PHARMACY

Improving Plant Drug Yield - A Study of the Hyoscine: Hyoscyamine Ratio in a Datura Hybrid

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ABSTRACT

The rapid depletion of drug plants in the wild due to uncontrolled exploitation has made it necessary to search for means of maximizing the yields and contents of drug plants. The potentiality of hybridisation as one of such means was investigated in *Datura*.

The alkaloid content, the hyoscine: hyoscyamine ratio of the F_1 hybrid, *D. stramonium X D. ferox*, was examined.

Although the hybrid demonstrated hybrid vigor (increased yield) the alkaloid content was lower than the higher alkaloid yielding parent *D. ferox*.

Keywords
Datura (Datura stramonium X Datura ferox), Hybridisation, Hyoscine, Hyoscyamine.

INTRODUCTION

Plant medicines continue to enjoy a viable reputation as therapeutic alternatives to synthetic drugs in health care delivery systems in most developing countries for several reasons. For most rural populations estimated to be about 70% of the national population, orthodox therapy is inaccessible while plant medicine is tangibly cheap as it is collected mainly from the wild.

However, uncontrolled and ruthless exploitation coupled with other destructive activities of modern man without recourse to restoration, have disrupted the supply of herbal drugs from the wild. For example, within a relatively short time, the shrub, *Cryptolepis sanguinolenta*, a potential anti malarial drug, has become almost extinct in its local habitat, the Akwapim ranges [Ayew, 1987].

It is in view of these dangers that attempts are being made to increase the production and productivity of our medicinal plants both for local consumption and for export.

Plants in the genus *Datura* were chosen for study because the daturas are easily cultivated and much is known about them. They have been the subjects of several studies in cytology, embryology and chemistry [D'Arcy, 1979; Conklin, 1976].

The *Datura* are self-fertile but natural interspecific hybrids are rare, the only one identified in the wild and obtained from several places in South America is the hybrid of D. *stramonium* and *D. ferox* [Rietsema, 1959]. However, over the years, a number of artificial hybrids both inter-specific and intraspecific have been produced for genetic and cytological studies. Others have also been studied for their morphological and chemical characters [Rietsema and Satina, 1959; Romeike, 1961, 1961; Evans et al, 1969; Mensah, 1981].

Although there is little folklore use of the datura, including its use in the treatment of certain poultry diseases, it is of economic importance because of its toxicity. Several ancient cultures used them in magico-religious rites e.g. the Amerindians as well as the East Indians [Schultes, 1979]. Today, the daturas provide useful anticholinergic drugs: hyoscine and hyoscyamine/ atropine.

EXPERIMENTAL

Plant Materials

Mature hybrid seeds produced by pollinating the emasculated flowers of D. *ferox* with pollen from *D. stramonium* were sown to give rise to hyhrid *D. stramonium* and *D. ferox* plants. Both parental seed stocks were introduced from Nottingham University, U.K.

Leaves of mature fruiting plants of *D. stramonium*, *D. ferox* and two of the hybrid plants were harvested and dried in an oven at a temperature not exceeding 60°C and powdered to a moderately fine powder.

Extraction and Assay

In a preliminary extraction, the dried powdered material (10g) was mixed with lime [$Ca(OH)_2$] and water in a ratio 5g:1g:2ml and mixed together. After standing for about $^1/_2$ hr, the mixture was exhaustively extracted by percolation with chloroform. The extract was evaporated to dryness and reconstituted to a small volume with chloroform and extracted with dilute sulphuric acid (H_2SO_4). The extract was filtered, basified with dilute ammonia and re-extracted with chloroform. The concentrated chloroformic extract was tested for alkaloids with Dragendorff's reagent prior to thin layer

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chromatographic (TLC) analysis on alumina plates in solvent ether.

For the assay, weighed powdered material (7-45g) were used and the assay procedure of Evans and Patridge [1952] followed except that light petroleum spirit was used for packing the column instead of carbon tetrachloride.

(Each ml. of 0.005N $H_2S0_4 \equiv 0.00152$g hyoscine and each ml of 0.005N $H_2S0_4 \equiv 0.00145$g hyoscyamine).

RESULTS AND DISCUSSION

The cross between D. *stramonium* (O) and *D. ferox* (♀) was successful and viable seeds were obtained which when sown produced the vigorous F_1 hyhrid *D. stramonium x D. ferox.*

The chemical compounds responsible for the known therapeutic and poison properties of datura plants are mainly tropane, for example alkaloids hyoscine and hyoscyamine [Evans, 1979]. Other secondary metabolites including triterpenes and C_{28} steroids are known in the *Datura* [Kocor et al. 1979, Mensah, 1981].

The TLC analysis confirmed the presence of both hyoscine and hyoscyamine. The alkaloid content when analysed gave the results inTable 1.

It was evident from the results that the total alkaloid content of both parents were lower than published. For *D. stramonium* the value is not less than 0.25% (B.P. 1985) and for *D. ferox*, 0.4% [Evans and Patridge, 1953]. This rather large difference is difficult to explain but climatic and onto genetic factors are known to play a role in the metabolism and elaboration of specific compounds [Aslanov, 1972; Loftus-Hills et al. 1954].

Over all, the hybrid alkaloid content could be said to be intermediate to the parents but with a strong *D. ferox* dominance (reflected in the hyoscine dominance). This may have arisen from a dominant gene-system responsible for hyoscine metabolism.

Results from analysis of other hybrid *Datura* indicate the possible use of hybridisation in some species to improve yields of specific secondary metabolites [Evans et al, 1969; Schieder, 1978] and in some cases produce new compounds altogether [Romeike, 1976; Griffin, 1975; Kirson et al. 1977].

CONCLUSION

The F_1 hybrid of *D. stramonium* and D. ferox showed hybrid vigor giving an alkaloid yield but gave lower alkaloid content.

The case of this F_1 hybrid and *D. stramonium x D. ferox* confirms the need for careful analysis prior to choosing between parents and hybrid offspring in the selection of medicinal plants for commercialization.

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Table 1: Analysis of alkaloid content of Datura plants

Total alkaloid content (as hyoscyamine)	D. stramonium	D. ferox	*Hybrid (for 2)
	0.06%	0.13%	0.07%
Hyoscine	0.05%	0.13%	0.07%
Hyoscyamine	0.009%	0.010%	0.007%
Hyoscine: Hyoscyamine	5:1	13:1	11:1

*Average for duplicate analysis.

REFERENCES

1. *Ayew, K. [1987] Personal communication. Mampong-Akwapim.*
2. *D'Arcy, W.G. [1979] The classification of the Solanaceae, In: The Biology and Taxonomy of the Solanaceae (eds. J.G.Hawkes et al).*
3. *Conklin, M.E. [1976] Genetic and Biochemical Aspects of theDevelopment of Datura. Monographs in DDev. Biol.. 12 S. Karge Basel.*
4. *Dhar, K.L. and Raina, M.L. [1973] Phytochem. 12 476.*
5. *Evans, W.C. [1979] Tropane alkaloids of the Solanaceae, In: The Biology and Taxonomy of the Solanaceae op. cit.*
6. *Evans, W.C. and Patridge, M.W. [1953] J. Pharm. Pharmacol. 5 772.*
7. *Evans, W.C , Stevenson, N.A. and Timoney, R.F. [1969] Planta Med. 17 120.*
8. *Griffin, W J. [1975] Naturwiss. 62 97.*
9. *Kirson, I., Abraham, A. and Lavie, D. [1977]. Ist. J. Chem.*
10. *Kocor, M. Pyrek, J.St., Atal, C.K., Bedi, K.L. and Sharma, B. [1973] J. Org. Chem. 38 3685.*
11. *Loftus-Hills, D. Bottomley, W. and Mortiller, P.I. [1954] Aust. J. Appl. Sci. 5 292.*
12. *Mensah, M.L.K. [1981] Ph.D Thesis Univ. of Nottingham, U.K.*
13. *Rietsema, J. and Satina, S. [1959] Barriers to crossability. In: Blakeslee: The Genus Datura (ed. A.G. Avery et al.) The Ronald Press Co. N.Y. 235.*
14. *Romeike, A. [1962] Die Kulturpflanze 10 140.*
15. *Schieder, 0. [1978] Pflanzenphysiol. 98 119.*
16. *Schultes, R.E. [1979] Solanaceous hallucinogens and their role in the development of New World cultures. In: The Biology and Taxonomy of the Solanaceae op. cit.*