

Short Communication

## Novel Indole Derivatives from the Fruit Bodies of *Tricholoma sciodes*

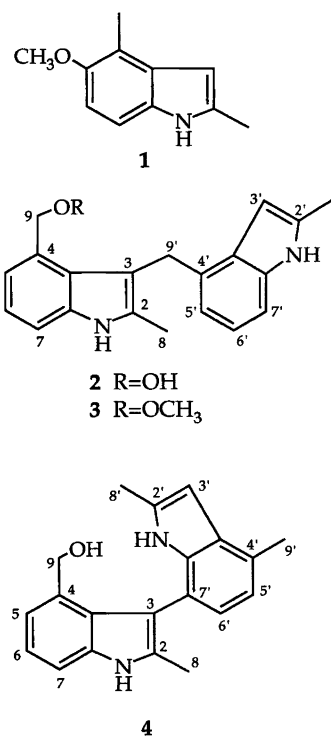
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The fruit bodies of *Tricholoma sciodes* have a bitter taste which slowly turns pungent, and this characteristic is used by mycologists as a taxonomic marker. Bitter or pungent natural products may also have biological functions as repellents or antifeedants, as for instance has been suggested for the bitter phenols and the pungent sesquiterpenes isolated from species belonging to the genus *Lactarius*.<sup>1,2</sup> A bitter compound has been isolated from the related species *Tricholoma lascivum*, and shown to be the glutamate derivative lascivol,<sup>3</sup> but no pungent principles have been reported from *Tricholoma*. However, previous investigations<sup>4,5</sup> of *T. sciodes* have shown that the pungency is very difficult to extract from the fruit bodies, probably because the pungent compounds are unstable. Instead several nonpungent indole derivatives were obtained: 2,4-dimethylindole,<sup>4</sup> 2-methyl-4-hydroxymethylindole,<sup>4</sup> 2-methyl-4-methoxymethylindole<sup>4</sup> and sciodule.<sup>5</sup> In this paper we report the isolation of four additional indole derivatives (compounds 1–4) that were obtained in smaller amounts.

The indole derivatives were isolated by silica-gel column chromatography, and the structure determinations were based on high-resolution mass spectrometry and NMR spectroscopy. The <sup>1</sup>H and <sup>13</sup>C NMR data of compounds 2–4 are summarised in Tables 1 and 2. Data obtained from direct as well as long-range <sup>1</sup>H–<sup>13</sup>C correlations and NOESY correlations (data not shown) supported the suggested structures 1–4. 5-Methoxy-2,4-dimethylindole (1) has previously been shown to be formed when the bitter principle of *T. lascivum*, lascivol, is treated with strong acid,<sup>3</sup> and is reported here as a natural product for the first time. The NMR data reported for compound 1 in Ref. 3 are identical with those obtained here. The dimers 2–4 are new compounds, and their formation



in the fruit bodies can be envisaged either by an oxidative coupling of the corresponding monomers (also present in the fruit bodies, *vide supra*) catalysed by an oxidase, or by a nucleophilic attack by 2-methyl-4-hydroxymethylindole or 2-methyl-4-methoxymethylindole on a hypothetical electrophilic derivative of 2-methyl-4-hydroxymethylindole in which the hydroxyl group has been converted into an efficient leaving group. It is possible that such radicals or electrophiles, if formed, are responsible for the pungency of the fruit bodies, which would explain why the pungent principles are difficult to isolate.

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Table 1. <sup>1</sup>H (500 MHz) NMR data for compounds 2–4.<sup>a</sup>

	2	3	4
H	δ; mult.; J	δ; mult.; J	δ; mult.; J
1	10.00; brs	10.05; brs	8.23; brs
3	—	—	—
5	6.96; m	6.88; d; 7.2	7.03; d; 7.2
6	6.96; m	6.97; dd; 7, 8	7.14; dd; 7, 8
7	7.24; d; 9	7.31; d; 8.0	7.30; d; 8.0
8	2.35; s	2.36; s	2.23; s
9	4.65; s	4.35; s	4.28; s
OCH <sub>3</sub>	—	3.14; s	—
1'	9.98; brs	9.98; brs	7.68; brs
3'	6.38; m	6.39; m	6.29; m
5'	6.33; d; 7.2	6.31; d; 7.3	6.96; d; 7.3
6'	6.77; dd; 7, 8	6.78; dd; 7, 8	6.99; d; 7.3
7'	7.08; d; 7.9	7.10; d; 8.1	—
8'	2.47; s	2.48; d; 0.9	2.33; s
9'	4.44; s	4.41; s	2.58; s

<sup>a</sup> The spectra were recorded in CD<sub>3</sub>COCD<sub>3</sub> (compounds 2 and 3) and CDCl<sub>3</sub> (compound 4), and the solvent signals (2.05 and 7.26 ppm) were used as reference. The coupling constants *J* are given in Hz.

Table 2. <sup>13</sup>C (125 MHz) NMR data for compounds 2–4.<sup>a</sup>

	2	3	4
C	δ; mult.	δ; mult.	δ; mult.
2	133.5; s	134.1; s	133.5; s
3	109.7; d	109.9; s	109.7; s
3a	127.5; s	128.4; s	126.0; s
4	134.3; s	130.2; s	132.9; s
5	118.9; d	121.0; q	119.9; d
6	120.7; d	120.5; d	121.3; d
7	110.5; d	111.3; d	110.3; d
7a	137.1; <sup>b</sup> s	137.4; s	135.8; s
8	11.5; q	11.5; q	12.0; q
9	63.1; t	73.8; t	63.3; t
OCH <sub>3</sub>	—	57.3; q	—
2'	135.3; s	135.5; s	134.7; s
3'	98.9; d	98.9; d	99.5; d
3a'	129.1; t	129.1; s	128.7; s
4'	134.1; s	134.1; s	128.6; s
5'	118.0; d	118.0; d	120.3; d
6'	121.1; d	121.2; d	123.1; d
7'	108.8; d	108.4; d	116.2; s
7a'	137.0; <sup>b</sup> s	137.2; s	136.2; s
8'	13.6; q	13.7; q	13.7; q
9'	28.8; t	28.4; t	18.8; q

<sup>a</sup> The spectra were recorded in CD<sub>3</sub>COCD<sub>3</sub> (compounds 2 and 3) and CDCl<sub>3</sub> (compound 4), and the solvent signals (29.8 and 77.0 ppm) were used as reference. <sup>b</sup> Interchangeable.

## Experimental

Fruit bodies of *Tricholoma sciodes* (Secr.) Mart. were collected in the vicinity of Lund, and extracted on the same day. The fruit bodies were ground in a meat grinder with

ethyl acetate (approximately 2 l per kg fresh mushroom), and the organic phase was separated and dried with Na<sub>2</sub>SO<sub>4</sub>, whereafter the solvent was evaporated. The compounds were isolated by chromatography on silica gel columns eluted with mixtures of ethyl acetate and heptane. From 1 kg of fresh mushrooms 9 mg of 5-methoxy-2,4-dimethylindole (1), 5 mg of compound 2, 11 mg of compound 3 and 9 mg of compound 4 were obtained. The NMR spectra (data given in Tables 1 and 2) were recorded with a Bruker ARX500 spectrometer, the UV spectra with a Cary 219 spectrometer, the IR spectra with a Perkin Elmer 257 spectrometer, and the mass spectra with a Jeol SX102 spectrometer.

4-Hydroxymethyl-3-[(2-methyl-4-indolyl)-methyl]-2-methylindole (2) was obtained as a white solid, m.p. 260°C (decomp.). UV (ethanol) λ<sub>max/nm</sub> (ε): 220 (47 100), 264 (10 800), 276 (13 700). IR (KBr): 3480, 3370, 2920, 1570, 1440, 1080, 1060, 990, 780 and 770 cm<sup>-1</sup>. For NMR data see Tables 1 and 2. MS (ionization energy, 70 eV), *m/z* 304.1574 (*M*<sup>+</sup>, 38%, C<sub>20</sub>H<sub>20</sub>ON<sub>2</sub> requires 304.1576), 286 (57%), 285 (100%), 271 (65%), 143 (25%).

4-Methoxymethyl-3-[(2-methyl-4-indolyl)-methyl]-2-methylindole (3) was obtained as a yellow solid, m.p. 238–239°C. UV (ethanol) λ<sub>max/nm</sub> (ε): 221 (36 600), 277 (10 400). IR (KBr): 3380, 3260, 2900, 1630, 1560, 1450, 1440, 1390, 1340, 1230, 1170, 1080, 955, 945 and 770 cm<sup>-1</sup>. For NMR data see Tables 1 and 2. MS (ionization energy, 70 eV), *m/z* 318.1725 (*M*<sup>+</sup>, 32%, C<sub>21</sub>H<sub>22</sub>ON<sub>2</sub> requires 318.1732), 286 (84%), 285 (100%), 271 (96%), 143 (33%).

4-Hydroxymethyl-3-(2,4-dimethyl-7-indolyl)-2-methylindole (4) was obtained as a brown oil. UV (ethanol) λ<sub>max/nm</sub> (ε): 226 (37 700), 280 (12 400). IR (KBr): 3360, 2910, 1630, 1560, 1440, 1390, 1060, 990, 780 and 760 cm<sup>-1</sup>. For NMR data see Tables 1 and 2. MS (ionization energy, 70 eV), *m/z* 304.1579 (*M*<sup>+</sup>, 54%, C<sub>20</sub>H<sub>20</sub>ON<sub>2</sub> requires 304.1576), 286 (100%), 285 (62%), 271 (37%).

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