STEREOSTRUCTURE OF PLAGIOCHILINE A AND CONVERSION OF PLAGIOCHILINE A AND STEAROYLVELLUTINAL INTO HOT-TASTING COMPOUNDS BY HUMAN SALIVA

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The stereostructure of plagiochiline A (1) isolated from the liverwort Plagiochila fruticosa has been established by X-ray crystallographic analysis. Plagiochiline A was converted into plagiochilal B (2) and furanoplagiochilal (3) by human saliva, and stearoylvellutinal (4) isolated from the fungus Lactarius vellerus was converted into velleral (5), also by human saliva.

KEYWORDS plagiochiline A; X-ray crystallographic analysis; human saliva; pungent unsaturated aldehyde; furanoplagiochilal; velleral

Pungent compounds such as polygodial (6) and sacculatal (7) from Porella and Pellia species (liverwort)\(^1,2\) and velleral (5) from Lactarius species (mushroom)\(^3\) have an unsaturated dialdehyde in the molecule, and show interesting biological activities such as antifungal, antimicrobial, piscicidal and anti-cancer promotion. When one chews a whole plant of Plagiochila fruticosa and a fruit body of Lactarius vellerus which contain plagiochiline A (1)\(^3\) and stearoylvellutinal (4),\(^6\) respectively, one feels a potent pungent taste slowly. It is suggested that 1 and 4 might be converted into pungent unsaturated dialdehydes by human saliva. In this paper, we report the stereostructure of 1, and the conversion of 1 and 4 into hot-tasting compounds by human saliva.

Dry material (1.09 kg) of P. fruticosa was extracted with ether, and the extract (19.33 g) was chromatographed on silica gel and Sephadex LH-20 to afford plagiochilide (8; 1.13 g), plagiochiline C (9; 0.24 g) and plagiochiline A (1; 1.36 g). This was the first time plagiochiline A was isolated in the crystalline form, and the relative configuration was established as depicted in formula 1 by X-ray crystallographic analysis.\(^5\)
Compound 1 was treated with human saliva (pH 6.9) at 37°C for 24 hr to give plagiochilal B (2) (22.0%) and furanoplagiochilal (3) (7.5%) as shown in Table I. Compound 3 immediately shows a more pungent taste than that of unsaturated dialdehyde 2. The spectral data of 2 and 3 were identical with those of authentic samples. Human saliva consists of α-amylase, peroxidase, catalase, lipase and sulfatase as enzymes, and sodium, potassium, magnesium, calcium cations, chlorine anion and phosphoric acid as inorganic substances. Compound 1 was treated with α-amylase in phosphate buffer (pH 6.8) at 20°C for 1 day to afford the main product 2 (53.9%) and minor product 3 (1.8%), as shown in entry 2. At 37°C, the yield of 3 increased ten times, as shown in entry 3. With only phosphate buffer, almost the same result was obtained as shown in entry 4. With only water, 2 was obtained as a single compound in high yield (75%) as shown in entry 6. When 1 was treated with potassium hydrogen carbonate at 20°C for 67 hr, compound 2 was obtained as minor product (8.8%) and 3 as major product (35.6%), as shown in entry 7. At 37°C, the same reaction as 1 gave complex mixtures. Compound 2 was treated with phosphate buffer at 20°C for 1 day to afford 3 (25%), and the starting material 2 (75%) was recovered.

Plagiochilal C (9) shows no pungent taste, compared with plagiochilal A (1). Therefore, it is suggested that the reaction for 9 did not convert into pungent plagiochilal A (10) when treated with human saliva at 37°C for 1 day under the same conditions as with 1.

Table I. The Conversion of Plagiochilal A (1) into Plagiochilal B (2) and Furanoplagiochilal (3)

<table>
<thead>
<tr>
<th>Entry No.</th>
<th>Reagent</th>
<th>Time (h)</th>
<th>Temp.</th>
<th>2 (yield)*</th>
<th>3 (yield)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>human saliva</td>
<td>24</td>
<td>37°C</td>
<td>22.0 %</td>
<td>7.5 %</td>
</tr>
<tr>
<td>2</td>
<td>α-amylase + phophate buffer*</td>
<td>24</td>
<td>20°C</td>
<td>53.9 %</td>
<td>1.8 %</td>
</tr>
<tr>
<td>3</td>
<td>α-amylase + phophate buffer*</td>
<td>24</td>
<td>37°C</td>
<td>52.8 %</td>
<td>12.5 %</td>
</tr>
<tr>
<td>4</td>
<td>phophate buffer*</td>
<td>24</td>
<td>37°C</td>
<td>52.8 %</td>
<td>12.5 %</td>
</tr>
<tr>
<td>5</td>
<td>α-amylase + dist. H₂O</td>
<td>24</td>
<td>37°C</td>
<td>49.0 %</td>
<td>2.3 %</td>
</tr>
<tr>
<td>6</td>
<td>dist. H₂O</td>
<td>24</td>
<td>37°C</td>
<td>75.0 %</td>
<td>0.0 %</td>
</tr>
<tr>
<td>7</td>
<td>KHCO₃/MeOH-H₂O</td>
<td>67</td>
<td>20°C</td>
<td>53.9 %</td>
<td>1.8 %</td>
</tr>
</tbody>
</table>

*Phosphate buffer: 0.1M KH₂PO₄ + 0.1M Na₂HPO₄. *Isolated yield.
From these results, the reaction mechanism for formation of dialdehyde (2) and furanoaldehyde (3) from plagiochiline A (1) in human saliva can be presumed. Hydroxy anion or water molecule will attack the C-3. Then two acetoxy groups will be easily hydrolyzed and deacetylated with water to give a hemiacetal (11), which will be converted into plagiochilial B (2). Compound 2 can be easily converted into furano plagiochilial (3) with weak base such as Na₂HPO₄ contained in the human saliva.

![Diagram of reaction mechanisms](image)

**Fig. 2 Possible Conversion Mechanism of 1 into 2 and 3 by Human Saliva**

Stearoylvelutinal (4) was also treated with human saliva under the same conditions as shown in Table I to give a pungent unsaturated dialdehyde, velleral (5) (32%).

In spite of the absence of the unsaturated dialdehyde moiety, 1 and 4 showed potent pungent taste, and several interesting biological activities including potent insect antifeedant and piscicidal activities.¹ ³ It has been considered that these biological activities may occur due to the unsaturated aldehyde moiety generated from 1 and 4 which have a hemiacetal group. In conclusion, compounds 1 and 4 were treated with human saliva to yield hot-tasting unsaturated aldehydes 2, 3 and 5, which are responsible for the pungent taste. The relative configuration of 1 was established by X-ray crystallographic analysis. The relative configuration of 2 and 3 isolated from *Plagiochila* species (liverwort) was deduced from this.

**REFERENCES AND NOTES**


5) The crystal data for 1 (mp 62-63°C; C₁₉H₂₆O₆) are as follows: Orthorhombic; space group P 2₁ 2₁ 2₁ with a=8.641 (2), b=26.269 (6), c=8.436 (2) Å, V=1915(8) Å³, Z=4, and Cu K-α (λ=1.54178) by Mac Science MXC 18 instrument. Final R value was 0.046 for 1753 reflections.


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