

곰팡이 독소

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2. Sterigmatocystins

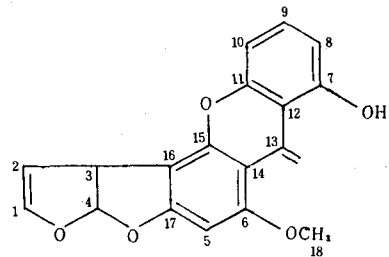
Sterigmatocystin은 *Aspergillus*種과 *Bipolaris*種에 의하여 生産되는 곰팡이 代謝產物과 밀접한 관계가 있는 곰팡이群이다. 化學적으로 이것들은 dihydrodifurano 또는 tetrahydrodifurano에 녹아있는 Xanthone性분에 의한 特徵을 가지고 있다. 여러 Sterigmatocystin사이의 化學적 차이점은 difurano環系의 2와 3 지점의 不飽和基 存在여부와 Xanthon系의 6과 7, 그리고 10의 지점에 있는 置換基, 그리고 difurano系의 3 지점에 있는 置換基에 따른다.

Sterigmatocystin 群 중에서 經濟적으로 가장 중요한 位置를 차지하고 있는 Sterigmatocystin은 毒性이 신속하며 發癌의 原因이 된다. Aflatoxin을 제외하고는 Sterigmatocystin 群에 속하는 대부분의 種類들의 독성에 관하여는 거의 알려져있지 않다. O-methyl sterigmatocystin과 같은 다른 種類들을 啮草동물에 적용하였을 때 급성중독증상은 전혀 나타나지 않았다.

生化學적으로 Sterigmatocystin과 이 群에 속하는 다른 種類들도 Aflatoxin의 生化合의인 前驅物質들이 된다. 이미 연구된 바로는 Sterigmatocystin과 Aflatoxin이 유사한 毒作用을 誘發하기는하나 그 毒作用이 同一한 것은 아니라는 것이 밝혀졌다.

Sterigmatocystin 群	分子量	分子式
Sterigmatocystin	324.0633	C ₁₈ H ₁₂ O ₆
Dihydrosterigmatocystin	326.0790	C ₁₈ H ₁₄ O ₆
O-Methylsterigmatocystin	338.0790	C ₁₉ H ₁₄ O ₆
Dihydro-O-methylsterigmatocystin	340.0946	C ₁₉ H ₁₆ O ₆
Aspertoxin	354.0739	C ₁₉ H ₁₄ O ₇
S-Methoxysterigmatocystin	354.0739	C ₁₉ H ₁₄ O ₇
Dihydrodemethylsterigmatocystin	312.0633	C ₁₇ H ₁₀ O ₆
Dimethoxysterigmatocystin	384.0844	C ₂₀ H ₁₆ O ₆

Sterigmatocystin



Common name Sterigmatocystin (3a, 12c - Dihydro-8-hydroxy-6-methoxyfuro[3', 2' : 4, 5]furo[3, 2-c]xanthen-7-one)

Molecular weight 324.0633

Molecular formula C₁₈H₁₂O₆

General characteristics Pale yellow crystals, mp 246°C (dec.) (of a sublimed sample)

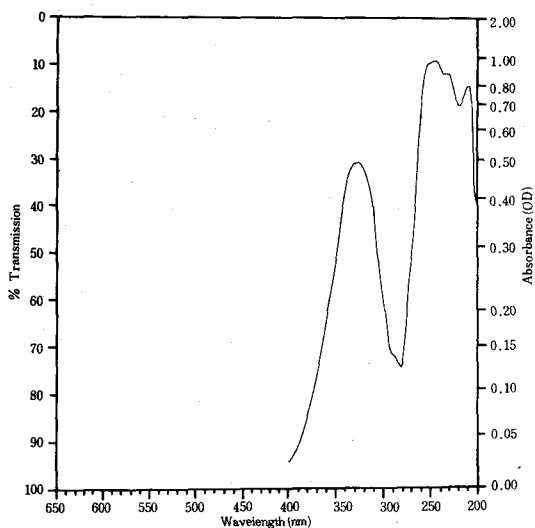
Sterigmatocystin is relatively insoluble in most solvents tested; solubility was

TLC data Adsorbent: silica gel G-HR

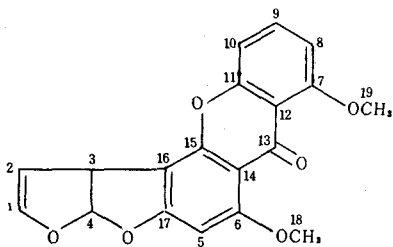
Solvent: chloroform-acetone, 93:7 v/v

Rf: 0.83

Detection: red-orange fluorescent spot under UV light



O-Methylsterigmatocystin



Common name O-Methylsterigmatocystin (6,7-Dimethoxydifuroxanthone)

Molecular weight 338.0790

Molecular formula C₁₈H₁₄O₄

General characteristics mp 274°C (colorless prisms from ethanol, synthetic compound)

mp 265°C (dec.) from methanol and chloroform heptane

mp 265° - 267°C, faintly yellow, slender rods from methanol

UV data λ_{max}^{MeOH} nm (ε) : 236 (40,700) and 310 (16,500)

[発生] : *Aspergillus flavus* Link

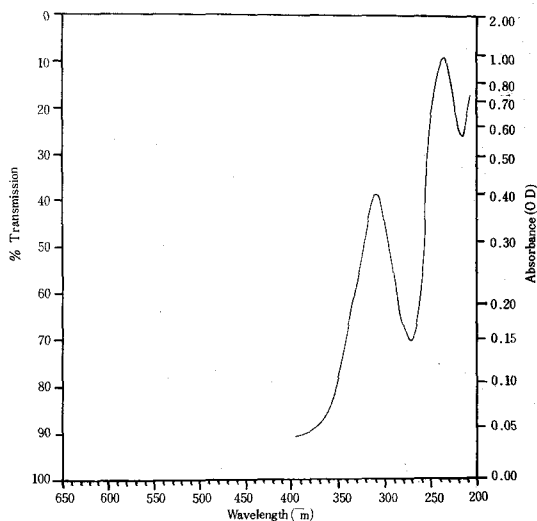
[毒性] : 알려진바 없다.

TLC data Adsorbent: silica gel G-HR

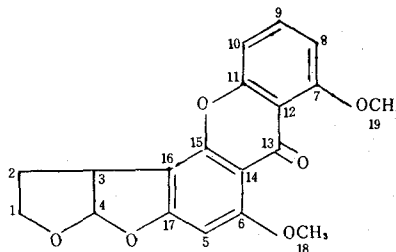
Solvent: chloroform-acetone, 93:7 v/v

Rf: 0.38

Detection: blue fluorescent spot under UV light; turns to yellow fluorescent spot after spraying with 50% ethanolic H₂SO₄



Dihydro-O-Methylsterigmatocystin



Common name Dihydro-O-methylsterigmatocystin (1,2-Dihydro-6-methoxy-7-hydroxydifuroxanthone)

Molecular weight 340.0946

Molecular formula C₁₈H₁₆O₄

General characteristics Colorless rods from methanol, mp 282° - 283°C Colorless needles from chloroform-methanol, mp 281° - 282°C

UV data λ_{max}^{MeOH} nm : 238 and 313 (ε_{max} not reported)

λ_{\max} nm (ϵ): 303 (26,300), 237 (38,900),
and 311 (17,300)

[發生]: *Aspergillus flavus*

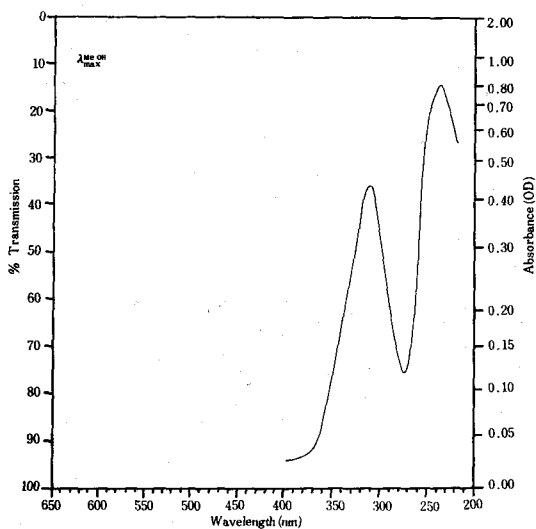
[毒性]: 原始細胞培養 (남아프리카産 긴꼬리 원숭이의 腎臟원시상피세포)에 적용된 Dihydro-O-methylsterigmatocystin의 毒性은 유사분열과 핵의 형태에 거의 영향을 미치지 않았다. 또한 [3 H] thymidine과 [3 H]Uridine의 결합에 거의 영향을 미치지 않기 때문에 DNA와 RNA 합성을 저해치 않는다.

TLC data Adsorbent: silica gel G-HR

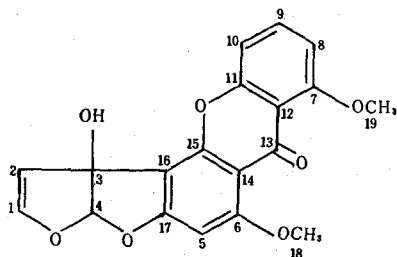
Solvent: chloroform-acetone, 93:7 v/v

Rf: 0.32

Detection: blue fluorescent spot under UV light; changing to yellow fluorescent after spraying with 50% ethanolic H_2SO_4 .



Aspertoxin



Common name Aspertoxin (3-Hydroxy-6,7-dimethoxydifuroxanthone)

Molecular weight 354.0739

Molecular formula $C_{18}H_{14}O_7$

General characteristics mp $240^\circ - 280^\circ$ (dec.) from dioxane/ H_2O
mp $325^\circ - 327^\circ$, from dimethylformamide (α) $^{27} - 140^\circ$ ($C=0.025$, in dimethylformamide)

Aspertoxin is insoluble in most organic solvents.

UV data λ_{\max}^{MeOH} nm (ϵ): 241 (33,900) and 310 (12,100)

[發生]: *Aspergillus flavus* Link

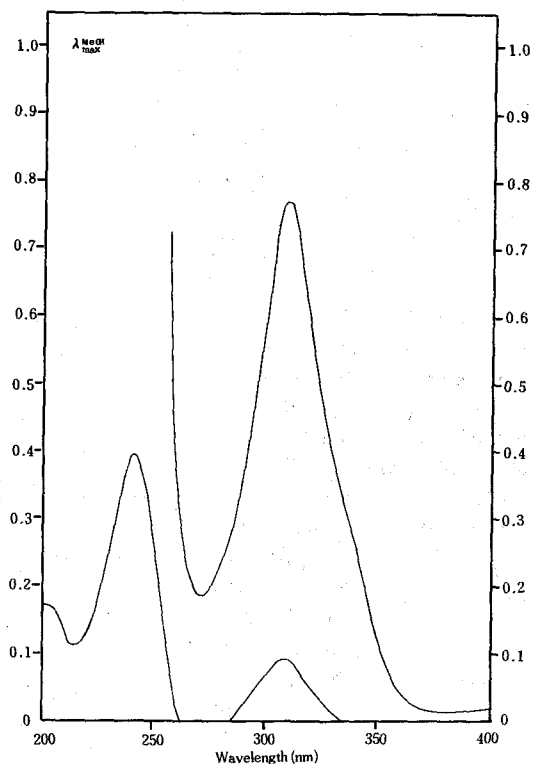
[毒性]: 發育중인 鷄胎兒에 계란 1개당 2.0 μ g씩을 난황 또는 氣囊에 注入하였을 경우 胚의 癱死率이 100%였으나 0.7 μ g씩을 주입하였을 때는 배폐사율은 50%였다. 현미경으로 胚를 살펴보면 부리가 畸形이며, 全身浮腫과 筋緊張力의 상실, 그리고 臍血管에서의 出血을 볼 수 있다.

TLC data Adsorbent: silica gel

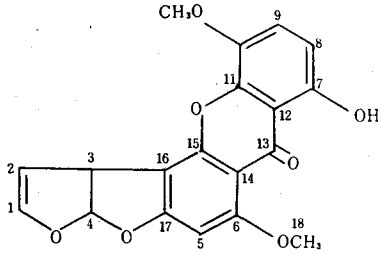
Solvent: chloroform-acetic acid, 9:1 v/v

Rf: 0.55-0.60

Detection: blue fluorescent spot under UV light



5 - Methoxysterigmatocystin



Common name 5-Methoxysterigmatocystin (7-Hydroxy-6,10-dimethoxydifuroxanthone)

Molecular weight 354.0739

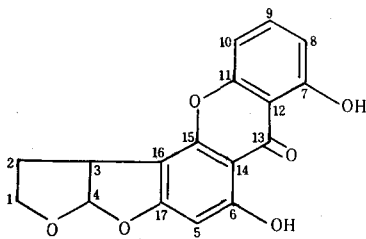
Molecular formula C₁₉H₁₄O₇

General characteristics Pale yellow needles from sublimed sample, mp 223°C (dec.)
[α]_D²⁰ -360° (C=0.238 in chloroform)

UV data λ_{max}^{EtOH} nm (ε) : 232 (24, 100), 248 (26, 800), 279 (11, 200), and 331 (12, 100)

[発生] : *Aspergillus versicolor* (Vuill.) Tiraboschi

Dihydrodemethyl sterigmatocystin



Common name Dihydrodemethylsterigmatocystin (1,2-Dihydro-6,7-hydroxydifuroxanthone)

Molecular weight 312.0633

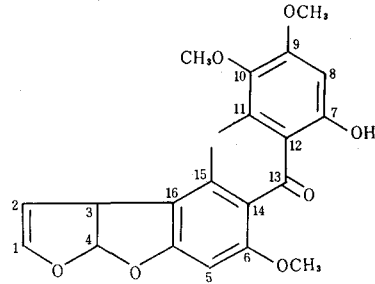
Molecular formula C₁₇H₁₂O₆

General characteristics Pale yellow needles from acetone, mp 202°C (dec.)
[α]_D²⁵ -376.6° (C=0.90 in chloroform)
Green ferric reaction in ethanol

UV data λ_{max}^{EtOH} nm (ε) : 233 (26, 800), 250 (33, 100), 259 (30, 300), and 335 (19, 400)

[発生] : *Aspergillus versicolor* (Vuill.) Tiraboschi

Dimethoxysterigmatocystin



Common name Dimethoxysterigmatocystin (6,9,10-Trimethoxy-7-hydroxydifuroxanthone)

Molecular weight 384.0844

Molecular formula C₂₀H₁₆O₈

General characteristics Pale yellow needles from acetone, mp 253°-254°C; dihydro derivative, mp 241°-242°C; acetate derivative, mp 188°-189°C (X-ray analysis); monomethyl ether derivative, mp 257°-258°C

UV data λ_{max}^{EtOH} nm (ε) : 233 (27, 200), 284 (34, 000), 275 (sh) (7, 700), and 330 (19, 200)

3. Versicolorin群

Versicolorin群은 脊椎動物에게 急性毒性을 나타내는 곰팡이 代謝産物群이다. 이 대사산물들의 중요한 様相은 곰팡이 毒素學과 관련이 있으므로 그들의 化學的構造 (Aflatoxin들과 Sterigmatocystin들에서와 마찬가지로 dihydrodifurano와 tetra hydrodifurano가 存在함)와 Versicolorin群의 대부분이 Aflatoxin과 Sterigmatocystin의 生合成的前體物質들이라는 論證을 밑바탕으로 하고 있다.

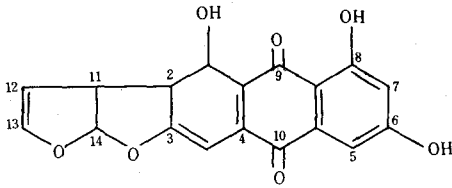
Versicolorin群은 dihydrodifurano와 tetrahydrodifurano뿐만 아니라 anthraquinone環의 置換位置와 數에 의하여 서로 구별되는 anthraquinone도 함유하고 있다.

또한 Versicolorin群에는 Versiconol hemiacetal acetate, Versiconol acetate, Versiconol, Averufin, Nidurufin, dimethylnidurufin, Aversin, Norsaloric acid 그리고 O-methylaversin이 포함되는데 이들 모두가 aflatoxin 들

의 生成成的前驅物質들이 된다.

Versicolorin 群	分子量	分子式
Versicolorin A	338.0426	C ₁₈ H ₁₀ O ₇
Versicolorin B	340.0582	C ₁₈ H ₁₂ O ₇
Versicolorin C	340.0582	C ₁₈ H ₁₂ O ₇
Averufin	368.0895	C ₂₀ H ₁₆ O ₇
Norsolorinic acid	370.1052	C ₂₀ H ₁₆ O ₇
Versiconal hemiacetal acetate	400.0793	C ₂₀ H ₁₈ O ₉
Versiconol acetate	402.0945	C ₂₀ H ₁₈ O ₉
Versiconol	360.0844	C ₁₈ H ₁₄ O ₈
Nidurufin	384.0844	C ₂₀ H ₁₆ O ₈
Dimethylnidurufin	412.1157	C ₂₂ H ₂₀ O ₈
Aversin	368.0896	C ₂₀ H ₁₆ O ₇
O-Methylaversin	382.1052	C ₂₁ H ₁₈ O ₇

Versicolorin A



Common name Versicolorin A (2,3-Bisfuran-1,6,8-trihydroxy-anthraquinone)

Molecular weight 338.0426

Molecular formula C₁₈H₁₀O₇

[一般的特性]: Versicolorin A는 acetone dioxane, ethyl acetate, ether와 ethanol에 녹으며 Chloroform과 Benzene에는 약간만 녹고 물과 수용성 중탄산에는 녹지않는다.

Versicolorin A는 Aflatoxin들의 전구물질이다.

Orange-yellow needles from acetone, mp 289°C (dec.)

Fine yellow needles from hexane, mp 287-288°C (dec.)

[α]_D²⁵ -354° (C=0.75 in dioxane)

Trimethyl ether, mp 241°C

UV data λ_{max}^{EtOH} nm (ε): 222 (31,488), 254 (16,227), 265 (17,756), 290 (26,547), 321 (12,118) and 453 (8,166)
λ_{max}^{EtOH} nm (ε): 222 (28,100), 255 (13,500), 267 (18,200), 290 (25,100), 326 (6,700), and 450 (7,000)

[發生]: *Aspergillus versicolor*

A. parasiticus (mutant strain 1-11-105 wk-1)

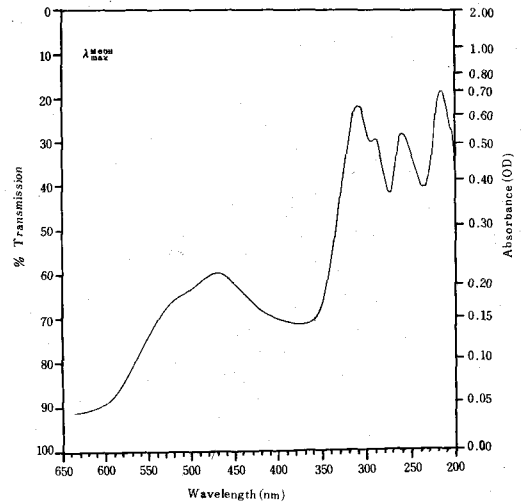
[毒性]: 毒性은 알려져 있지 않다.

TLC data Adsorbent: adsorbosil-1 silica gel

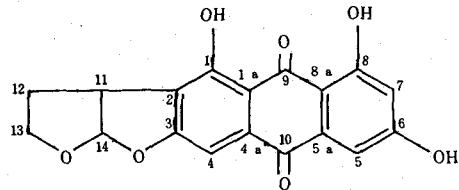
Solvent: benzene-acetic acid, 95:5 v/v

Rf: 0.32

Detection: yellow-orange spot in visible light



Versicolorin B



Common name Versicolorin B (2,3-Bis-tetrahydrofuran-1,6,8-trihydroxyanthraquinone)

Molecular weight 340.0582

Molecular formula C₁₈H₁₂O₇

[一般的特性]: Fine yellow needles from acetone, mp 298°C (dec.)

Trimethyl ether, mp 216°C

[α]_D²⁵ -223° (C=0.42 in dioxane)

Versicolorin B는 acetone, dioxane, ethyl acetate, ether와 ethanol에 잘 녹으나 chloroform

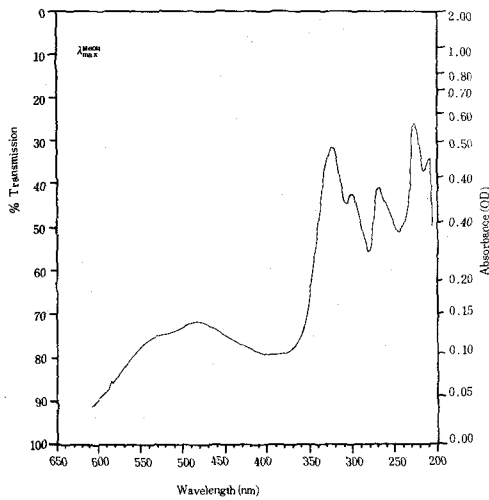
과 Benzene에는 약간만 녹고 물과 水性, 중탄산소디움에는 녹지 않음.

UV data $\lambda_{\text{max}}^{\text{EtOH}}$ nm (ϵ): 223 (23,900), 255 (13,500),
266 (19,500), 291 (24,900),
324 (12,800), and 450 (8,700)

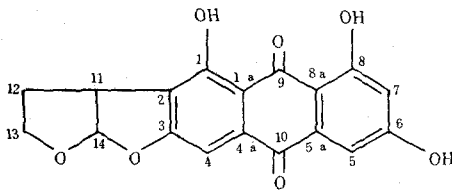
[發生]: *Aspergillus versicolor* (Vuill.) Tiraboschi

[毒性]: 毒性은 알려져 있지 않음.

TLC data Adsorbent: silica gel
Solvent: benzene-acetic acid, 95:5 v/v
Rf: 0.23
Detection: yellow spot in visible light



Versicolorin C (2,3-Bistetra hydrofurano-1, 6,8-trihydroxy anthraquinone)



Common name Versicolorin C (2,3-Bistetrahydrofurano-1,6,8-trihydroxyanthraquinone)

Molecular weight 340.0582

Molecular formula $C_{18}H_{12}O_7$

[一般的特性]: Orange needles from acetone, mp 310°C

$[\alpha]_D^{20}$ (C=0.44 in dioxane)
Trimethyl ether, mp 216°C
 $[\alpha]_D^{20}$

Versicolorin C는 acetone, dioxane, ethyl acetate, ether와 ethanol에 잘 녹고 Chloroform과 Benzene에 약간 녹으며 물과 水性 중탄산에는 안 녹는다.

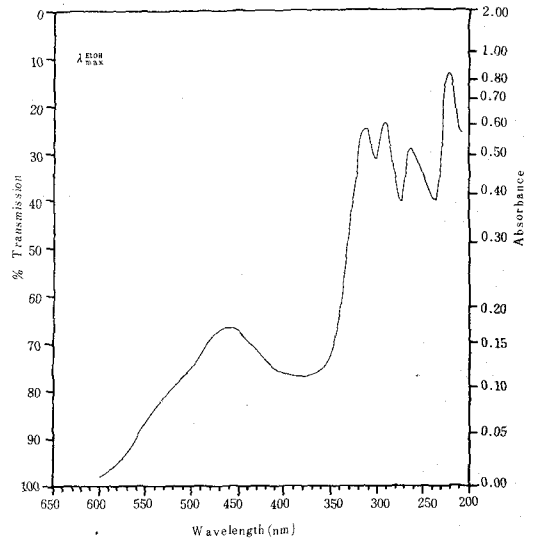
Versicolorin C는 Aflatoxin들이 生合成的 前驅物質이다.

UV data $\lambda_{\text{max}}^{\text{EtOH}}$ nm (ϵ): 223 (28,800), 255 (15,800),
267 (20,400), 292 (28,800),
326 (10,000), and 450 (10,700)

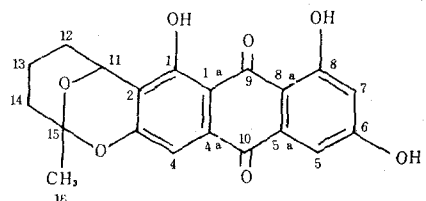
[發生]: *Aspergillus versicolor* (Vuill.) Tiraboschi

[毒性]: 毒性은 알려져 있지 않다.

TLC data Adsorbent: silica gel
Solvent: benzene-acetic acid, 95:5 v/v
Rf: 0.23
Detection: yellow spot in visible light



Averufin



Common name Averufin
Molecular weight 368.0895
Molecular formula C₂₂H₁₆O₇

[一般的特性]:

Bright orange-red laths from acetone, mp 280° - 282° (dec.)
 $[\alpha]_D^{25} = +1^\circ$ (C=0.30 in ethanol)
 Crystals from acetone, mp 283° - 289° (dec.)
 Tri-O-acetyl derivative, yellow needles from ethanol, mp 297° - 311°C
 $[\alpha]_D^{25} = -15^\circ$ (5g/liter in chloroform)

Averufin은 알칼리에 대하여 不安定하나 酸에는 안정하다. 이것은 Aflatoxin B₁의 生合成의 前駆物質이다.

[発生]: *Aspergillus versicolor* (Vuill.) Tiraboschi

A. parasiticus (mutant ATCC 15517)

A. ustus

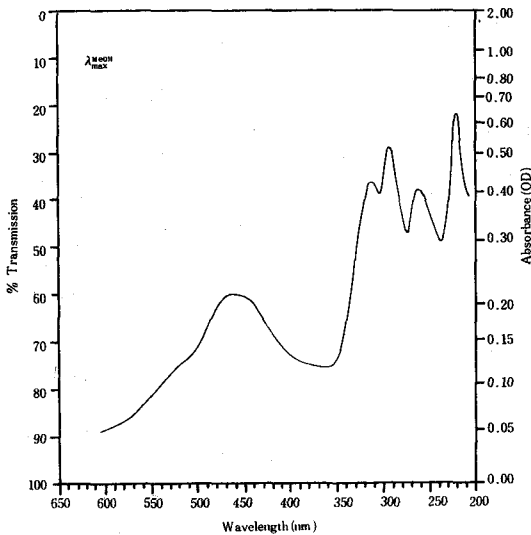
TLC data Adsorbent: silical gel (Eastman 6060)

Solvent: chloroform-acetone-acetic acid, 97:

2:1 v/v/v

R_f: 0.5

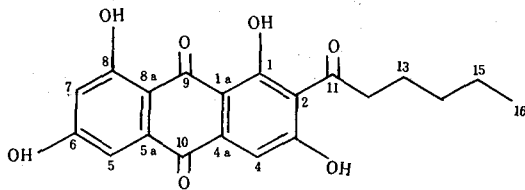
Detection: red spot in visible light



[一般的特性]:

Red prisms from acetone, mp 256° - 257°C (dec.); forms tetramethyl ether, mp 131° - 132°C

Norsolorinic酸



Common name Norsolorinic acid (2-π-Hexanoyl-1,3,6,8-tetrahydroxyanthraquinone)

Molecular weight 370.1052

Molecular formula C₂₈H₁₈O₇

Norsolorinic酸은 아세톤, 에탄올과 메탄올에 약간 녹는다. 물, Hexane, ether와 중탄산소디움에는 녹지 않는다. 탄산소디움과 수산화나트륨에 녹아서 자주색을 나타낸다. Norsolorinic酸은 Aflatoxin生合成의 前駆物質이다.

UV data λ_{max}^{EtOH} nm (ε): 235 (24,500), 269 (16,900),

284 (18,600), 297 (19,900),

314 (22,900), and 465 (7,760)

λ_{max}^{EtOH} nm (ε): 234 (23,667), 265 (16,650),

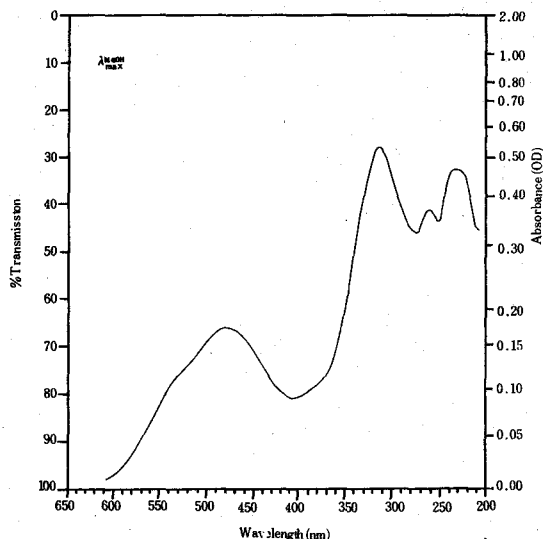
283 (17,352), 297 (sh) (19,872)

313 (23,763), and 465 (7,336)

[発生]: *Aspergillus versicolor* (Vuill.) Tiraboschi

A. parasiticus (mutant strain, NRRL-A-27,996)

The lichen, *Sorlorina crocea* (L.) Ach.



[毒性]: 毒性은 알려져 있지 않다.

TLC data Adsorbent: adsorbosil-1

Solvent: A : chloroform-acetone-n-hexane,
85:15:20 v/v/v

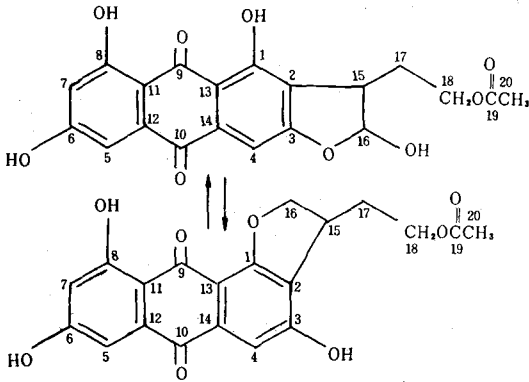
B : ethyl acetate-2-propranol-water
10:2:1 v/v/v

Rf: A : 0.69

B : 1.0

Detection: orange-red spot in normal light

Versiconal hemiacetal acetate



Common name Versiconal hemiacetal acetate (2,3-Tetrafurano-1,6,8-trihydroxy-15-ethyl acetate)

Molecular weight 400.0793

Electron-impact mass. spectral analysis shows 382.0688 due to $M^+ - H_2O$ ($C_{20}H_{14}O_8$); chemical ionization shows distinct m/e 401 due to $M^+ + H^+$.

Molecular formula $C_{20}H_{14}O_8$

[一般的特性]:

Orange needles from chloroform-acetone, mp 216°-220°C; from acetone, mp 234°-236°C

Dimethyl Sulfoxide와 같은 有極溶媒에서 Versiconal hemiacetal acetate는 異性體의 同量 混合으로서 존재한다. 아세톤 용액에서 角狀 hemiacetal型은 없어진다. Versiconal hemiacetal acetate는 Aflatoxin生合成의 저해요소인 殺虫劑 dichlorvos로 처리한 *A. flavus*와 *A. parasiticus*의 배양물에 축적된다. Aflatoxin生合成과정의 중

간생성물이다.

UV data λ_{max}^{EtOH} nm (ϵ): 225 (23,800), 267 (14,000),
298 (23,000), 323 (11,300),
and 480 (7,269)

λ_{max}^{EtOH} nm (ϵ): 224 (23,800), 225 (sh) (13,000),
265 (14,000), 295 (23,000),
323 (11,300), and 480 (7,250)

λ_{max}^{MeOH}

λ_{max}^{MeOH} nm (ϵ): 223 (25,700), 265 (14,400),
291 (2,400), 315 (10,200),
and 453 (7,000)

[發生]: *Aspergillus flavus*

A. parasiticus

[毒性]: 毒性은 알려져 있지 않다.

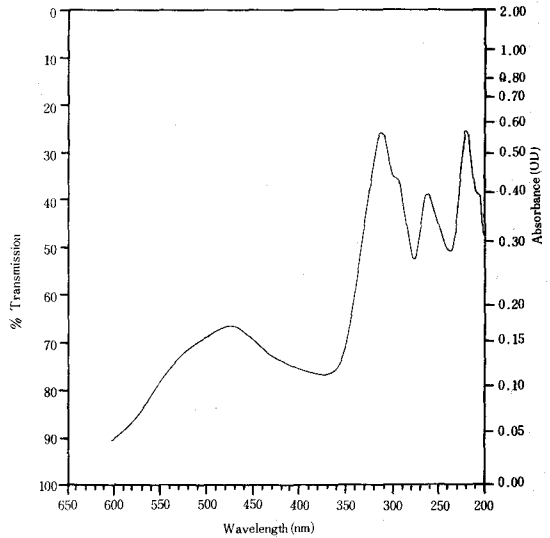
TLC data Adsorbent: silicar TLC-7G silica gel

Solvent: A : toluene-ethyl acetate, 27:12 v/v
B : chloroform-acetone, 8 515 v/v

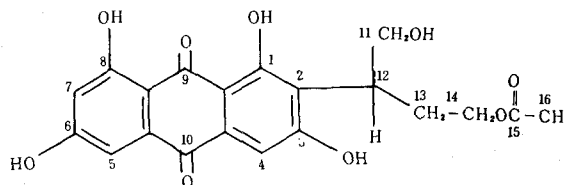
Rf: A : 0.32

B : 0.33

Detection: orange-red spot in normal light



Versiconal acetate

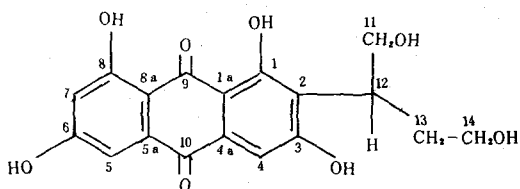


Common name Versiconol acetate
Molecular weight 402.0945
Molecular formula C₂₀H₁₈O₈
General characteristics Isolated as a glass
UV data $\lambda_{\max}^{\text{MeOH}}$ nm (ϵ) : 225 (30,900), 265 (sh)
 (15,800), 294 (25,700),
 315 (12,800), and
 453 (8,500)

[発生] : Aspergillus parasiticus의 遮断变異株.

[毒性] : 毒性은 알려져 있지 않다.

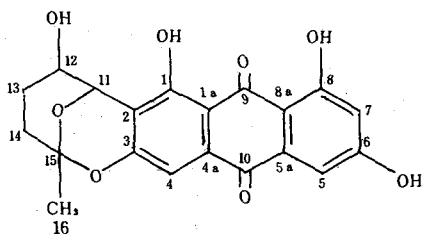
Versiconol



Common name Versiconol
Molecular weight 360.0844
 Electron-impact mass spectral analysis shows 342.0739 due to M⁺ -H₂O
Molecular formula C₁₈H₁₆O₈
General characteristics Crystals from acetone, mp 257°-259°C
 Orange-red needles, mp 265°C (dec.)
 $[\alpha]_D^{25}$ -35.8° (C=0.35 in dioxane)
UV data $\lambda_{\max}^{\text{MeOH}}$ nm (ϵ) : 224 (30,100), 266 (14,100),
 294 (23,900), 315 (12,300),
 and 455 (7,400)
 $\lambda_{\max}^{\text{EtOH}}$ nm (ϵ) : 224 (44,600), 255 (22,300),
 265 (22,300), 295 (33,800),
 322 (13,800), and
 460 (10,400)

[発生] : Aspergillus parasiticus의 遮断变異株.

Nidurufin

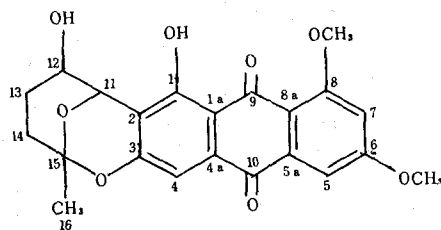


Common name Nidurufin
Molecular weight 384.0844
Molecular formula C₂₀H₁₈O₈
General characteristics Crystals from chloroform-methanol,
 mp 188°C
UV data $\lambda_{\max}^{\text{EtOH}}$ nm (ϵ) : 223 (33,500), 253 (15,300),
 264 (19,000), 291 (30,400),
 319 (10,700), and
 450 (10,000)

[発生] : Aspergillus nidulans

[毒性] : 毒性은 알려져 있지 않다.

Dimethylnidurufin

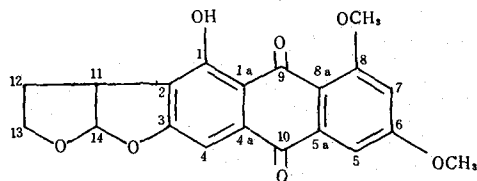


Common name Dimethylnidurufin
Molecular weight 412.1157
Molecular formula C₂₂H₂₀O₈
General characteristics Crystals from acetone-hexane,
 mp 211°-213°C
 $[\alpha]_D^{25}$ -77° (C=0.15 in chloroform)
UV data $\lambda_{\max}^{\text{MeOH}}$ nm (ϵ) : 224 (48,200), 251 (19,000)
 288 (30,900), 314 (8,540),
 and 444 (8,790)

[発生] : Aspergillus Versicolor

[毒性] : 毒性은 알려져 있지 않다.

Aversin



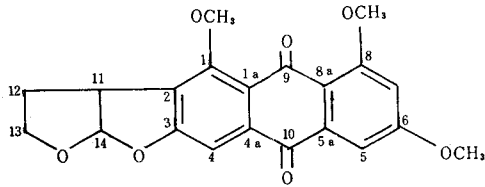
Common name Aversin
Molecular weight 368.0896
Molecular formula C₂₀H₁₈O₇
General characteristics Slender golden needles from acetone
 solution, mp 217°C
 $[\alpha]_D^{25}$ -222° (C=0.248 in chloroform)

UV data λ_{\max} nm (ϵ) : 224 (36,700), 251 (13,400),
285 (33,600), 313 (8,900),
363 (4,960), and
440 (7,830)
 $\lambda_{\max}^{\text{NaOH}}$ nm (ϵ) : 240 (21,300), 263 (34,800),
307 (13,800), 355 (5,040),
498 (6,890), and
501 (6,890)

[發生] : *Aspergillus versicolor* (Vuill.) Tiraboschi

[毒性] : 毒性은 알려져 있지 않다.

O-Methylaversin



Common name O-Methylaversin (Tri-O-methylversicolorin B)

Molecular weight 382.1052

Molecular formula $C_{21}H_{18}O_7$

General Fine golden-yellow needles from chloroform-methanol, mp 216°-217°C

Characteristics $[\alpha]_D^{25} -127^\circ$ (C=0.1804 in chloroform)
Golden-yellow crystals from methanol, mp 212°-213°C

Sublimed sample, mp 229°-230°C

UV data $\lambda_{\max}^{\text{EtOH}}$ nm (ϵ) : 222 (33,800), 285 (39,200)
348 (4,700), and
407 (4,200)

[發生] : *Aspergillus versicolor* (Vuill.) Tiraboschi

[毒性] : 毒性은 알려져 있지 않다.

4. Ochratoxins

多量으로 毒性症候群을 發生시키므로 인하여 자연히 Aflatoxin發見이 촉진되는데 반하여 Ochratoxin群은 毒原性곰팡이를 연구실에서 찾고 있던 남아프리카의 과학자들에 의하여 발견되었다. 이 과학자들은 실험동물에서 毒性을 띠는 *Aspergillus Ochraceus*의 菌株를 종종 分離하고는 했다. 그들은 그 후에 毒性의 주요 物質로서 Ochratoxin A라고 명명된 염소를 含有하

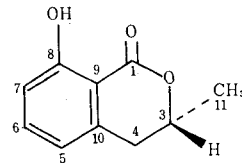
는 代謝產物을 分離하였다. Ochratoxin群은 Ochratoxin A와 Ochratoxin A의 에틸과 에틸에스테르화물, 그리고 Ochratoxin B (dechloroochratoxin A)와 Ochratoxin B의 메틸과 에틸에스테르화물 그리고 4-hydroxyochratoxin A로 구성된다. Ochratoxin A는 다른 Ochratoxin類들이 급성독성을 조금 보이거나 또는 전혀 보이지 않는데 반하여, Ochratoxin의 메틸과 에틸에스테르화물과 함께 Ochratoxin群중에서 毒性을 나타낸다. Ochratoxin A의 제 1차적인 標的器官은 肝과 腎臟이다. 化學的으로 Ochratoxin類는 아미드결합에 의하여 7-탄소群을 통하여 L-B phenyl alanine에 연결된 3,4-dihydro-3-methylisocoumarin成分으로 구성되어 있다. Ochratoxin類는 A, Ochraceus균주에 의하여 생산될 뿐 아니라 penicillium·Virnidicatum Westling균주에 의해서도 생산된다.

명백한 화학적 관계 때문에 이 群에 포함되어 있는 것도 역시, mellein과 4-hydroxymellein이다.

Ochratoxin類에 대하여 여러가지 측면에서 다른 연구보고서들이 이미 出刊되어 있다.

Ochratoxin 群	分子量	分子式
Mellein	178.0629	$C_{10}H_{10}O_3$
4-Hydroxymellein	194.0579	$C_{10}H_{10}O_4$
Ochratoxin A	403.0822	$C_{20}H_{18}O_8NCl$
Ochratoxin B	369.1212	$C_{20}H_{18}O_8N$
4-Hydroxyochratoxin A	419.0771	$C_{20}H_{18}O_9NCl$
Ochratoxin C	431.1135	$C_{22}H_{22}O_8NCl$

Mellein



Common name Mellein (Ochracin) [(-)-3,4-Dihydro-8-hydroxy-3-methylisocoumarin]

Molecular weight 178.0629

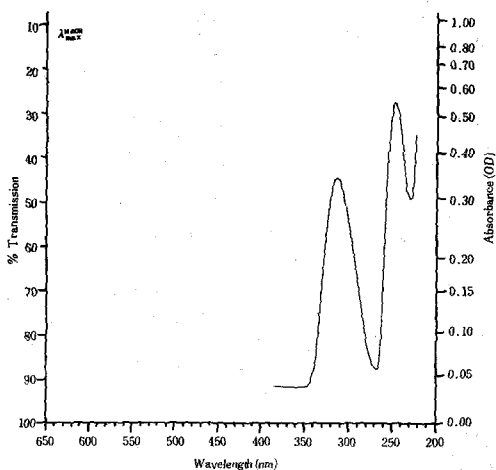
Molecular formula $C_{10}H_{10}O_3$

General characteristics Crystals (subl.), mp 54° - 55°C
UV data λ_{max}^{EtOH} nm (ϵ): 212 (20,000), 246 (6,500), and 314 (4,100)

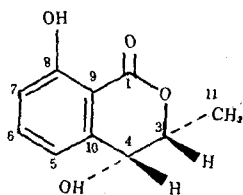
[發生] : *Aspergillus melleus* Yukawa
A. ochraceus Wilh.

[毒性] : 毒性은 알려져 있지 않다.

TLC data **Adsorbent**: silica gel G-HR
Solvent: toluene-ethyl acetate-formic acid, 5:4:1 v/v/v/
Rf: 0.82
Detection: blue fluorescent spot under UV light



4 - Hydroxymellein

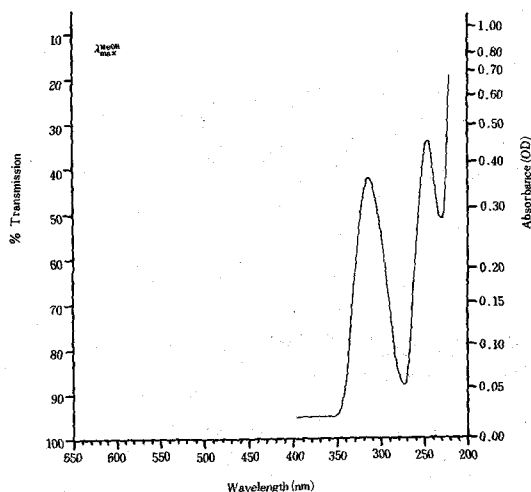


Common name 4-Hydroxymellein (3-Methyl-4,8-dihydroxy-3,4-dihydroisocoumarin)
Molecular weight 194.0579
Molecular formula C₁₀H₁₀O₄
General characteristics^{4,17} Crystals from chloroform-hexane, mp 131° - 132°C
 $[\alpha]_D^{25}$ -40° (C=1.0 in chloroform)
UV data^{4,17} λ_{max}^{MeOH} nm (ϵ): 247 (5,300) and 315 (4,200)

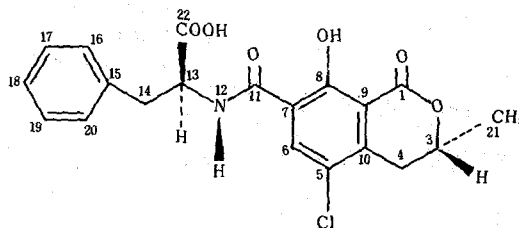
[發生] : *Aspergillus ochraceus* With. (NRRL 3174)
A. omki
Lasiodiplobia theobromae (cis-4-hydroxymellein)
Apiospora camptospora

[毒性] : 毒性은 알려져 있지 않다.

TLC data **Adsorbent**: silica gel G-HR
Solvent: toluene-ethyl acetate-formic acid, 5:4:1 v/v/v
Rf: 0.74
Detection: blue fluorescent spot under UV light



Ochratoxin A



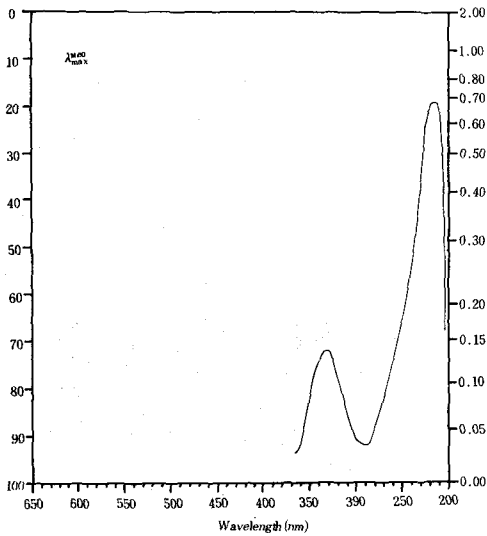
Common name Ochratoxin A (7-Carboxy-5-chloro-8-hydroxy-3,4-dihydro-3R-methylisocoumarin 7-L-β-phenylalanine)
Molecular weight 403.0822
Molecular formula C₂₈H₁₉O₆NCI
General characteristics Crystals from benzene, mp 94° - 96°C
 Crystals from xylene, mp 169°C
 $[\alpha]_D$ -118° (C=1.1 in chloroform)
UV data λ_{max}^{MeOH} nm (ϵ): 215 (36,800) and 333 (6,400)

[發生] : *Aspergillus ochraceus* Wilh. (NRRL 3174)
A. sulphureus (NRRL 4077)
A. melleus (NRRL 3519;3520)
Penicillium viridicatum (ATCC 18411)

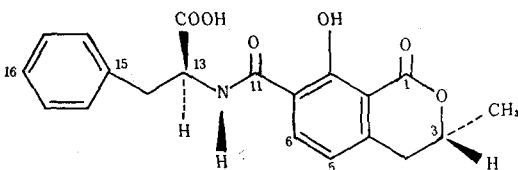
[毒性] : 離乳한 쥐에게 經口投與하였을 때 반수치사량은 22mg/kg이고 송어에 복강내 투여할 때 반수치사량은 3.0mg/kg이었다. Ochratoxin A는 急性肝損傷과 지방침윤, 초자양변성과 巢狀壞死를 일으킨다. 이러한 결과는 쥐에 더욱 잘 나타난다.

Ochratoxin A를 經口的으로 투여한 Beagle犬은 식욕부진과 체중감소, 구토, 裏急後重과 직장에서 粘液血便이 나오고, 發熱, 脫水, 虛脫과 腎臟傷害를 나타낸다. Ochratoxin A는 마우스에서 畸形을 일으키고 미토콘드리아 輸送系의 障礙요소로서 작용한다.

TLC data Adsorbent: silica gel
 Solvent: benzene-acetic acid, 3:1 v/v
 Rf: 0.5
 Detection: green fluorescent spot under UV light



Ochratoxin B



Common name Ochratoxin B (7-Carboxy-8-hydroxy-3,4-dihydro-3R-methylisocoumarin-7- L-β-phenylalanine)

Molecular weight 369.1212

Molecular formula C₂₀H₁₉O₄N

General characteristics Crystals from acidic methanol, mp 221 °C

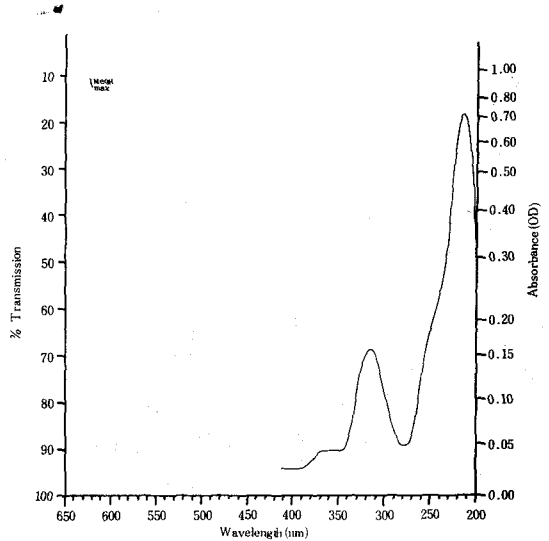
[α]_D²⁰ -35°C (C=0.15 in ethanol); -56° (C=0.29 in methanol)

UV data λ_{max}^{25°C} (nm (ε)) : 218 (37,200) and 318 (6,900)

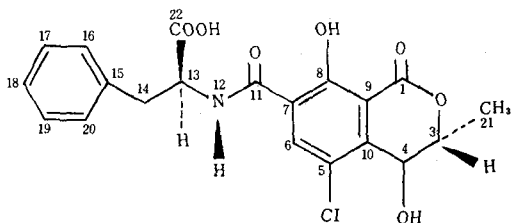
[發生] : *Aspergillus ochraceus* Wilh. (NRRL 3174)

[毒性] : Ochratoxin B는 Ochratoxin A 또는 C보다 독성이 적다. 수일령의 병아리에 경구투여한 반수치사량이 54mg/kg인데 반하여 같은 방법으로 Ochratoxin A의 반수치사량은 3.3 ~ 3.9mg/kg이었다.

TLC data Adsorbent: silical gel
 Solvent: benzene-acetic acid, 4:1 v/v
 Rf: 0.35
 Detection: blue fluorescent spot under UV light



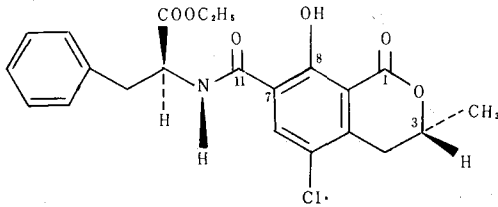
4 - Hydroxyochratoxin A



Common name 4-Hydroxyochratoxin A
Molecular weight 419.0771
Molecular formula C₂₃H₁₅O₇NCI
General characteristics Colorless crystals from benzene, mp 216° - 218°C
UV data λ_{max}^{EtOH} nm (ε) : 213 (32, 400) and 334 (6,400)

[**発生**] : *Penicillium viridicatum* Westling (ATCC 18411)

[**毒性**] : 4-hydroxyochratoxin A는 Ochratoxin A를 투여한 Wistar 숫놈쥐의 尿에 들어있다. 4-hydroxyochratoxin A는 40mg/kg 수준으로 쥐에게 투여하였을 때 아무런 영향도 끼치지 않았으나 Ochratoxin A의 경우 이 정도 수준의 量에는 100% 폐사율을 보였다. 이렇게 볼 때 4-hydroxyochratoxin A는 Ochratoxin A를 투여한 동물체내의 해독작용에 의한 産物인 것 같다.



TLC data **Adsorbent**: silica gel
Solvent: benzene-acetic acid, 4:1 v/v
Rf: 0.25
Detection: green fluorescent spot under UV light

Common name Ochratoxin C (ethyl ester of ochratoxin A)

Molecular weight 431.1135

Molecular formula C₂₂H₂₂O₄NCI

General characteristics Amorphous compound

[α]_D -100° (C=1.2)

Ochratoxin A methyl ester

[α]_D -78° (C=0.027)

UV data λ_{max} nm (ε) : 214 (30,000), 333 (7,000), and 378 (2,050)

[**発生**] : *Aspergillus ochraceus* Wilh

[**毒性**] : 처음에는 Ochratoxin C가 비교적 非毒性쪽에 가까운 것으로 생각되었었다. 그러나 그후에 A. Ochraceus의 독성이 단지, Ochratoxin C도 함유하고 있는 염소함유대사산물 때문이란 것이 밝혀졌다. Ochratoxin A와 메틸, 에틸에스테르화물이 지니는 주일령의 복경오리병 아리에 대한 독성은 마리당 135~170μg이었다.

TLC data **Absorbent**: silica gel
Solvent: benzene-acetic acid, 25:1 v/v
Rf: 0.55
Detection: light green fluorescent spot under UV light

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