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The Species of *Dioscorea* Containing Sapogenin

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Diosgenin, the sapogenin most widely used in the synthesis of steroidal drugs, was first discovered in 1936 by Fujii and Matsukawa. That discovery lay dormant for some years, however, until Marker and his associates (about 1943) revealed the potential use of plant sapogenins for the synthesis of cortisone and other drugs. After World War II, the growing need for steroidal drugs and the high cost of obtaining them from animal sources led to a widespread search for plant sources of steroidal sapogenins. That search has been ably documented by Correll et al. (11). The major program of the United States Department of Agriculture stimulated scores of other expeditions and screening programs of smaller scope among both public and private institutions. These continue today.

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Although less well documented in scientific publications, the sequel to that story has been the development of the steroidal industry. That industry depends chiefly on two abundant and rich sources of diosgenin from Mexico and Central America, *D. composita* Hemsl. and D. *floribunda* Mart. and Gal. In addition, other species of *Dioscorea* have been or are being exploited commercially (12). One species, *D. sylvatica* Ecklon from southern Africa, has probably been exhausted as a commercial source. *D. deltoidea* Wall. is still harvested from the wild in India. Information on certain Asian species is difficult to obtain. Probably some are being utilized commercially. Some of the sapogenin-bearing species listed in this review have not yet been commercially utilized.

The purpose of this article is to provide a list of species that have been tested for sapogenin content. A partial list, covering most of the species containing at least a trace of sapogenin, was published by Coursey (12).

Compilation of this list was complicated by taxonomic and nomenclatorial problems.

TABLE I

Dioscorea SPECIES KNOWN TO HAVE BEEN TESTED FOR SAPOGENIN CONTENT

Dioscorea species	Probable geographic source	Highest known percentage sapogenin	Selected reference
abyssinica Hochst. ex Knuth	Africa	Trace	Martin, unpublished; Peal, 1961
aculeata L. (probably D. esculenta (Lour.) Burk.)	India	None	Barua et al., 1956
aguilarii Standl. & Steyerm.	Mexico	None	Wall et al., 1957
alata L.	Philippine Islands	None or .25	Anzaldo et al., 1956
althaeoides Knuth	China	Some	Chou, C., 1965
asclepiadea Prain & Burk.	Japan	0.5	Akahori, 1965
asteriscus Burk.	Tanzania	None	Martin, unpublished
auriculata Poepp.	Chile	0.2	Wall et al., 1957
balcanica Kosanin	Europe	2.00	Martin, unpublished
bartlettii Morton	Mexico, Guatemala	0.8	Wall et al., 1957

TABLE I (continued)

Dioscorea species	Probable geographic source	Highest known percentage sapogenin	Selected reference
batatas Decne. (probably D. opposita Thunb.)	Panama (introduced)	None	Wall et al., 1954a
belizensis Lundell	British Honduras	2.6	Blunden et al., 1966
belophylla Voigt.	India	None	Barua et al., 1956
buchanani Benth.	Tanzania	None	Martin, unpublished
bulbifera L.	Africa, India	None or 0.5	Barua et al., 1956; Marker et al., 1943
campestris Griseb.	Argentina	None	Labat, 1959
capillaris Hemsl.	Mexico	1.2	Marker et al., 1943
caucasica Lipsky	Russia	0.6	Kichenko, 1961
cayenensis Lam.	Africa	None, 0.2	Wall et al., 1961
ceratandra Uline	Mexico	None	Martin, unpublished
chiapensis Matuda	Guatemala	1.0	Harrison et al., 1961
cochleari-apiculata De Wild	Tanzania	None	Martin, unpublished
collettii Hook f.	China	2.0	Tien-Hsi Cheng, 1965
composita Hemsl.	Mexico	13.0	Cruzado et al., 1965
convolvulacea Cham. & Schlecht.	Mexico	None	Wall et al., 1957
convolvulacea subsp. grandifolia (Schlecht.) Uline	Mexico	0.2	Marker et al., 1947
continifolia Knuth	South Africa	None	Wall et al., 1957
cyphocarpa Robinson	Mexico	0.2	Marker et al., 1943
deltoides Wall.	India	8.0	Barua et al., 1956
densiflora Hemsl.	Guatemala	None	Hurlimann, unpublished
dodecaneura Vell.	Brasil	None	Wall et al., 1954b
dregeana (Knuth) Dur. & Schinz	South Africa	None	Wall et al., 1954a
dugesii Robinson	Mexico	0.2	Marker et al., 1943
dumetorum (Knuth) Pax.	Kenya	None	Wall et al., 1954b
elephantipes (L'Her.) Engl.	South Africa	None	Wall et al., 1954a
entomophila Hauman	Argentina	None	Labat, 1959
escuintlensis Matuda	Guatemala	Some	Koch, 1966
esculenta (Lour.) Burk.	India	0.7	Anzaldo et al., 1956
fastigiata Gay	Chile	Some	Silva & Deijesin, 1960
floribunda Mart. & Gal.	Mexico, Central America	10.0	Cruzado et al., 1965
floridana Bartlett	U.S.A.	1.7	Marker et al., 1947
friedrichsthalii Knuth	Costa Rica	4.0	Martin et al., 1963
galeottiana Knuth	Mexico	Trace	Barua et al., 1956
gallegosi Matuda	Mexico	None	Gómez-Pompa, 1962
glabra Roxb.	India	None	Barua et al., 1954

TABLE I (continued)

Dioscorea species	Probable geographic source	Highest known percentage sapogenin	Selected reference
glandulosa Klotzsch ex Knuth	Brasil	None	Wall et al., 1954b
glauca Muhl.	North America	1.0	Marker et al., 1947
glomerulata Hauman	Argentina	None	Labat, 1959
gracillima Miq.	Japan	0.2	Taukamoto & Kawasaki, 1954
grandifolia Schlecht. (probably D. galeottiana Knuth)	Mexico	0.2	Marker et al., 1943
grisebachii Knuth	Brasil	None	Wall et al., 1954b
hemicrypta Burk.	South Africa	None	Wall et al., 1954a
hirsuta Mart. & Gal. (probably D. convolvulacea Cham. & Schlecht.)	Mexico	0.3	Marker et al., 1943
hirsuticaulis Rob. (probably D. jaliscana f. Matuda)	Mexico	0.1	Marker et al., 1943
hispida Dennst.	Philippine Islands	None or 0.73	Anzaldo et al., 1956
izuensis Akahori	Japan	1.0	Akahori, 1965
jaliscana Wats.	Mexico	0.3	Marker et al., 1943
japonica Thunb.	Japan	None or 1.0	Akahori, 1965
laurifolia Wall. ex Hook. f.	Malaya	None	Amarasingham et al., 1964
laxiflora Mart.	Brasil	None, Some	Wall et al., 1954b; Antonaccio, 1958
lecardii De Wild	Uganda	1.0	Peal, 1961
lobata Uline	Mexico	0.5	Marker et al., 1943
longicuspis R. Knuth	Tanzania	None	Martin, unpublished
malifolia Bak.	South Africa	Trace	Wall et al., 1954a
megalantha Griseb.	Argentina	None	Labat, 1959
mexicana Scheidw.	Mexico	0.4	Barua et al., 1956
microbotrya Griseb.	Argentina	None	Labat, 1959
militaris Robinson	Mexico	0.4	Marker et al., 1943
minima Rob. & Seaton	Mexico	0.3	Marker et al., 1943
minutiflora Engl.	Africa, Uganda	None or trace	Wall et al., 1954b; Peal, 1961
monadelpha Griseb.	Brasil	None	Wall et al., 1954b
multiflora Mart. ex Griseb.	Argentina	1.0	Labat, 1959
multinervis Benth.	Mexico	0.3	Marker et al., 1943
nelsonii Uline	Mexico	1.8	Wall et al., 1957
nervosa Phil.	Chile	Some	Ibañez et al., 1950
nigrescens Phil.	China	Some	Wang and Chou, 1964

TABLE I (continued)

Dioscorea species	Probable geographic source	Highest known percentage sapogenin	Selected reference
nipponica Makino	Japan	2.0	Tsukamoto & Kawasaki, 1954
nummularia Lam.	India	Trace	Ibañez et al., 1950
oppositifolia L.	India	None	Barua et al., 1954
orbiculata Hook.	Malaya	Some	Amarasingham et al., 1964
paniculata Michx.	United States	None	Martin, unpublished
panthaica Prain & Burk.	China	2.0	Tien-Hsi, Cheng, 1965
pentaphylla L.	India	None	Barua et al., 1954
pilosiuscula Bertero ex Spreng.	Puerto Rico	None	Martin, unpublished
platycolpota Uline	Mexico	0.4	Wall et al., 1957
plumifera Rob.	Mexico	0.4	Marker et al., 1943
polygonoides Humb. & Bonpl.	Honduras	0.25	Wall et al., 1957
polystachya Turcz.	Russia	0.6	Kichenko, 1961
praehensilis Benth.	Africa	None	Wall et al., 1954b
prazeri Prain & Burk.	India	2.1	Barua et al., 1954
prazeri var. glauca (author unknown)	India	4.5	Chakravarti & Dash, 1967
preussii Pax	Tanzania, Uganda	None, 0.3	Martin, unpublished; Peal, 1961
pringlei Rob.	Mexico	0.4	Marker et al., 1943
pubera Blume	India	None	Barua et al., 1954
pyrifolia Knuth	Malaya	None	Amarasingham et al., 1964
quartiniana A. Rich.	Tanzania, Uganda	None	Martin, unpublished; peal, 1961
quaternata J. F. Gmel.	United States	1.2	Wall et al.
quinqueloba Thunb.	Japan	0.4	Tsukamoto & Kawasaki, 1954
remotiflora Knuth	Mexico	0.3	Marker et al., 1943
retusa Mast.	South Africa	None	Wall et al., 1954a
rotundata Poir.	Belgian Congo, Uganda	None	Martin, unpublished; Peal, 1961
sansibarensis Pax	Kenya	None	Wall et al., 1954b
sativa (invalid name, identity uncertain)	El Salvador	None	Wall et al., 1954a
saxatilis Poepp.	Chile	None	Wall et al., 1957
schimperiana Hochst. ex Knuth	Uganda	None	Peal, 1961
schimperiana Knuth var. vestita Pax	Tanzania	None	Martin, unpublished

TABLE I (continued)

Dioscorea species	Probable geographic source	Highest known percentage sapogenin	Selected reference
scortechinii Prain & Burk.	Malaya	None	Amarasingham et al., 1964
septemloba Thunb.	Japan	0.1	Akahori, 1965
sinuata Vell.	Brasil	None	Wall et al., 1954b
sititoana Honda et Jotani	Japan	Trace	Akahori, 1965
spiculiflora Hemsl.	Mexico	15.0	Martin & Delpin, 1965; Cox et al., 1958
stegelmanniana R. Knuth	Peru	None	Wall et al., 1957
sublignosa R. Knuth	Uganda	None	Peal, 1961
subtomentosa Miranda	Mexico	0.4	Marker et al., 1943
sylvatica Ecklon	South Africa	6.0	Blunden & Hardman, 1964
tenuipes Franch. & Sav.	Japan	0.1	Tsukamoto & Kawasaki, 1954
tepinapensis Uline (probably D. composita)	Mexico	0.7	Wall et al., 1957
testudinaria Knuth	South Africa	0.6	Marker et al., 1943
tokoro Makino	Japan	1.0	Tsukamoto & Ueno, 1936
tomentosa Koen ex Roxb.	India	Trace	Barua et al., 1956
trifida L. f.	Puerto Rico	None	Wall et al., 1954a
ulinei Greenm.	Mexico	0.4	Marker et al., 1943
urceolata Uline	Mexico	0.5	Marker et al., 1943
urophylla Hemsl.	Mexico	None	Wall et al., 1957
valdiviensis R. Knuth	Chile	None	Wall et al., 1957
villosa L.	United States	1.3	Wall et al., 1961
wallichii Hook. f.	India	Trace	Barua et al., 1954
zingiberensis C. H. Wright	China	Some	Chou, C., 1965

In most cases the names originally given by the authors have been used unchanged, and the reader must exercise his own judgment. The number of species of *Dioscorea* is large (600–800), and a new general treatment to supersede that of Knuth (20) is sorely needed. As the percentage of sapogenin in the tubers varies with age and season and as different methods of analysis have been used by different investigators, the percentage figures should be interpreted with caution.

An extensive literature search preceded the study. In addition, provisional lists of species were sent to various investigators for suggestions, additions, and corrections. Not all references that cover the species in question were used, but the selected references often lead to still others. Some of the data included in the list have not been published. On the other hand, much negative information, some of which was developed in part by commercial concerns, was not available to us.

Although many species of *Dioscorea* remain to be tested for sapogenin content, certain areas (North and Central America,

Africa, Asia) have probably been sufficiently explored to predict that no extensive stands of new suitable wild species will be discovered. On the other hand, some areas of South America need more exploration.

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