PROGRESS IN THE CHEMISTRY OF MARKETED TRADITIONALLY USED PLANTS OF ETHIOPIA

Berhanu M. Abegaz[1]

Department of Chemistry, University of Botswana, Private Bag 0022, Gaborone, Botswana

CONTENTS

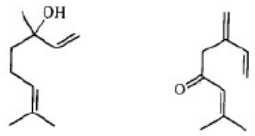
1. INTRODUCTION

The first paper in chemistry to be published in an international journal from the Department of Chemistry of Addis Ababa University, AAU, is almost certainly that of L.R. Pittwell [1]. It is entitled **Color of Fusion of the Elements** and it appeared in *Chemist Analyst* in 1962. Pittwell, in subsequent years, published papers dealing with emission spectroscopy and the analysis of natural waters from Ethiopia [2,3,4]. Pittwell was an expatriate analytical chemist and he may also have been the first in the Department to acquire a research grade instrument - an emission spectrograph. W.J. Horton, J. Gay and R.M. Baxter would probably feature very

[1] Permanent address: Department of Chemistry, Addis Ababa University, P. O. Box 1176, Addis Ababa, Ethiopia.

undertaken and one of the difficulties encountered in the early stages was taxonomic. The taxonomic name given to this plant is *Lippia adoensis* (Verbenaceae), which is also the same name given to the wild plant locally known as *Kesse*. *Kesse* is used for washing utensils and to impart fresh and spicy fragrance. Our investigations on the chemical constituents of the oils derived from these wild and cultivated plants of *Lippia adoensis* revealed qualitative as well as quantitative differences in the composition of the oils. Qualitatively, the rather sweet fragrance can be used to differentiate the cultivated from the wild form, which has a lemon-like odor . Fourteen compounds representing *ca* 90% of the oil of *Kosseret* and sixteen components representing *ca* 80% of the oil of *Kesse* were identified [12]. Linalool (**4**) is the major component (*ca* 75%) of the oil of *Kosseret* which is totally absent in the oil of *Kesse*. Only trace amounts (0.7%) of the rare monoterpene 2-methyl-6-methylene-2,7-octadien-4-one (ipsdienone, **5**) was present in *Kosseret* while *Kesse* oil contains up to 15% of **5**. Ipsdienone is an important compound since its reduction product, ipsdienol, is the principal component of the sex attractant of the male *Ips confusus* [13]. Based on the chemical and morphological characters the wild and cultivated plants were classified to varietal levels, the wild plant being *L. adoensis* var.*adoensis* and the cultivated, *L. adoensis* var. *koseret* [64].

Several projects were undertaken in collaboration with the Ethiopian Spice Extraction Company. Two of the staff of the Company were trained to M.Sc. level. Projects involved analyses of essential oils and oleoresins derived from exotic black pepper (*Piper nigrum*, Piperaceae), cardamon (*Elettaria cardamomum*, Zingiberaceae), cinnamon (*Cinnamomum verum*, Lauraceae), exotic and indigenous ginger (*Zingiber officinale*, Zingiberaceae), turmeric (*Curcuma longa*, Zingiberaceae) and the indigenous *Korarima* (Ethiopian cardamon, *Aframomum corrorima*, Zingiberaceae). These studies have enabled the establishment of quality standards and have also assisted the Ethiopian Spice Extraction Company in its efforts to find international markets for locally produced essential oils and oleoresins. Two papers were published [14,15] and several reports submitted to the company. It is very gratifying to learn that these efforts have been very useful to the company.

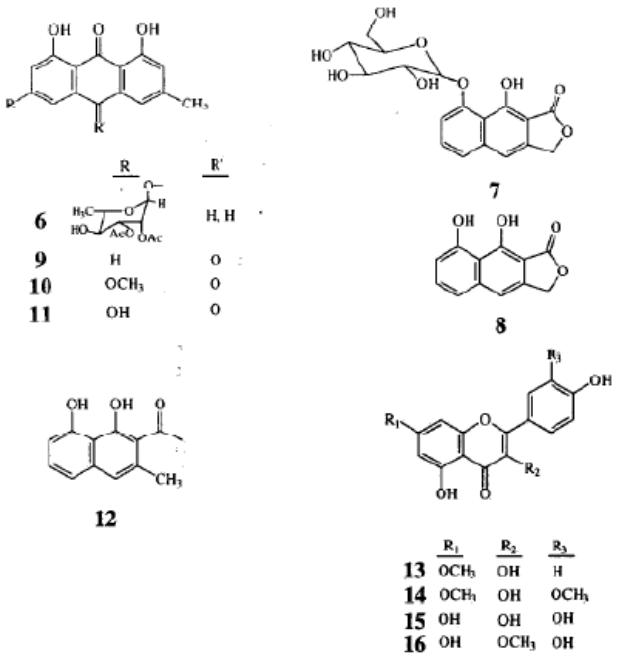


4 **5**

2.3 Studies on *Gesho* - *Rhamnus prinoides*

R. prinoides, (Rhamnaceae) is a plant which is also known to occur outside Ethiopia in Cameroon, Sudan, throughout East Africa to South Africa and Angola and also in Arabia [16]. It is cultivated in Ethiopia and is an important commodity which is sold in almost every traditional market in Ethiopia. Although it is quite common to find *Gesho* cultivations throughout the country, it is worth mentioning that regions in Tigrai, around Kara Kori in North Shoa and Sebeta, just west of Addis Ababa, are important centers of production of *Gesho*. Travelers passing through Kara Kori will undoubtedly notice villagers sitting by the street side chopping *Gesho* branches and allowing them to dry all along the length of the highway passing through the town. The leaves and stems of *Gesho* are ingredients in the making of the traditional fermented beverages *Tella* and *Tej*, respectively. Although it is

generally known that *Gesho* imparts the characteristic bitterness of these beverages, more precise understanding of the scientific role of this plant in the brewing process is emerging only very slowly. Coady in 1965 [17] suggested that *Gesho* may have a role in the fermentation process. More concrete information on the microbiological role of *Gesho* came out in two publications [18, 19] where it is claimed that the plant regulates the microflora responsible for the fermentation process. It is also indicated that the bitterness of the brew is directly related to the amount of *Gesho* added. Recently efforts have been made to develop technologies that allow the utilization of extracts from *Gesho* to hop beer [20]. We have observed that care is always taken to remove the fruits of the plant from the leaves and stems during the making of *Tella*. The fruits are, however, used for the treatment of ring worm infections. Prinoidin (**6**), a novel emodinanthrone rhamnoside diacetate and related compounds have been reported from the fruits of *R. prinoides* [21,22]. Our recent investigations on the leaves led to the characterization of the previously unknown naphthalenic compound ß-sorigenin-8-*O*-ß-D-glucoside (**7**), which is responsible for the bitter taste of the leaves [23]. The name 'geshoidin' is proposed for this novel glucoside. The leaves were also found to contain ß-sorigenin (**8**), chrysophanol (**9**), physcion (**10**), emodin (**11**), musizin (**12**), rhamnocitrin (**13**), rhamnazin (**14**), quercetin (**15**) and 3-O-methylquercetin (**16**). The co-occurrence of musizin (**12**) and geshoidin (**7**) in the leaves of the same plant undoubtedly has biosynthetic significance, and most probably musizin is a precursor of geshoidin.



An organoleptic evaluation was made by locating five volunteers who independently confirmed that geshoidin possess bitter properties. It is interesting to note that geshoidin is

6. REFERENCES

1. Pittwell, L. R. *Chemist Analyst* **1962**, 51, 94.
2. Pittwell, L. R. *Can. Spectrosc.* **1968**, 13, 17.
3. Pittwell, L. R. *J. Hydrol. (Amsterdam)* **1972**, 16, 225.
4. Pittwell, L. R. *Mikrochim. Acta* **1975**, 2, 425.
5. Baxter, R.M. *Bull. Chem. Soc. Ethiop.* **1987**, 1, 87.
6. Abegaz, B.M.; Tadesse, M.; Majiñda, R. *Biochem. Syst. Ecol.* **1991**, 19, 323.
7. Tadesse, M.; Abegaz, B.M. AETFAT Proceedings, Symposium VI, Mitt. Inst. Allg. Bot., Hamburg, **1990**, 23b, 605.
8. Abegaz, B.M.; Yohannes, P.G. *Phytochemistry* **1982**, 21, 1791.
9. Abegaz, B.M.; Yohannes, P.G.; Dieter, R.K. *J. Nat. Prod.* **1983**, 46, 424.
10. Abegaz, B.M.; Atnafu, G.; Duddeck, H.; Snatzke, G. *Tetrahedron* **1987**, 43, 3263.
11. Abegaz, B.M.; Tecle, B. *SINET: Ethiop. J. Sci.* **1983**, 6, 75.
12. Abegaz, B.M.; Asfaw, N.; Lwande, W. *J. Essent. Oil Res* **1993**, 5, 487.
13. Reece, C.A.; Rodin, J.O.; Brownlee, R.G.; Duncan, W.G.; Silverstein, R.M. *Tetrahedron* **1968**, 24, 4249.
14. Abegaz, B.M.; Asfaw, N.; Lwande, W. *SINET: Ethiop. J. Sci.* **1994**, 17, 145.
15. Asfaw, N.; Abegaz, B.M. *SINET: Ethiop. J. Sci.* **1994**, 18 133.
16. Thulin, M. in *Flora of Ethiopia* V.3 (Hedberg, I.; Edwards, S. Eds.) Addis Ababa and Asmara, Ethiopia and Uppsala; Sweden; 1988.
17. Coady, A. *Eth. Med. J.*, **1965**, 3, 173.
18. Kleyn, J.; Hough, J. *The Microbiology of Brewing: Annual Review of Microbiology*, **1971**, 25, 583.
19. Sahle, S.; Gashe, B.A. *SINET: Ethiop. J. Sci.*, **1991**, 14, 93.
20. Tessema, A. D. Ph.D. dissertation, Moscow State Academy of Food Products, 1994, Moscow.
21. Abegaz, B.M.; Dagne, E. *Bull. Chem. Soc. Ethiop.* **1988**, 2, 15.
22. Abegaz, B.M.; Peter, M.G. *Phytochemistry* **1995**, 39, 1411.
23. Abegaz, B.M.; Kebede, T. *Bull. Chem. Soc. Ethiop.* **1995**, 9, 107.
24. Holmes, E.M. *Pharm. J.* **1913**, 90, 795; *Chem. Abstr.* **1913**, 7, 2979.
25. Spencer, P.S.; Roy, D.N.; Ludolph, A.; Hugon, J.; Dwivedi, M.P.; Schaumburg, H.S. *Lancet* **1986**, II, 1066.
26. Rao, S.L.N.; Adiga, P.R.; Sarma, P.S. *Biochem.* **1964**, 3, 432.
27. Cohn, D.F. in *Nutrition, Neurotoxins and Lathyrism: The ODAP Challenge* (Abegaz, B.M.; T.-Haimanot, R.; Palmer, V.S.; Spencer. P.S. Eds.) Third World Medical Research Foundation: New York; 1994; pp 33-35.
28. Gebre-Ab, T.; Wolde-Gabriel, Z.; Maffi, M.; Ahmed, Z.; Ayele, T.M.; Fanta, H. *Ethiop. Med. J.* **1978**, 16, 1.
29. Rao, S.L.N. *Anal. Biochem.* **1978**, 86, 386.
30. Abegaz, B.M.; Nunn, P.B.; De Bruyn, A.; Lambein, F. in *Nutrition, Neurotoxins and Lathyrism: The ODAP Challenge* (Abegaz, B.M.; T.-Haimanot, R.; Palmer, V.S.; Spencer, P.S. Eds.), Third World Medical Research Foundation: New York:, 1994; pp 89-96.
31. Bell, E.A.; O'Donovan, J.P. *Phytochemistry* **1966**, 5, 1211.
32. Bridges, R.J.; Hatalski, C.; Shim, S.N.; Nunn, P.B. *Brain Res.* **1991**, 561, 262.
33. Abegaz, B.M.; Nunn, P.B.; De Bruyn, A.; Lambein, F. *Phytochemistry* **1993**, 33, 1121.
34. De Bruyn, A.; Van Haver, D.; Lambein, F. Abegaz, B.; *Natural Toxins* **1993**, 1, 328.
35. De Bruyn, A.; Becu, C.; Lambein, F.; Kebede, N.; Abegaz, B.; Nunn, P. *Phytochemistry* **1994**, 36, 85.
36. Belay, A.; Moges, G.; Solomon, R.; Johansson, G. Paper presented at the International Conference on Lathyrus and Lathyrism, 27-29 November, 1995, Addis Ababa, Ethiopia.

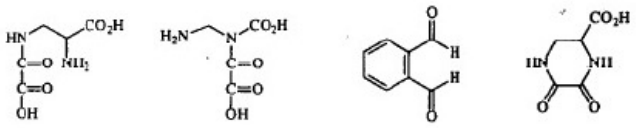
bitter despite the presence of a glucose moiety in the structure. The toxicity of geshoidin to brine shrimp (*Artemia salina)* was evaluated at seven different concentrations over a range of 64 folds (15 to 1000 μg/ml)[2]. No lethality was observed. Preliminary assay for possible cytotoxicity of geshoidin has also been negative[3]. Although rigorous toxicity tests should be conducted on geshoidin, the results obtained so far suggest that this compound may have commercial potential.

3. POISONOUS PLANTS

3.1 *Lathyrus sativus (Guaya)*

One of the poisonous plants listed in Appendix 1 is the food legume, *Lathyrus sativus*, or grass pea, which is commonly known in Amharic as *Guaya*. In my childhood, I had been made aware of the debilitating effects of this plant. I recall being told not to lay down on the fresh plant, nor to consume any *Kita*[4] made from *Guaya* together with milk as this was thought to lead to enhanced toxicity manifestations. With this background, I was understandably keen to learn about the chemistry of this otherwise very tasty legume. Although the above claims are not scientifically substantiated, we now know a lot more about the chemical composition and toxicological properties of *Guaya*.

As early as 1913, *L. sativus* was reported as a cumulative poison causing paralysis of the lower limbs in man [24]. The human neurological disorder, Lathyrism, resulting from excess consumption of the seeds of grass pea, is caused by the non protein amino acid ß-N-oxalyl-2,3-diaminopropanoic acid (**17**) (ß-ODAP) [25, 26]. There are historical accounts on how several hundred Rumanian jews were intentionally fed with this legume, which resulted in many of them becoming lathyritic [27]. There have also been epidemic levels of lathyrism resulting from high level consumption of grass pea in communities where food shortages occur either due to flooding or drought. One such epidemic occurred in northwest Ethiopia in 1976 [28].



17 **18** **19** **20**

The simplest and the most common method for assaying the level of toxin in *L. sativus* is that of Rao, which relies on the formation of a colored derivative when the hydrolysis product of ß-ODAP is reacted with *ortho*-phthaldehyde (**19**) [29].. This method has been employed in the Department of Chemistry of Addis Ababa University for the determination of the toxin level in seed samples and also in various food preparations (Table 1). While this method is quite simple and can be used to determine the amount of diaminopropanoic acid (DAP, which is the hydrolysis product of ß-ODAP) in seeds and other samples it also detects any other substance

---

[2] We are grateful to Ato Mesfin Bogale of ESTC for making this determination.

[3] We are grateful to Dr. R. Becker of the University of the North, South Africa for this information.

[4] An unleavened bread prepared from the flour of cereals or legumes or a mixture of both.