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# KAVA LACTONES IN *PIPER METHYSTICUM* FROM FIJI

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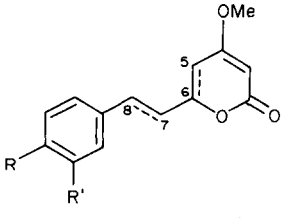
**Key Word Index**—*Piper methysticum*; Piperaceae; tissue variation; chemotaxonomy; kava lactones; alkaloids.

**Abstract**—The kava lactone compositions of the leaves, stems and roots of *Piper methysticum* from Fiji were markedly different but no differences were found between two cultivars. The leaves also contain the alkaloid pipermethystine as a major component.

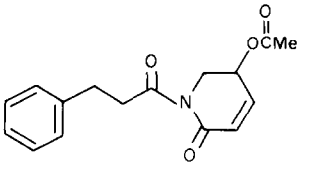
## INTRODUCTION

The tropical shrub *Piper methysticum* is used in the islands of the South Pacific in folk medicine and as the basis of the ceremonial and social drink, kava or yaqona [1, 2]. The roots, which are sold commercially, have been widely examined and the major components include the kava lactones ($\delta$-lactones) (**1**–**7**), which have attracted interest because of their pharmacological activity, and the related flavokawains [3–6].

Although the individual lactones have been widely studied, relatively little work has been carried out to determine their concentrations and distribution in the plant. In an early study the concentrations of the principal lactones in the rhizomes of six cultivars from Hawaii were determined by TLC, extraction and spectrophotometry. [7] Similar methods were used to estimate kawain [8–10], methysticin [9, 10] and yangonin [9, 10] in extracts of rhizomes. GC was first used in 1971 as a qualitative method and led to the identification of additional constituents in the roots [11] and in recent reports GC [12] and HPLC [13] have been used in quantitative studies of the roots. The present work reports the comparison using GC of the compositions of extracts from roots, stems and leaves of two cultivars of *P. methysticum* from Fiji.




| | | R | R' | $C_5$–$C_6$ | $C_7$–$C_8$ |
|---|---|---|---|---|---|
| **1** | Dihydrokawain | H | H | — | — |
| **2** | Kawain | H | H | — | = |
| **3** | Desmethoxyyangonin | H | H | = | = |
| **4** | Tetrahydroyangonin | -OMe | H | — | — |
| **5** | Yangonin | -OMe | H | = | = |
| **6** | Dihydromethysticin | $-O-CH_2-O-$ | | — | — |
| **7** | Methysticin | $-O-CH_2-O-$ | | — | = |




**8** Pipermethystine

## RESULTS AND DISCUSSION

Two cultivars of *P. methysticum*, black and white, distinguished by their stem colour, are recognized in Fiji. Whole plants of both cultivars were collected and divided into roots (rhizomes), leaves and stems, which were dried, milled and extracted with ethyl acetate. The extracts were examined by GC using OV101 and OV17 columns (Table 1). The latter column gave better peak shapes and was used for quantitative studies. The studies were carried out three times at different times of the year with essentially identical results. Most of the major peaks in the chromatograms could be identified by comparison with the individual kava lactones, which had been obtained by fractionation of the root extract, by TLC and by identification of the components by comparison of mp, IR and UV spectra with reported values [3, 4, 14].

Although the extracts of the corresponding plant parts from the two cultivars gave very similar chromatograms, there were considerable differences between the plant parts. Kawain (**2**) and desmethoxyyangonin (**3**) being major constituents of the roots, but dihydrokawain (**1**) and dihydromethysticin (**6**) being more prominent in the stems and leaves.

The chromatogram of the leaf extract contained an additional major component with a similar $RR_t$ to kawain on the OV101 column ($RR_t$ 0.29) but which was resolved from kawain on the OV17 column ($RR_t$ 0.24, kawain $RR_t$ 0.30). This compound, which was not a significant component of the other extracts, has been isolated and identified as the novel alkaloid pipermethystine (**8**) [15] which has a related structure to two minor alkaloids previously found in the roots [16]. Because the differences between the stems and leaves were so marked, an individual stem was divided into its segments from the soft growing tip to woody main stem, but each yielded a very similar chromatogram.

Table 1. GC of roots, stems and leaves of two cultivars of *P. methysticin* on OV17 at 260°

| $RR_t$ | | | Relative peak areas on OV17 | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Roots | | Stems | | Leaves | |
| OV17* | OV101† | Compound | White | Black | White | Black | White | Black |
| 0.21 | 0.22 | Dihydrokawain (**1**) | 18.9 | 14.3 | 36.8 | 34.4 | 31.4 | 30.0 |
| 0.24 | 0.29 | Pipermethystine (**8**) | — | — | 4.2 | 5.8 | 36.0 | 37.8 |
| 0.30 | 0.31 | Kawain (**2**) | 18.1 | 18.9 | 2.1 | 3.9 | t | 0.3 |
| 0.37 | 0.39 | Desmethoxyyangonin (**3**) | 20.7 | 16.8 | 3.5 | 3.9 | t | 0.7 |
| 0.49 | 0.51 | Tetrahydroyangonin (**4**) | 2.6 | 3.1 | 7.0 | 7.3 | 4.0 | 4.8 |
| 0.75 | 0.72 | Dihydromethysticin (**6**) | 6.8 | 9.1 | 29.6 | 26.4 | 19.2 | 18.5 |
| 1.00 | 1.00 | Yangonin (**5**) | 17.1 | 16.4 | 7.9 | 11.7 | 1.4 | 1.9 |
| Unidentified components (No. of peaks) | | | 15.6(7) | 21.0(7) | 8.8(3) | 6.7(3) | 8.0(4) | 3.0(2) |

*Relative to yangonin $R_t$ 19.7 min.
†Relative to yangonin $R_t$ 14.7 min.

However, the analyses of the extracts are incomplete as no peaks were obtained for methysticin (**7**) which, by using other techniques, has been found to be a major constituent of root extracts (9–12%) [7]. A sample of methysticin could be readily obtained in the present study by TLC but when it was injected into the gas chromatograph only minor rapidly eluting peaks ($RR_t$ 0.09 and 0.13) were obtained. The chromatographic conditions were varied, but almost identical results were obtained with injector and column temperatures from 200 to 275° and on four separately prepared OV17 columns and three different models of chromatograph.

In the earlier GC study, using similar conditions, **7** was reported to have a similar $RR_t$ to yangonin, which would be in agreement with its size and structure compared with the other lactones [11]; partial decomposition of methysticin occurred in the injector to give minor peaks and a broad baseline disturbance. The recently reported GC method for the analysis of kava roots also noted problems with methysticin [12]. Its peak was only partially resolved from yangonin and the peak height was not linearily related to sample size. Quantification was possible by peak height matching using a series of standards. However, the present problems with methysticin suggest that GC may not be a reliable technique for this determination.

The relative proportions of the other kava lactones in the roots found in the present study are comparable to those reported previously using TLC and spectrophotometry [7].

HPLC appears an attractive alternative method of analysis and an assay for rhizomes and commercial extracts using a Si gel column has recently been reported [13]; however, preliminary studies suggest that isomerization of the lactones can occur giving confusing results [Smith, R. M., unpublished observations].

## EXPERIMENTAL

*Plant material.* Cultivated *P. methysticum* was collected near Suva, Fiji, dried at 60° and milled. Samples of individual plant parts were extracted in a Soxhlet with EtOAc for 5 hr.

*GC.* Carried out using a chromatograph equipped with dual FID, carrier gas $N_2$ at 30 ml/min and glass columns 2 m × 3 mm packed with 3% OV101 at 225° or 2.5% OV17 at 260°.

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## REFERENCES

1. Watt, J. M. (1972) in *Plants in the Development of Modern Medicine* (Swain, T., ed.). Harvard University Press, Cambridge.
2. Emboden, W. (1979) *Narcotic Plants*. Studio Vista, London.
3. Mors, W. B., Magalhaes, M. T. and Gottlieb, O. R. (1962) *Fortschr. Org. Naturst.* **20**, 131.
4. Hansel, R. (1968) *Pac. Sci.* **22**, 293.
5. Kämpf, R. (1970) *Schweiz. Apoth. Ztg.* **108**, 520.
6. Shulgin, A. T. (1973) *Bull. Narcotics* **25**, 59.
7. Young, R. L., Hylin, J. W., Plucknett, D. L., Kawano, Y. and Nakayama, R. T. (1966) *Phytochemistry* **5**, 795.
8. Coclers, L., Mottet, J., 'T. Siobbel, J. B. and Parmentier, J. (1969) *J. Pharm. Belg.* 415.
9. Csupor, L. (1970) *Pharmazie* **25**, 197.
10. Di Renzo, N. (1972) *Il. Farmaco* **27**, 318.
11. Achenbach, H., Karl, W. and Smith, S. (1971) *Chem. Ber.* **104**, 2688.
12. Duve, R. N. (1981) *Analyst* **106**, 160.
13. Gracza, L. and Ruff, P. (1980) *J. Chromatogr.* **193**, 486.
14. Dutta, C. P., Ray, L. P. K., Chatterjee, A. and Roy, D. N. (1972) *Phytochemistry* **11**, 2891.
15. Smith, R. M. (1979) *Tetrahedron* **35**, 437.
16. Achenbach, H. and Karl, W. (1970) *Chem. Ber.* **103**, 2535.