1981, Vol. 42, pp. 229–235, © Hippokrates Verlag GmbH

Planta medica Journal of Medicinal Plant Research

The Content of Psilocybin in Norwegian Psilocybe semilanceata

A. L. Christiansen*, K. E. Rasmussen* and K. Høiland**

* Institute of Pharmacy, University of Oslo, Norway

** Botanical Garden and Museum, University of Oslo, Norway

Key Word Index: Psilocybe semilanceata; Habitat; Distribution; Psilocybin Content.

Abstract

Psilocybe semilanceata contains hallucinogenic indole alkaloids and has been used as a narcotic drug in Norway. The content of psilocybin, the major constituent in Norwegian *P. semilanceata*, has been investigated as well as its habitats and its distribution throughout the country. The mushroom is growing on grassy sites in most parts of Norway from the middle of August to the middle of October. The psilocybin content in dried mushrooms varied considerably, from 0.17 to 1.96 %. The highest concentrations in percent was found among the smaller mushrooms whereas the content in mg was highest in larger mushrooms. The content of psilocybin makes *P. semilanceata* to a potent hallucinogenic drug.

Introduction

Ingestion of *Psilocybe semilanceata* (Fr. ex Secr.) Kummer as a hallucinogenic drug has been rather popular among groups of young people in Norway. Until 1977 the narcotic properties of this fungus was unknown to the Norwegian public. However, the fungus itself was known from popular handbooks dealing with edible and poisonous mushrooms [1], but only as a tiny, unedible species very like other small mushrooms growing on grassy sites. In the autumn 1977 came the first report of people ingesting *P. semilanceata* (from Sandnes in Rogaland county, SW Norway), and since then the use of it as a narcotic drug has increased. Some people have been hospitalized after eating *P. semilanceata* [2, 3]. The knowledge of this narcotic mushroom and the use of it, has been spread over the whole country by means of daily newspapers, coloured weekly magazines, and underground literature. The use of *P. semilanceata* is also known from other European countries e.g. Denmark, Great Britain and The Netherlands.

The hallucinogenic substance psilocybin is previously reported from Norwegian specimens of *P. semilanceata* [4,

5]. In these reports the identification of psilocybin was based on thin-layer chromatography. Because of the increasing use of *P. semilanceata* as a hallucinogenic drug it was necessary to study more carefully the content of psilocybin in Norwegian species and the habitats and the distribution of the mushroom throughout the country. A liquid chromatographic method was worked out for the psilocybin assay [6] and the results from the investigation of the psilocybin content in Norwegian *P. semilanceata* is reported in this paper.

Material and Methods

Distribution of P. semilanceata in Norway

The map in figure 1 is based on a map of the distribution of *P. semilanceata* in Norway [5], but some later finds are included. In addition the places where misuse is reported are plotted on the map. These informations are gathered from newspapers, weekly magazines, medical journals, police reports, and personal communications from Norwegian mycologists.

Harvest of P. semilanceata

During 1979 and 1980 mushrooms were harvested for analysis from 16 different locations in Norway. These locations are plotted as numbers on the map in figure 1. Immediately after harvesting the mushrooms were dried overnight at 50° C and sent to the laboratory for analysis. The date of collection as well as the habitat was recorded, and the data are given in table I.

Analysis of the psilocybin content

The air dried mushrooms were analyzed for the content of psilocybin by means of a liquid chromatographic procedure [6]. Three mushrooms from each location were usually analyzed and the results are given in table I.

The dried mushrooms were accurately weighed and ground to a powder in a mortar. The mushroom powder was transferred to a glass-stoppered centrifuge tube and extracted twice with a total of

Fig. 1. Psilocybe semilanceata in Norway.
Filled circles: Finds of *P. semilanceata* where material is present. Numbers: Specimens analyzed for psilocybin in table I.
Open circles: Literature records with no present material.
Asterisk: places where ingestion of the mushroom as a narcotic drug is reported.

Table I

The content of psilocybin in *Psilocybe semilanceata*.

location	time of collection	habitat	weight of dried mushroom mg	content of psilocybin mg	%
1	ult. Aug. 1979	grassy field	18	0.19	1.06
			29	0.31	1.04
			31	0.38	1.22
2	14. Sept. 1980	lawn	17	0.20	1.13
			21	0.18	0.84
			40	0.53	1.34
3	25. Aug. 1980	lawn	24	0.31	1.27
			37	0.36	0.95
			56	0.63	1.13
4	31. Aug. 1980	grassy side of a track 850 m above sea level	45	0.35	0.77
			53	0.30	0.55
			61	0.35	0.58
5	12. Oct. 1980	grassy field nearby hill farm 850 m above sea level	98	0.75	0.76
6	not recorded	not recorded	53	0.33	0.62
			64	0.39	0.60
7	not recorded	not recorded	31	0.24	0.77
			35	0.34	1.00
			45	0.23	0.52
			47	0.42	0.87
			54	0.30	0.57
			55	0.21	0.38
8	3. Sept. 1980	cultivated pasture	18	0.36	1.96
			31	0.52	1.68
			39	0.75	1.96
9	7. Sept. 1980	sheep pasture	17	0.17	1.01
			25	0.34	1.34
			32	0.53	1.66
10	12. Sept. 1980	grassy side of a track 950 m above sea level	38	0.27	0.72
			58	0.41	0.70
			65	0.42	0.65
11	14. Sept. 1980	lawn	39	0.40	1.00
			52	0.38	0.73
			54	0.44	0.82
12	12. Sept. 1980	not recorded	18	0.18	0.98
			31	0.48	1.53
			74	0.13	0.17
13	9. Sept. 1980	pasture	7	0.13	1.95
			9	0.11	1.17
			16	0.13	0.82
			23	0.20	0.88
14	10. Sept. 1980	grassy field near farm	25	0.21	0.87
			33	0.20	0.60
			118	0.85	0.72

location	time of collection	habitat	weight of dried mushroom mg	content of psilocybin mg	%
15	not recorded	uncultivated pasture	40	0.10	0.27
			40	0.43	1.06
			72	0.36	0.50
16	26. Aug. 1979	grassy side of a track	27	0.20	0.73
			30	0.16	0.55
			38	0.26	0.68

5.00 ml 10 % 1 N ammonium nitrate in methanol. 10 µl of the extract was injected into the liquid chromatograph. The column was a 25 cm × 4.6 mm I.D. stainless steel tube, slurry packed with small particle silica (6 µm Partisil 5, Whatman Ltd., England). The mobile phase was methanol – water – 1 N ammonium nitrate (220:70:10). The 1 N ammonium nitrate solution was buffered to pH 9.6 with 2 N ammonia. A reciprocating pump (Glenco Scientific, Houston, Texas) was used to deliver the solvent at 1 ml min^{-1}, and a Spectra Physics Model 225 UV-detector was used to monitor the eluent at 254 nm. Samples were introduced through a Rheodyne Model 7120 rotary valve injector equipped with an external 10 µl sample loop. Quantitation was based on peak height measurements, and psilocybin supplied by Sandoz (Basel, Switzerland) was used as standard.

Results and Discussion

Figure 1 shows the recorded distribution of *P. semilanceata* in Norway. It is found north to Troms county, but unofficial reports are from Finnmark county. It occurs in all parts of Norway, but is probably most common along the coast. In the inland areas mushrooms are found scattered on the localities, while in the coastal sites they usually are frequent and can be collected in large quantities. *P. semilanceata* is perhaps most frequent in areas with a rainy climate [7]. This can explain why the fungus is so common along the coast.

P. semilanceata grows always among grass. It must be dependant on decaying grass debris. Its main habitats (see table I) are grassy fields, pastures, lawns, and grassy sides of tracks. Moderately grazed, old pastures and untrimmed lawns seem to be its most favorable growing places. It is often found in hummocks of *Deschampsia caespitosa* (L.) PB., a grass typical for uncultivated pastures with a high ground water level. It is never found directly on dung, and it is seldom on highly manured soil.

The season for *P. semilanceata* endures from the middle of August to the middle of October. Its main season seems to be September (see table I).

From Figure 1 we see that all reports of misuse of *P. semilanceata* in Norway are from the coast or in the vicinity; i.e. in the areas of Norway where the mushroom seems to be most frequent. This is natural, since it is probably only in the coastal areas where the mushroom could be collected in large enough quantities for misuse.

The Norwegian *P. semilanceata* is a tiny mushroom. Figure 2 shows the weight frequencies of the dried mush-

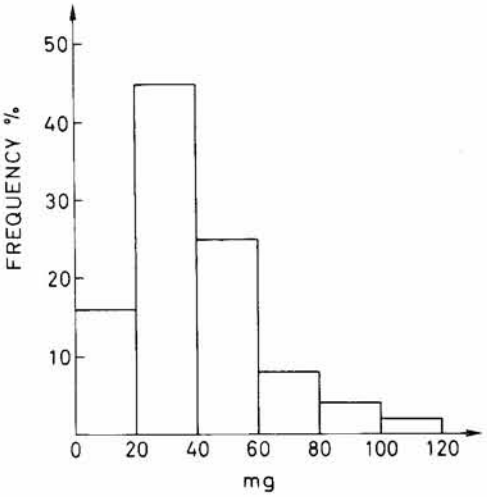

Fig. 2. Weight frequencies of the dried mushrooms taken to analysis.

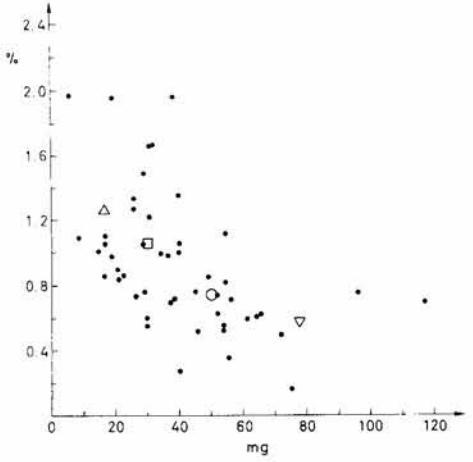

Fig. 3. Content of psilocybin in percent plotted against the mushroom weight.
△: mean value of mushrooms weighing up to 20 mg.
□: mean value of mushrooms weighing 20–40 mg.
○: mean value of mushrooms weighing 40–60 mg.
▽: mean value of mushrooms weighing more than 60 mg.

rooms taken to analysis. 70 % of the dried mushrooms collected weighed between 20 and 60 mg. Freshly collected *P. semilanceata* showed a weight loss of 92 % after drying overnight at 50 ° C.

The psilocybin content varied considerably (see table I), but does not seem to be correlated with the geographical location of the mushroom. There must be other reasons for the variation of the psilocybin content. We suggest that the concentration of soluble nitrogen and phosphorus compounds in the soil may play an important role for the psilocybin content in the mushroom. On the other hand, there seems to be a correlation between the psilocybin content and the weight of the mushroom.

Figure 3 shows the psilocybin content in percent plotted against the mushroom weight. From this figure it seems as the smaller mushrooms contain a higher tissue concentration of psilocybin than the larger ones. This is more clearly seen after dividing the mushrooms into increa-

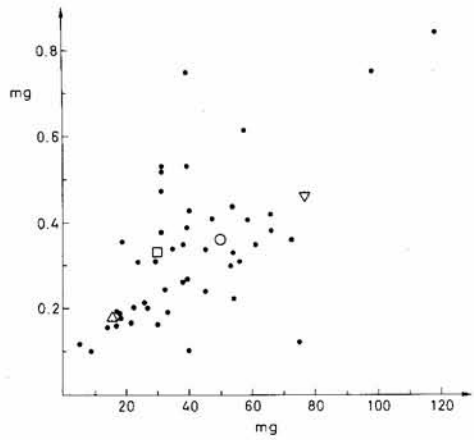

Fig. 4. Content of psilocybin in mg plotted against the mushroom weight.
△: mean value of mushrooms weighing up to 20 mg.
□: mean value of mushrooms weighing 20–40 mg.
○: mean value of mushrooms weighing 40–60 mg.
▽: mean value of mushrooms weighing more than 60 mg.

sing 20 mg weight groups and calculating the mean values within each group. The average tissue concentration decreases as the weight increases. Mushrooms weighing up to 20 mg had an average tissue concentration of 1.26 % whereas the ones weighing more than 60 mg had an average tissue concentration of 0.57 %. However, within each group there was a large variation in psilocybin content.

The psilocybin content in mg is plotted against the mushroom weight in figure 4. Even if the tissue concentration in percent is higher in the smaller mushrooms than in the larger ones, figure 4 shows that the psilocybin content in mg is highest in the larger mushrooms. Psilocybin must therefore be produced during the growth. This is more clearly seen form the calculations of the mean values within the increasing 20 mg weight groups. The average content of psilocybin in mushrooms weighing up to 20 mg was 0.18 mg and the mushrooms weighing more than 60 mg had an average content of 0.46 mg psilocybin.

The content of psilocybin makes the Norwegian *P. semilanceata* to a potent narcotic drug. The psilocybin level is uncommonly high (up to 2.0 %) since values reported for psilocybin in hallucinogenic mushrooms are usually below 1 % [8, 9]. North American *P. semilanceata* is, however, reported to contain up to 1.5 % psilocybin and is considered to be the most potent North American species [10]. *P. semilanceata* is also probably the most potent European species.

A medium oral dose of psilocybin is about 4–8 mg [9]. It produces psychic symptoms with effects on the mood and the environmental contact [9]. Ingestion of ten to twenty dried 40 mg mushrooms with a 1 % psilocybin content should produce similar effects. However, because of the large variation in potency within individual mushrooms, identical dosages based on a weight basis or on the number of mushrooms ingested may produce a powerful hallucinogenic effect as well as almost no effect at all. Two cases of hospitalization due to overdose of *P. semilanceata* have been reported in Norway.

Psilocybin is placed on the list of narcotic drugs. However, according to the Norwegian law Norwegian mushrooms containing psilocybin are not regarded as narcotic drugs.

Acknowledgements

We are indebted to Mr. O. AAS (University of Bergen), Mr. O. GRANDE (Ålesund), Mr. S. SIVERTSEN (University of Trondheim), and Mr. O. SKIFTE (University of Tromsø) for collecting *P. semilanceata*; Dr. U. SØCHTING and Dr. H. KNUDSEN (University of Copehagen), Dr. M. NOORDELOOS (State University of Leiden), Dr. R. WATLING (Royal Botanic Garden, Edinburgh), and Dr. P. MARGOT (University of Strathclyde, Glasgow) for information about misuse of *P. semilanceata* in Denmark, The Netherlands, and Great Britain; and to Mr. F. TØNNESEN (University of Oslo) for skilful technical assistance.

References

1. Lange, L.: Soppflora. Norsk utgave ved F. E. Eckblad, 3. utg., Oslo 1976, NKS-Forlaget.
2. Gundersen, T.: Tidsskr. Nor. Lægeforen. *99*, 424 (1979).
3. Kvambe, E. and J. Edenberg: Tidsskr. Nor. Lægeforen. *99*, 1453 (1979).

4. Schumacher, T.: Våre nyttevekster *71*, 110 (1976).
5. Høiland, K.: Norw. J. Bot. *25*, 111 (1978).
6. Christiansen, A. L., K. E. Rasmussen and F. Tønnesen: J. Chromatogr., *210*, 163 (1981).
7. Duffy, T. J. and P. P. Vergeer: California Toxic Fungi, San Fransisco 1977, Mycological Society San Fransisco Inc.
8. Heim, R., K. Genest, D. W. Hughes and G. Belec: J. Forensic Sci. Soc. *6*, 1922 (1966).
9. Lincoff, G. and D. H. Mitchel: Toxic and Hallucinogenic Mushroom Poisoning, New York 1977, Van Nostrand Reinhold Company.
10. Miller, R. A. and D. Tatelman: Magical Mushroom Handbook, Seatle, Washington 1977, Homestead Book Company.

Address:
A. L. Christiansen and K. E. Rasmussen,
Department of Pharmaceutical Chemistry,
Institute of Pharmacy, University of Oslo,
P. O. Box 1068 Blindern, Oslo 3, Norway

K. Høiland,
Botanical Garden and Museum,
University of Oslo,
Trondheimsveien 23 B,
Oslo 5, Norway