. (1958) *J. Gen. Chem. USSR* **28**, 3159. (Trans. by Consultants Bureau).
83. Yurashevskii, N. K. (1939) (cited in ref. 82) *J. Gen. Chem. USSR* **9**, 595.
84. Gardner, R. L., Kerst, A. F., Wilson, D. M. and Payne, M. G. (1967) *Phytochemistry* **6**, 417.
85. Men'shikov, G. P. and Rubinshtein, M. M. (1943) *J. Gen. Chem USSR* **13**, 801. (*Chem. Abs.* **39**, 1172).
86. Michel, K.-H. and Sandberg, F. (1968) *Acta Pharm. Suec.* **5**, 67.
87. Gewitz, H.-S. and Völker, W. (1961) *Z. Naturforsch.* **16b**, 559.
88. Udenfriend, S., Lovenberg, W. and Sjoerdsma, A. (1959) *Arch. Biochem. Biophys.* **85**, 487.
89. Ullmann, A. (1922) *Biochem Z.* **128**, 402.
90. Karaev, A. I., Alayev, P. K. and Rakhimov, A. K. (1954) *Izv. Akad. Nauk Azerbaidzhan SSR* No. 6, 71 (*Chem. Abstr.* **50**, 10988e).
91. Boruttau, Von H. and Cappenberg, H. (1921) *Arch. Pharm.* **259**, 33.
92. White, E. P. (1970) *N.Z. J. Sci.* **13**, 359.
93. Stuart, K. L. and Byfield, D. Y. (1971) *Phytochemistry* **10**, 460.
94. Iketubosin, G. O. and Mathieson, D. W. (1963) *J. Pharm. Pharmacol.* **15**, 810.
95. Eijk, Van J. L. (1957) *Pharm. Weekbl.* **92**, 581.
96. Abdel-Wahab, S. M., Hilal, S. H. and El-Keiy, M. A. (1960) *Egypt. Pharm. Bull.* **42**, 9.
97. Willaman, J. J. and Schubert, B. G. (1961) (cited by) Alkaloid bearing plants and their contained alkaloids. Agric. Res. Service USDA Tech. Bull. 1234.
98. Willaman, J. J. and Li, H.-L. (1970) (cited by) *Lloydia* (Suppl.) **33**, No. 3A.
99. Yamasaki, K., Tamaki, T., Uzawa, S., Sankawa, U. and Shibata, S. (1973) *Phytochemistry* **12**, 2877.
100. Boit, H. G. (1961) (cited by) *Ergebnisse der Alkaloid Chemie bis* 1960. Akademie-Verlag, Berlin.
101. Yamasaki, K., Fujita, K., Sakamoto, M., Okada, K., Yoshida, M. and Tanaka, O. (1974) *Chem. Pharm. Bull.* **22**, 2898.
102. Shah, C. S. and Shah, N. S. (1966) *Ind. J. Pharm.* **28**, 103.
103. Pelt, J. M., Junk, M. G. and Younos, M. C. (1967) *Plantes Med. Phytothér.* **1**, 130.
104. Raoul, Y. (1937) *C.R. Acad. Sci. Paris* **204**, 74.
105. Rabitzsch, G. (1959) *Planta Med.* **7**, 268.
106. McFarlane, W. D. (1966) *Am. Soc. Brew. Chem. Proc.* 184.
107. Hardwick, B. C. and Axelrod, B. (1969) *Plant Physiol.* **44**, 1745.
108. O'Donovan, D. G. and Horan, H. (1971) *J. Chem. Soc.* (Sect. C) 331.
109. Hashitani, Y. (1920) *J. Tokyo Chem. Soc.* **41**, 545 (*Chem. Abstr.* **14**, 3096).
110. Brady, L. R. and Tyler, V. E. (1958) *Plant Physiol.* **33**, 334.
111. Rabitzsch, G. (1958) *Planta Med.* **6**, 103.
112. Sato, H., Sakamura, S. and Obata, Y. (1970) *Agr. Biol. Chem.* (Tokyo) **34**, 1254.
113. Audette, R. C. S., Bolan, J., Vijayanagar, H. M., Bilous, R. and Clark, K. (1969) *J. Chromatog.* **43**, 295.

114. Hashitani, Y. (1924) *J. Coll. Agric. Hokkaido Univ.* **14**, 1.
115. Neumark, H. (1964) *Nature* **201**, 527.
116. Kwasniewski, Von V. (1959) *Planta. Med.* **7**, 35.
117. Gottlieb, R. and Magalhaes, M. T. (1960) *Bol. Inst. Quim. Agr.* No. 60, 7. (*Chem. Abstr.* **56**, 13027i).
118. White, E. P. (1957) *N.Z. J. Sci. Tech.* **38B**, 718.
119. White, E. P. (1951) *N.Z. J. Sci. Tech.* **33B**, 54.
120. Fitzgerald, J. S. (1964) *Australian J. Chem.* **17**, 160.
121. Camp, B. J. and Lyman, C. M. (1956) *J. Am. Pharm. Assoc.* **45**. 719.
122. Adams, H. R. and Camp, B. J. (1966) *Toxicon* **4**, 85.
123. White, E. P. (1944) *N.Z. J. Sci. Tech.* **25B**, 137.
124. White, E. P. (1954) *N.Z. J. Sci. Tech.* **35B**, 451.
125 Poupat, O. and Sevenet, T. (1975) *Phytochemistry* **14**, 1881.
126. Prista, L. N., Alves, A. C. and Silva, L. A. E. (1962) *Garcia de Orto* **10**, 93.
127. Applewhite, P. B. (1973) *Phytochemistry* **12**, 191.
128. Ghosal, S. and Srivastava, R. S. (1973) *J. Pharm. Sci.* **62**, 1555.
129. Tocher, R. D. and Tocher, C. S. (1972) *Phytochemistry* **11**, 1661.
130. Ghosal, S. and Mehta, R. (1974) *Phytochemistry* **13**, 1628.
131. Ghosal, S. and Bhattacharya, S. K. (1972) *Planta. Med.* **22**, 434.
132. Ghosal, S., Banerjee, P. K., Rathore, R. S. and Bhattacharya, S. K. (1972) *Biochemie und Physiologie der Alkaloid.* (Mothes, K., Schreiber, K. and Schütte, H. R. eds.). p. 107. Akademie:Verlag, Berlin.
133. Ghosal, S., Mazumder, U. K. and Mehta, R. (1972) *Phytochemistry* **11**, 1863.
134. Ghosal, S. and Srivastava, R. S. (1973) *Phytochemistry* **12**, 193.
135. Larsen, P. O., Pedersen, E., Sørensen, H. and Sørup, P. (1973) *Phytochemistry* **12**, 2243.
136. Kasai, T. and Sakamura, S. (1973) *J. Fac. Agr. Hokkaido Univ.* **57**, 153.
137. Miettinen, J. K. (1955) *Ann. Acad. Scient. Fenn.* **A2**, 520.
138. Graziano, M. N., Ferraro, G. E. and Coussio, J. D.)1971) *Lloydia* **34**, 453.
139. Neumark, H. (1962) *Nature* **195**, 626.
140. Piccinelli, D. (1955) *Boll. Soc. Eustachiana e Ist. Sci. Univ. Camerino* **48**, 105. (*Chem. Abstr.* **53**, 8372a).
141. Akramov, S. T. and Yunusov, C. U. (1961) *Dok. Akad. Nauk. Uz. SSR* (No. 2) p. 34. (*Chem. Abstr.* **61**, 960d).
142. Graziano, M. N. Widmer, G. A., Coussio, J. D. and Juliani, R. (1967) *Lloydia* **30**, 242.
143. Crawford, A. C. and Watanabe, W. K. (1914) *J. Biol. Chem.* **19**, 303.
144. Ostenberg, Z. (1915) *Proc. Soc. Exp. Biol. Med.* **12**, 174.
145. Durand, E., Ellington, E. V., Feng, P. C., Haynes, L. J., Magnus, K. E. and Philip, N. (1962) *J. Pharm. Pharmac.* **14**, 562.
146. Crawford, A. C. and Watanabe, W. K. (1916) *J. Biol. Chem.* **24**, 169.
147. Leprince (1907) *C.R. Acad. Sci.* (*Paris*) **145**, 940.
148. Matsutani, H. and Shiba, T. (1975) *Phytochemistry* **14**, 1132.
149. Nakano, T. (1954) *Pharm. Bull.* **2**, 321.
150. Nakano, T. and Uchiyama, M. (1956) *Pharm. Bull.* **4**, 409.
151. Yang, T. H., Lu, S.-T. and Hisao, C.-Y. (1962) *Yakagaku Zasshi* **82**, 811. (*Chem. Abstr.* **58**, 7991)
152. Dutta, T. (1963) *Bull. Reg. Res. Lab. Jammu, India,* **1**, 178. (*Chem. Abstr.* **60**, 9600d).
153. Ghosal, S., Chauhan, R. B. P. S. and Mehta, R. (1975) *Phytochemistry* **14**, 830.
154. Deacon, W. and Marsh, H. V. (1971) *Phytochemistry* **10**, 2915.
155. Askar, A., Rubach, K. and Schormüller, J. (1972) *Chem. Mikrobiol. Technol. Lebens.* **1**, 187.
156. Buelow, D. W. and Gisvold, O. (1944) *J. Am. Pharm. Assoc.* 33, 270.
157. Maille, M. and Morel, M. G. (1974) *C.R. Acad. Sci. Paris Sér. D* **278**, 2217.
158. Kwasniewski, V. (1958) *Pharmazie* **13**, 363.
159. Konowalowa, R., Yunousoff, S. and Orekhoff, A. N. (1939) *Bull. Soc. Chim. France* **6**, 1479.
160. Larher, F. (1974) *C.R. Acad. Sci. Paris Ser. D.* **279**, 157.
161. *Merck Index* (1968) (cited in) 8th ed. Merck, Rahway N.J., U.S.A.
162. Coffin, D. E. (1970) *J. Assoc. Offic. Anal. Chem.* **53**, 1071.
163. Chakravarti, R. N. and Dasgupta, B. (1955) *Chem. Ind.* 1632.
164. Shoeb, A., Kapic, R. S. and Popli, S. P. (1973) *Phytochemistry* **12**, 2071.
165. Kincl, F. A., Romo, J., Rosenkranz, G. and Sondheimer, F. (1956) *J. Chem. Soc.* 4163.
166. Wheaton, T. A. and Stewart, I. (1969) *Phytochemistry* **8**, 85.
167. Kuck, A. M., Albónico, S. M. and Deulofeu, V. (1966) *Chem. Ind.* 945, *J. Chem. Soc.* (1967) 1327.
168. Kunitomo, J. (1962) *Yakagaku Zasshi* **82**, 611. (*Chem. Abstr.* **57**, 4760d).
169. Chatterjee, A., Chakrabarty, M. and Kundu, A. B. (1975) *Australian J. Chem.* **28**, 457.
170. Kundu, A. B. and Chakrabarty, M. (1975) *Chem. Ind.* 433.
171. Badger, G. M., Christie, B. J. and Rodda, H. J. (1963) *Australian J. Chem.* **16**, 734.
172. Laforge, F. B. and Barthel, W. F. (1944) *J. Org. Chem.* **9**, 250.
173. Tomko, J., Awad, A. T., Beal, J. L. and Doskotch, R. W. (1967) *Lloydia* **30**, 231.
174. Freudenberg, W. and Rogers, E. F. (1937) *J. Am. Chem. Soc.* **59**, 2572.
175. Faugeras, G., Debelmas, J. and Paris, R. R. (1967) *C R. Acad. Sci. Paris Sér. D* **264**, 1864.
176. Faugeras, G. (1967) *Plantes Med. Phytothér* **1**, 87.
177. Samokish, I. I. and Shinkarenko, A. L. (1975) *Izv. Sev.-Kauk, Nauchn. Tsentra Vyssh. Shk. Ser. Estestv Nauk* 3, 25. (*Chem. Abstr.* **84**, 102283).
178. Zacharius, R. M. and Steward, F. C. (1959) S.E.B. Symposium XIII *Utilization of nitrogen and its compounds by plants.* pp. 168.
179. Tso, T. C. and McMurtrey, J. E. (1960) *Plant Physiol.* 35; 865.
180. Irvine, W. J. and Saxby, M. J. (1969) *Phytochemistry* **8**, 473.
181. Bygdeman, S. (1960) *Ark. Kemi.* **16**, 247.
182. Gulland, J. M. and Virden, C. J. (1931) *J. Chem. Soc.* 2148.
183. Serenkov, G. P. (1959) *Nauk Dok vyssh. Shk. Biol. Nauk* **2**, 175.