

Antibacterial and Antitumor Activities of Piperine from Black Pepper

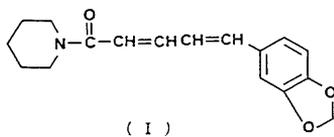
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(Received October 9, 1984)

Introduction

Piperine (I) was isolated from black pepper (*Piper nigrum* L.) as long ago as 1820, later also from other pepper fruits such as *P. longum* L., *P. retrofractum* Vahl (*P. officinarum* C. DC.), and *P. clusii* C. DC., from root bark of *P. geniculatum* Sw. and Piperaceae.

Oerstedt¹⁾ (1821) suggested that the presence of piperine gave the pungency of black pepper but later it was clarified by Buchheim²⁾ (1876) that chavicine which was the stereoisomer of piperine had more pungent taste than piperine, and the structure of piperine was proven by Ladenburg and Scholtz³⁾ (1894).



Harvill⁴⁾ et al (1943) showed that piperine was more toxic than pyrethrum against housefly but according to Su⁵⁾ (1977), piperine was not the constituent in black pepper that was responsible for contact toxicity to the insects.

Salzer⁶⁾ et al (1977) showed that pepper was active against *Escherichia coli* in sausage but they found the curing organisms, the micrococci and lactobacilli, to be unaffected by relatively high concentrations. Hitokoto⁷⁾ et al (1978) reported that the chloroform extract of black pepper fruits powder had from 1 to 7% inhibition of the growth and 100% inhibition of the toxin production of several toxigenic fungi. Huhtanen⁸⁾ (1980) also showed that the ethanol extract of black

pepper was active against *Clostridium botulinum* with a minimum inhibitory concentration ($\mu\text{g/ml}$) of 125 ppm.

From last three literatures we did not know what constituent was active against them, so we reported in this paper the results of bioassay for antibacteria and antitumor activities of piperine, of all constituents from black pepper.

Experimental and Results

Dried black pepper fruits from Brazil in 1980 were presented for us by Takasago Perfumery Co. Piperine was purified from the chloroform extract in our laboratory, all solvents used for extraction and recrystallization were distilled once before use and of reagent grade quality commercially in Japan.

The infrared spectrum was taken by a JEOL IRA-1 spectrometer, the nuclear magnetic resonance spectrum for ¹H was recorded by a Hitachi R-40 90 MHz spec-

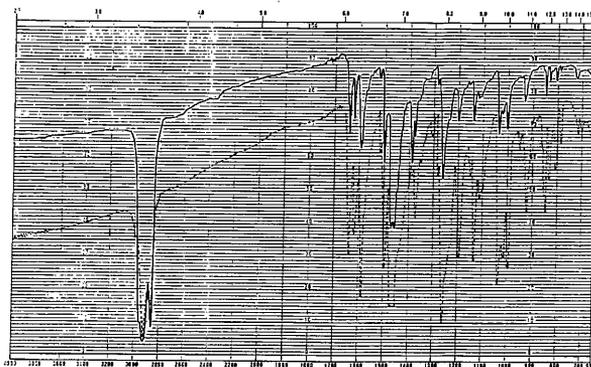


Fig. 1. IR Spectrum of Piperine from Black Pepper (nujol mull) (solid line), the Standard Spectrum of Piperine (nujol mull) (broken line)

trometer using tetramethylsilane as an internal reference and the melting point was measured with a Meihou automatic thermal analyser MR-2.

The bioassays of piperine for bactericidal and antitumor activities were proceeded by the laboratory of Kyowa Hakko Kogyo Co.

1. Extraction and Purification of Piperine

The extract was made by steeping 5 kg of dried black pepper fruits in 6 l of chloroform after benzene at room temperature with occasional stirring, the extract was filtered with a filter paper and the filtrate was concentrated continuously with a rotary evaporator into a

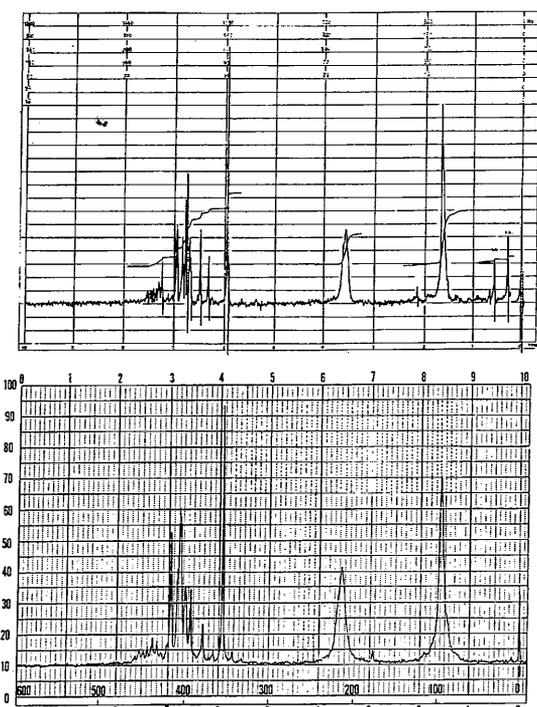


Fig. 2. ¹H-NMR Spectrum of Piperine from Black Pepper (above), the Standard Spectrum of Piperine (below)

paste. 50.6g of the residue was separated to 9 fractions by a silica gel (Kiesel Gel 60 Merck) column (5.0 x 45.0 cm) chromatography eluted with solvents of benzene: ethyl acetate (4:1 v/v), acetone and n-butanol by turns, the fraction 4 of benzene:ethyl acetate was concentrated with a rotary evaporator, 1.45g of monoclinic prisms (like rock sugars) was obtained after recrystallization with benzene from 4.5g of the residue. m.P. 131°C (L⁹). 130°C), the tlc showed one spot at R_f=0.44,

which was developed with benzene:acetone (9:1 v/v). From the data of the infrared spectrum and the ¹H-nmr spectrum, the prisms was identified piperine in comparison with the authentic spectra^{11,12} (Fig. 1 and 2).

2. Bioassay of Piperine against Bacteria

Piperine was bioassayed in vitro against 27 species of bacteria, from 10 genus mainly enterobacteriaceae. The results showed that piperine was active with a MIC of 100 ppm against *Pseudomonas aeruginosa* # 1 and *Alcaligenes F 2518* (Table 1). Determination of MIC was made visually by observing turbidity with a photometer detected through transmitted light.

Table 1. Antibacterial Activities of Piperine in Vitro

Species	MIC(μg/ml)
<i>Staphylococcus aureus</i> 209-P	>100
<i>S. aureus</i> SMITH	> 100
<i>S. epidermidis</i>	> 100
<i>Escherichia coli</i> NIHJJC-2	> 100
<i>E. coli</i> CN2411-5	> 100
<i>E. coli</i> JUHL	> 100
<i>Klebsiella pneumoniae</i> 3045	> 100
<i>K. pneumoniae</i> Y-60	> 100
<i>Serratia marcescens</i> T-26	> 100
<i>S. marcescens</i> T-55	> 100
<i>Proteus mirabilis</i> 1287	> 100
<i>P. vulgaris</i> 6897	> 100
<i>P. morganii</i> KY4298	> 100
<i>P. rettgeri</i> 4289	> 100
<i>Enterobacter cloacae</i> F1510	> 100
<i>E. cloacae</i> F1870	> 100
<i>E. aerogenes</i> F1948	> 100
<i>E. aerogenes</i> F1949	> 100
<i>Citrobactor freundii</i> F1526	> 100
<i>C. freundii</i> F1528	> 100
<i>Pseudomonas aeruginosa</i> #1	100
<i>P. aeruginosa</i> DBT145	> 100
<i>P. putida</i> F264	> 100
<i>P. cepacia</i> F2251	> 100
<i>P. maltophilia</i> F3438	> 100
<i>Acinetobacter</i> F2575	> 100
<i>Alcaligenes</i> F2518	100

3. Bioassay of Piperine against Sarcoma-180A Solid Tumor

Piperine was also bioassayed against the intraperitoneal sarcoma-180A solid tumor in mice. The results revealed that the activity of piperine was no match for mitomycin C which was developed by Kyowa Hakko Kogyo Co., Japan (Table 2). Determination of activity was made by comparing the weight of tumor untreated with the weights of tumor treated with drugs injected intraperitoneally.

Table 2. Anti-Solid-Tumor Activity of Piperine against Sarcoma-180A in Mice

Drug	Dose(mg/kg)	Treated/Control(wt)
Control	—	— (15.37mm ³)
Mitomycin C	6 × 1 (i.p)	0.48
Piperine	100 × 1 (i.p)	0.77
	400 × 1 (i.p)	0.72

Discussion

We knew since old times that pepper fruits powder was sprinkled over meat for curing. It was reasonable scientifically because a certain component had inhibition of the growth and the toxin production of toxigenic fungi, and was active against *Clostridium botulinum*. Piperine also had activities against *Ps. aeruginosa* #1 and *Alcaligenes F2518*. Pillitorine which was one of Piperaceae amides had activity against Lows lung carcinoma in mice Loder¹⁰⁾ et al (1969), but piperine had not responsibility for the sarcoma-180A tumor in mice.

Finally we express our appreciation to staffs of the laboratory of Kyowa Hakko Kogyo Co. for bioassays of piperine, to Misses Sayuri Chiba and Michiko Natsume who were students in our laboratory for extractions with several solvents.

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黒こしょうからのペペリンの抗細菌性と抗腫瘍性

山口 功・尾関 幸子

(昭和59年10月9日受理)

黒こしょうから抽出して得たペペリンについて抗細菌活性を調べた結果、*Pseudomonas aeruginosa* #1 (緑膿菌) と *Alcaligenes F2518* (腸内および酪農産物細菌) に活性を示したが、抗腫瘍性試験では Sarcoma-180A 固型腫瘍に対して、市販の抗癌剤であるマイトマイシンCに比し約1/27の活性しか示さなかった。