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PHARMACOGNOSY--ITS IMPORTANCE AND ROLE IN MODERN MEDICINE

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ABSTRACT

The paper deals with the importance of Pharmacognosy and Pharmacognostic research, the main differences between Conventional and Modern Pharmacognosy, checking of crude drugs available in the market and finding out adulterations if any, importance of anatomy in Pharmacognosy, classification of crude drugs of plant origin according to their chemical constituents and finally role of Pharmacognosy in Modern Medicine.

INTRODUCTION

The term "Pharmacognosy" was first used by C. A. Seydler in his dissertation entitled "Analecta Pharmacognostica" which appeared in 1815. It is derived from the greek words *pharmacon*, drug or medicine and *gnosis*, knowledge (24). So Pharmacognosy literally means knowledge of drugs (14). Pharmacognosy is restricted to natural products with attention centred on sources of drugs from plant and animal. It is a highly applied branch of science which when in practice requires a number of scientific disciplines for solving the problems pertaining to identity, purity, quality and preservation of drugs from plant and animal kingdoms. The general biology of pharmacognosy is largely descriptive. It includes the taxonomic position of the natural sources of the product, the part of the plant or animal yielding the drug, the scientific and common names of the biologic sources, the gross anatomic characterization of the parts used, and the principal uses of the product in the medical professions (14). India is a country where a large number of medicinal plants are growing. The trade in crude drug from plant origin is mostly in the hands of unqualified persons, and collection is usually made from plants growing wild in forests. The collectors are not always able to distinguish the correct variety, and a mixing up of a number of them during collection is often the ultimate result. Not to speak of the ignorance of the plant collectors, it is often found that the genuine samples of crude drugs are adulterated with samples of plant materials more or less of the similar appearance but without any therapeutic properties. The result is, the manufacturers who use such crude drugs for finished products fail to get the genuine materials. Moreover, the important crude drugs of plant origin which have a great demand in foreign markets are exported either adulterated or are of sub-standard qualities. This lowers the prestige of our country which cannot be allowed to continue. It is for these reasons it has been suggested that this condition of crude drug trade can only be improved, if the plants which yield valuable medicines are collected by trained personnel and cultivated properly and pharmacognostic details of these crude drugs are available in order to identify the market samples easily and properly for their authenticity. The selection of right type of crude drugs and checking and screening of their adulterants are the most important items of work in pharmacognosy amongst others. The search for medicinal plants which can yield the precursors of the drug cortisone or from which safe contraceptives or anti-cancer and anti-tumour drugs can be prepared is also a part of the pharmacognostic study. So the importance of pharmacognosy can very well be assessed, and a systematic study in all its branches can save the people of the country as a whole and the drug industries in particular, that will be able to produce the important medicines of modern day therapy from authentic plant materials at a much cheaper rate.

Pharmacognosy is basically divided into two main groups *viz.* 1) Conventional and 2) Modern Pharmacognosy.

CONVENTIONAL PHARMACOGNOSY

This is mainly based on the studies of macroscopic and microscopic characters of crude drugs as well as their powders for checking the genuine samples from adulterated ones and for different diagnostic elements by which these crude drugs can be identified in the powdered forms too.

TABLE I

Some important distinctions between Roots of Rauwolfia micrantha, R. canescens and R. serpentina

	Rauwolfia micrantha	*Rauwolfia canescens*	*Rauwolfia serpentina*
Cork:	Stratified	Usually not stratified	Stratified
Phloem sclerenchyma:	Present and more abundant	Present and less abundant	Absent
Vessels:	Least numerous, mostly upto 57 μ, rarely upto 72 μ in diameter	Most numerous upto 70 μ, very rarely to 85 μ in diameter	Less numerous upto 57 μ in diameter
Wood fibers:	Upto 1460 μ in length	Upto 1500 μ in length, many showing irregular curvature	Upto 750 μ in length
Stone cells:	Isodiametric, oval to fibre-like and without pointed cuticular projections; one form of fibre-like stone cell with hooked end	Isodiametric, to fibre-like, irregularly lobed, curved and polymorphic. One form with septated lumen and pointed circular projections	Absent
Starch grains:	Least abundant, (in powder) the unaltered grains upto 21 μ, the altered upto 31 μ in diameter	Less abundant, mostly under 15 μ, occasionally upto 26 μ in diameter	Most abundant, the unaltered grains upto 27 μ, the altered upto 50 μ in diameter
Xylem rays:	1 to 5 cells in width	1 to 5 cells in width	Usually 1 to 5 cells in width, occasionally 1 to 8 cells in width

TABLE II

Microscopical characters

	Holarrhena antidysenterica	*Wrightia tomentosa*
Cork:	Cells are narrower and tangentially elongated	Cells are radially elongated and somewhat square-shaped.
Stone cells:	Bigger, greater in number and arranged in concentric tangential bands in the secondary phloem region. They often possess prismatic crystals of calcium oxalate inside the cells	Smaller, lesser in number, often forming patches and usually associated with phloem fibres. They do not contain any crystals within them
Pericyclic fibres:	Absent	Present
Phloem Parenchyma:	Polyhedral to more or less isodiametric	Rectangular
Medullary rays:	Mostly bi-or tri- seriate, very few uni-seriate. They become multi-seriate upto six cells wide in the outer end of the ray. Rays are 6-7 per mm arc in the inner region. Some of the ray cells become thick-walled and lignified	Mostly uni-seriate, a few cells occasionally dividing to make the ray bi- or tri-seriate. They are 3-5 per mm arc in the inner region. The ray cells remain always thin-walled and non-lignified
Calcium oxalate:	Present as rosettes and prisms	Present as large prisms only
Latex:	Present in cells of non-articulate type, the contents being cream coloured and somewhat transparent	Present in ducts of articulate type, distributed mostly in the phloem region, the contents being densely granular and darker in colour

TABLE III

Comparative study of leaf constants

	Catharanthus roseus					*Catharanthus pusillus*				
	E	S	S.I.	VI.T.	P. R.	E.	S.	S.I.	VI.T.	P. R.
a	182	16	8			180	12	6		
b	182	13	7			178	15	7		
c	148	14	8			149	13	8		
d	292	74	20			196	53	21		
e	257	60	19			170	53	23		
f	300	75	20			195	61	23		
g				8	4.50-6.00				3	3.25-4.75
h				9	3.25-5.25				3	3.50-4.75
i				7	4.25-5.25				4	3.50-4.75

a,b,c = Upper apex, middle and base; d,e,f = lower apex, middle and base;
g,h,i = Apex, middle and base.
E.&S. = No. of epidermal cells and stomata per sq mm of leaf surface;
S.I. = stomatal index;
VI.T. = vein-let termination no. per sq mm of leaf surface;
P.R. = Palisade ratio.

TABLE IV

	Stomatal index	Palisade ratio	Vein-islet No.
Barosma betulina (Thunb.) Bart. & Wendl. (Genuine Buchu)	17-18.5	Average 25 (never less than 10)	8-13
Myrtus communis Linn. (Indian Buchu)	17-20	6-10	6-12
Atropa acuminata Royal ex Lindl.	16.7-18.8	4-13	3-5
Phytolacca acinosa Roxb. (Used as adulterants of *A. acuminata*)	14.7-15.2	2-3	1-2.5

TABLE V

Colur changes in fluorescence of alcoholic extracts of three powdered drugs at different stages of Tests no. 1 and 2

Step	Reagent	Belladonna Test No. I	Hyoscyamus	Stramonium
Test No. 1:				
1	1 drop No. I	Purple	Red	Red (slightly darker than Hyoscyamus)
Test No. 2:				
2	3 drops No. II	Blue Test No. 2	Green	Brown
1	2 drops No. II	Blue	Red	Red
2	1 drop No. III	Purple	Brown	Red
3	1 drop No. III	Bright blue-green	Gray	Red
4	2 drops No. III	Blue	Gray-green	Red-violet

I. $AgNO_3$ ..... Saturated aqueous solution
II. NaOH ..... 0.1 N aqueous solution
III. $HgCl_2$ ..... 5% aqueous solution

Test No. 1
1. Add 1 drop of Reagent 1 to 2 ml. of extract and note color of fluorescence under U. V., then
2. Add 3 drops of Reagent II to extract containing I and note color of fluorescence under U.V.

Test No. 2
1. Add 2 drops of Reagent II to 2 ml of extract and note color of fluorescence under U.V., then
2. Add 1 drop of Reagent III to extract containing II and note color of fluorescence under U.V., then
3. Add 1 more drop of III and note color of fluorescence under U.V., and then
4. Add 2 more drops of III and again note fluorescence as above.

Importance of Anatomy in Pharmacognosy : One function of the pharmacognocists is to identify properly the crude drugs used as such in medicine or as sources for commercial exploitation by drug industries or for export. Anatomical structures are most likely to provide evidence concerning the interrelationships of larger groups such as families, or in helping to establish the real affinities of genera of uncertain taxonomic status. Anatomy sometimes proves very much helpful for individual identification. For example in case of herbarium specimens which are not accompanied by flowers or fruits microscopical methods are of great value in establishing the identity. By microscopical methods it is also possible to identify fruits, roots or leaves of plants and sometimes the species also can be determined from these isolated plant parts. Moreover, for establishing the botanical identity of commercial samples of medicinal plants anatomy plays an important role, and also in checking adulteration, substitution and fraud ; and have on occasions been helpful in establishing the guilt or innocence of suspected criminals (9).

Rauvolfia serpentina Benth. ex Kurz roots commonly known as Sarpagandha yields several alkaloids. Of these the alkaloid reserpine is widely used in the treatment of hypertension and as a tranquilizing agent in staties of tension and anxiety. Its widest use, however, appears to be in the treatment of mental disease (23). The roots have great demand in foreign markets. It is often found in the crude drug trade that the dealers supply genuine roots of other species of *Rauvolfia* which are not efficacious from the therapeutic point of view. They even adulterate roots of other plants with no alkaloids of the reserpine group. We sometimes meet with these types of cases at the time of checking the samples received from local Customs or from different crude drug dealers. Several authors in India and abroad have studied the roots and shown the methods as to how the different species of the roots of *Rauvolfia* can be

easily and properly identified through their anatomical characters (18, 23, 25 ; Table I). Similarly barks of *Holarrhena antidysenterica* Wall. commonly known as Kurchi, a pharmacopoeial drug used for the preparation of Kurchi-bismuth iodide are often found in the market adulterated with a similar type of bark of no therapeutic value. These barks on identification have been found to be the barks of *Wrightia tomentosa* Roem. & Schult. Though they look more or less similar they can be easily identified from their anatomical characters (15; Table II).

So far as the pharmacognostical anatomical studies of leaves are concerned, quantitative microscopy plays an important role in determining the different species in a particular genus or even the adulteration of other leaves in a particular genuine sample. The number of stomata and epidermal cells, vein-islet and vein-let termination numbers per sq. mm of leaf surface, palisade ratio and the stomatal index give the constant figures so far as the different species of leaves are concerned. Not only do we get a definite idea about the different species in a particular genus but with the help of quantitative microscopy we can go a step forward in identifying leaves of different plants (7, 19, 21 ; Tables III & IV). These tables will give an idea of the importance of quantitative microscopy in the field of pharmacognostic research.

Moreover different types of stomata, crystals of calcium oxalate, starch grains, fibres and trichomes are playing a great role in the identification of different plant parts.

MODERN PHARMACOGNOSY

Alexander Tschirch (1856-1939) one of the founders of Modern Pharmacognosy defines Pharmacognosy in the following way : "By the term Pharmacognosy is meant the science whose object is to study scientifically the drugs of plant and animal origin from every view point, with exception of their physiological action, to describe them correctly and correlate them under certain general view points". Like most applied sciences Pharmacognosy unites a variety of disciplines and has utilized related fields to bridge the transition from a descriptive science to a functional one. The Pharmacognocists can supply general information needed by the pharmacists, such as understanding the active principles of drugs as chemicals, and specific information needed by the specialists (16).

During the twentieth century, crude drugs in crude forms are playing a dominant role in medicine as compared with chemically pure compounds. As such, the reliable pharmaceutical manufacturers have taken over procuring and extraction of crude drugs as well as the synthesis of pharmaceutical chemicals. Many of the constituents to which crude drugs owe their activity have now become available in pure form. The isolation and chemical identification of new potentially useful plant and animal constituents are an important aspect of biochemical research in Pharmacognosy. Egil Ramstad, Professor of Pharmacognosy, Perdue University, U.S.A. has given a beautiful account in his book "Modern Pharmacognosy" in which he has given a classification of drugs according to their chemical constitueuents, which is as follows :

1) Drugs of Carbohydrate group
2) Drug products from dissimilative fermentation
3) Drugs of the Fatty acid group
4) Drugs of the Tetracyclin group
5) Drugs of the Steroid group
6) Drugs of the Isoprenoid group
7) Drugs of the Phenylpropide group
8) Drugs of the (Gallo) Tannin group
9) Drugs of the Flavonoid group
10) Drugs of the Anthranol and Anthraquinone group
11) Drugs of the Proteid group
12) Purines, Pyrimidines and related drugs
13) Drugs of the Alkaloid group

Besides this he has also dealt with the commercia- aspect of drug production, formation of drug constil tuents, variability in drug activity, preservation and storage of crude drugs and finally analysis of natural drug products (16).

Most plants of the Solanaceae family were formerly considered important from the medicinal point of view as they yield alkaloids *viz.* Hyoscyamine, Hyoscine, Atropine and Scopolamine ; but modern pharmacognostic and phytochemical researches have resulted in isolating new types of constituents *i.e.* steroidal substances which can commercially be exploited by the Drug Industries for the preparation of Cortisone. Formerly this drug was prepared from animals and so it was very costly and could not be made available to the common people of our country. But due to rapid increasing importance of steroid sapogenins for the manufacture of cortisone, sex hormones and oral contraceptives, there is a vigorous search all over the world for vegetable raw materials which can provide cheap and sustained supplies of starting material for further synthesis of a variety of steroid hormones. The plants which produce these raw materials are either very

common in different parts of our country or can be easily cultivated for commercial exploitation. So these drugs which can now very well be prepared from plant products will be comparatively less costly than before. Chopra *et al.* (8) have isolated glucoalkaloids from the fruits of *Solanum indicum* Linn. and *S. surattense* Burm. f. to the extent of 4.8% and 3.5% respectively. The same authors have also studied the rhizomes of *Dioscorea deltoidea* Wall. and *D. prazeri* Prain & Burkill and isolated 4.8-8% and 2.4-4% of Diosgenin respectively which is the most favourite starting material for the synthesis of Steroid Hormones (13). Chakravarti *et al* (1, 2, 3, 4, 5) found that *Agave cantala* and *Agave sisalana* contain 0.15% and 0.10% of Hecogenin respectively. Search for new and potent steroid sapogenin bearing plants is now going on and a systematic screening of such vegetable raw materials is being carried out. As a result, preliminary screening has given a positive hemolysis test for the presence of saponin in some plants and so detailed investigations have been suggested for finding out sapogenin bearing plants.

Similarly researches are going on in Chittaranjan National Cancer Research Centre, Calcutta; Indian Cancer Research Centre, Bombay ; Central Drug Research Institute, Lucknow and other laboratories to find out plants which can be used for Cancer or Tumour therapy. Cancer is a disease in our country in which two lakhs of people die every year (20). Cancer has now become the major health hazard with the increase in life expectancy and control of infectious diseases through wonder drugs. The Indian Council of Medical Research has also initiated research on the carcinogenic effects of some food toxins at the Indian Cancer Research Centre at Bombay and the Nutrition Research Laboratories at Hyderabad (20). During recent years the plant *Catharanthus roseus* (Linn.) G. Don (*Vinca rosea* Linn.) has come into prominence in the medical world as the plant yields besides others an alkaloid Vincaleukablastine which is used for the treatment of Hodgkin's disease and Choriocarcinoma (10, 11, 12). The plant has developed a good market value due to great demand in India and abroad. So modern pharmacognostic research is mainly based on the phytochemical studies.

When physical and chemical methods are inapplicable, as often happens with the powdered drugs, there are methods to identify the plant materials from their powders. Table V will give an idea how powdered drugs can be identified and adulteration, if any, can be checked. Moreover the study of fluorescence of powdered drugs as a means of effecting their identification appears to possess distinct possibilities of practical application, especially in the case of similar drugs that may be more or less difficult to distinguish. For example, Ceylon Cinnamon can be quickly and reliably distinguished from other common varieties such as those of China and Saigon by virtue of the fluorescent spots. All the three varieties fluoresce when a small amount of the powdered drug placed on the microscope slide is treated with 1 N NaOH in methanol and observed under the ultra violet radiations while still wet ; Ceylon Cinnamon fluoresces blue but the China and Saigon Cinnamons both appear green. The latter two may be separated, however, by the difference in intensity of fluorescence. In all cases that require the use of estimates of intensity of fluorescence for identification, the comparison of the unknown should be made with a reference standard slide prepared with a sample of known identity (6). So fluorescence analysis also helps in the identification of genuine samples and in checking adulterations.

Moreover in certain instances one can determine the properties of the substances present or the percentage of foreign matters by Lycopodium spore method as devised by Dr. T. E. Walls (21). Wallis found that there were on average 94,000 spores per milligram of Lycopodium. Starches and starchy drugs, when used as adulterants, can be determined by counting the number of starch grains per milligram and calculating the amount from the known number of starch grains per milligram of pure starch or starchy materials. Similarly it is possible to estimate the percentage of foreign organic matter in many powder drugs by this method (22).

Microchemical tests are also to a certain extent very much helpful in finding out chemical constituents in the plant materials and also the site where they are located or accmulated.

So it can be confidently said that this branch of applied science has got different fields of research ; and proper study in a systematic manner can lead the country to prosperity by isolation of new chemical constituents from plant materials which will ultimately produce new drugs of modern day therapy to combat difficult types of diseases like Cancer, Tumour, Virus etc. and can check increase in population of our country by preparation of safe contraceptives. On the other hand trade in crude drug can be improved by finding out potential crude drugs from plant materials and checking adulter-

ations. Although researches have already been taken up in our country as well as abroad to find out plants which can act as hallucinating agents and tranquilisers, more attention should be focussed on this aspect also.

It may be mentioned that unfortunately the proper development of the subject in India has been hindered by Pharmacognosy being confused with Botany. Pharmacognosy can play a very important role in the development of all systems of medicines whether modern, Ayurvedic, Unani or Homeopathic. Development for scientific cultivation, scientific arrangements for collection and grading should be suggested in order to give impetus to our export trade. The situation prevailing in the crude drug trade is chaotic and nothing is being done to improve the condition. Pharmacognosy is a subject of primary importance in the proper development of health schemes of our country but it is not receiving the attention it deserves.

Another point which is to be noted is, the facilities for proper training of Scientists in this highly applied branch of science are not adequate in our country. As a result by sudden switch over from conventional to modern pharmacognosy, the scientists in this branch except those who are already conducting researches on modern lines are a bit confused. Moreover interdisciplinary researches should go on in Pharmacognosy, Phytochemistry and Pharmacology so that new types of drugs can be found out without much delay. Attention should also be focussed to find out what the special therapeutic properties are in those plants which are very commonly used by the Adivasis or Aborigines of the different states of our country and by which they get magic relief for various ailments.

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REFERENCES

1. Barua, A. K., (Mrs.) D. Chakravarti and R. N. Chakravarti. Steroid Sapogenins from Indian *Dioscorea* Plants. Part I. *Ind. J. Chem. Soc.* 31 : 173, 1954.
2. Chakravarti, R. N. Possibilities for the preparation of Steroid Hormones from Indian *Dioscorea* Plants. *J. & Proc. Inst. Chem. (India)* 27 : 108, 1955.
3. —— (Mrs.) D. Chakravarti and M. N. Mitra. A simplified method for isolation of Diosgenin from Indian *Dioscorea* Yams. *Ibid.* 30 : 106, 1958.
4. —— M. N. Mitra and D. Chakravarti. Diosgenin from *Dioscorea prazeri* by the method of Rothrock *et al. Bull. Cal. School of Trop. Med.* 7 : 5, 1959.
5. —— and S. N. Dash. Diosgenin from *Dioscorea glauca. Ibid.* 8 : 59, 1960.
6. Chase, C. R. (Jr.) and R. Pratt. Fluorescence of Powdered Vegetable Drugs with particular reference to development of a system of identification. *J. Am. Pharm. Assoc. Sci. Ed.* 38 : 324, 1949.
7. Chaudhuri, Rai H. N. Comparative Pharmacognostic studies on the leaves of *Catharanthus roseus* (Linn.) G. Don and *C. pusillus* (Murr.) G. Don. *Indian J. Pharm.* 25 : 338, 1963.
8. Chopra, I. C. and L. D. Kapoor. Steroid Sapogenin bearing plants of India. *Indian For.* 94 : 620, 1968.
9. Fairbairn, J. W. Anatomy & Pharmacognosy. *Proc. Linn. Soc. Lond.* 179 : 251, 1968.
10. Farnsworth, N. R. The Pharmacognosy of the Periwinkles *Vinca* and *Catharanthus. Lloydia* 24 : 105, 1961.
11. Hertz, R. M., M. B. Lipsett and R. H. Roy. Effect of Vinalcukablastine on metastatic Choriocarcinoma and related Trophoblastic Tumors in women. *Cancer Research* 20 : 1050, 1960.
12. Hodes, M. E., R. J. Rohn and W. H. Bond. Vincaleukablastine I. Preliminary Clinical studies. *Ibid.* 20 : 1041, 1960.
13. Karnick, C. R. Seasonal Periodicity of Sapogenin Production in *Dioscorea deltoidea* Wall. & *D. prazeri* Prain & Burkill. *Planta Medica Heft.* 3 : 269, 1968.
14. Mc-Graw-Hill Book Co. Inc. U.S.A. *Mc. Graw-Hill Encyclopedia of Science and Technology.* 10 : 94, 1960.
15. Prosad, S. and P. N. Kaul. Pharmacognostical studies of *Holarrhena antidysenterica* and *Wrightia tomentosa* Barks. *Indian J. Pharm.* 18 :423, 1956.
16. Ramstad, E. *Modern Pharmacognosy.* Mc-Graw-Hill Book Co., New York, 1959.
17. Singh, H.,V. Pareira (Jr.) and V. V. Parashar. Sipogenins Steroid Drugs. *Indian J. Pharm.* 27 : 150, 1965.
18. Sulochana, (Miss) C. B. Indian species of *Rauwolfia. J. Indian Bot. Soc.* 38 : 575, 1959.
19. Trease, G.E. *A Text Book of Pharmacognosy.* Baillieri, Tindall & Cox, London, 1952.
20. U. N. I. Two lakh die of Cancer in India every year. W.H. O. Report. *Amrita Bazar Patrika* dated 6.4.70.
21. Wallis, T.E. *Text Book of Pharmacognosy.* J. & A. Churchill Ltd., London, 1960.
22. —— and A. H. Saber. The quantitative determination of foreign leaves in powdered drugs. *Qurt. J. & Year Book of Pharm.* 6 : 655, 1933.
23. Woodson, R. E., H. W. Youngken, E. Schlittler and J. A. Schneider. *Rauwolfia : Botany, Pharmacognosy, Chemistry & Pharmacology.* Little Brown & Co. Boston, Toronto.
24. Youngken H. W. *Text Book of Pharmacognosy.* Mc.Graw-Hill Book Co., New York, 1950.
25. —— *Malabar rauvolfia, Rauwolfia micrantha* Hook. f. *J. Amer. Pharm. Assoc. Sci. Ed.* 43 : 141, 1954.