AUSTRALIA 680778

PATENTS ACT 1990

PATENT REQUEST : STANDARD PATENT

I/We being the person(s) identified below as the Applicant(s), request the grant of a patent to the person(s) identified below as the Nominated Person(s), for an invention described in the accompanying standard complete specification.

Full application details follow:

[71/70] Applicant(s)/Nominated Person(s):

Kureha Chemical Industry Co., Ltd.

of

9–11, Nihonbashihoridome–cho, 1–chome, Chuo–ku, Tokyo 103, Japan

[54] Invention Title:

Binding agent for growth factor

[72] Name(s) of actual inventor(s):

Kenichi MATSUNAGA
Yoshiharu OGUCHI
Minoru OHARA

[74] Address for service in Australia:

DAVIES COLLISON CAVE, Patent Attorneys, 1 Little Collins Street, Melbourne, Victoria, Australia. Attorney Code: DM

Basic Convention Application(s) Details:

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6–224281	Japan	JP	25 August 1994

DATED this TWENTY FIFTH day of AUGUST 1995

Keith Walker

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a member of the firm of DAVIES COLLISON CAVE for and on behalf of the applicant(s)

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NOTICE OF ENTITLEMENT

We, **Kureha Chemical Industry Co., Ltd.**, the applicant/Nominated Person named in the accompanying Patent Request state the following:-

The Nominated Person is entitled to the grant of the patent because the Nominated Person derives title to the invention from the inventors by assignment.

The Nominated Person is entitled to claim priority from the basic application listed on the patent request because the Nominated Person made the basic application.

DATED this TWENTY FIFTH day of AUGUST 1995

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a member of the firm of
DAVIES COLLISON CAVE
for and on behalf of the
applicant(s)

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BINDING AGENT FOR GROWTH FACTOR

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(71) Applicant(s)
KUREHA CHEMICAL INDUSTRY CO., LTD.

(72) Inventor(s)
KENICHI MATSUNAGA; YOSHIHARU OGUCHI; MINORU OHARA

(74) Attorney or Agent
DAVIES COLLISON CAVE , 1 Little Collins Street, MELBOURNE VIC 3000

(56) Prior Art Documents
JP 60-45525 60-45529
JP 02-11521 03-109331 06-157333

(57) Claim

1. A method of treatment or prevention of a disease or condition selected from the list comprising fibroid lung, hepatic fibrosis, glomerulonephritis and scleroderma, wherein said disease or condition is directly or indirectly caused by transforming growth factor-β (TGF-β) or platelet-derived growth factor (PDGF), said method comprising administering to a mammal an effective amount of a protein-bound polysaccharide which is obtained from a fungus belonging to *Coriolus*, and contains about 18 to 38% by weight of proteins.

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COMPLETE SPECIFICATION

NAME OF APPLICANT(S):

Kureha Chemical Industry Co., Ltd.

ADDRESS FOR SERVICE:

DAVIES COLLISON CAVE
Patent Attorneys
1 Little Collins Street, Melbourne, 3000.

INVENTION TITLE:

Binding agent for growth factor

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a binding agent for particular growth factors, namely, transforming growth factor-β (TGF-β) and platelet-derived growth factor (PDGF). The binding agent of the present invention selectively binds to the particular growth factors to inhibit their biological activities. Therefore, the binding agent of the present invention can be used for treatment or prevention of various diseases directly or indirectly caused by the particular growth factors.

2. Description of the Related Art

Various factors which are produced in a living body and act on a particular cell to promote its growth have been found, and the structures and the functions thereof have been elucidated. It has been discovered that some growth factors exhibit not only the promotion of the growth, but also the various biological activities, and that the overproduction and/or abnormal metabolism of such factors are involved in various diseases.

Transforming growth factor-β (TGF-β) and platelet-derived growth factor (PDGF) belong to such a growth factor. TGF-β was first found as a factor to promote growth of a rat fibroblast. Thereafter, it has been found that TGF-β inhibits growth of a lot of cells, strongly suppresses immunological activity, and increases extracellular matrix. It is suggested that the overproduction and/or abnormal metabolism of TGF-β are involved in various diseases and symptoms of immunosuppression in a cancer patient or the like, fibroid lung, hepatic fibrosis, glomerulonephritis, scleroderma, or the like. Further, PDGF acts on smooth

muscle cells, fibroblasts, nerve gliacytes or the like to promote their growth. The relationship between PDGF and arterial sclerosis caused by wandering and growth of vascular smooth muscle cells attracts attention.

It would be possible to use an antibody which specifically binds to TGF-β and/or PDGF to inhibit their functions, as a means of inhibiting the functions of the growth factors. In fact, the attempts to use such an antibody were actually made. Nevertheless, when the antibody is administered, there exist many problems to be solved, for example, prevention of allergic reaction caused by the administration, or prevention of the activity reduction by the production of antibodies to neutralize the administered antibody. Therefore, it is desired to develop an agent which inhibits the function of the growth factors, and can be safely administered.

SUMMARY OF THE INVENTION

The inventors of the present invention engaged in intensive studies to solve the above problems, and as a result, found that the particular protein-binding polysaccharide which is obtained from Basidiomycetes, and which has been clinically used as a carcinostatic agent and proved to hardly produce side-effects, binds to the above growth factors to inhibit the functions thereof. The present invention is based on the findings.

Accordingly, the object of the present invention is to provide a binding agent for the above growth factors.

Other objects and advantages will be apparent from the following description.

In accordance with the present invention, there is provided a binding agent for a growth factor selected from the group consisting of transforming growth factor-β (TGF-β) and platelet-derived growth factor (PDGF), comprising a

protein-bound polysaccharide which is obtained from a fungus belonging to Coriolus, and contains about 18 to 38 % by weight of proteins.

BRIEF DESCRIPTION DRAWINGS

Figure 1 is a graph showing the results of an enzyme-immunoassay (●) and radio-immunoassay (○) of the binding of TGF-β and PSK by the reaction therebetween, as carried out in Example 1.

Figure 2 is a graph showing the results of the control experiments using only ^{125}I labeled TGF-β1, in the experiments wherein ^{125}I labeled TGF-β1 was reacted with PSK, the reaction mixture was applied on a gel filtration chromatography column, and the radioactivities in fractions were measured as carried out in Example 2.

Figure 3 is a graph showing the results of the case that ^{125}I labeled TGF-β1 and PSK were added, in the experiments wherein ^{125}I labeled TGF-β1 was reacted with PSK, the reaction mixture was applied on a gel filtration chromatography column, and the radioactivities in fractions were measured as carried out in Example 2.

Figure 4 is a graph showing the restoring effect of PSK to the growth inhibition by TGF-β1, in the experiments wherein PSK and TGF-β1 were added to the in vitro growing system of the fetal mink lung cell line Mv1Lu, as carried out in Example 3.

Figure 5 is a graph showing a dose-dependency of the restoring effect of PSK to the growth inhibition by TGF-β1, in the experiments wherein PSK and TGF-β1 were added to the in vitro growing system of the fetal mink lung cell line Mv1Lu, as carried out in Example 3.

Figure 6 is a graph showing the restoring effect of PSK to the growth inhibition by TGF-β1, in the experiments wherein PSK and TGF-β1 were added to the in vitro growing

system of the mouce T cell line CTLL-2, as carried out in Example 3.

gure 7 is a graph showing a dose-dependency of the restoring effect of PSK to the growth inhibition by TGF-β1, in the experiments wherein PSK and TGF-β1 were added to the in vitro growing system of the mouse T cell line CTLL-2, as carried out in Example 3.

Figure 8 is a graph showing a dose-dependency of the TGF-β binding to the fetal mink lung cell line Mv1Lu, in the experiments wherein the ^{125}I labeled TGF-β1 was added to the in vitro binding assay system of the cell line Mv1Lu, as carried out in Example 4.

Figure 9 is a graph showing a dose-dependency of the TGF-β1 binding to the mouse T cell line CTLL-2, in the experiments wherein the ^{125}I labeled TGF-β1 was added to the in vitro binding assay system of the cell line CTLL-2, as carried out in Example 4.

Figure 10 is a graph showing a dose-dependency of the cell binding inhibitory by PSK, in the experiments wherein the ^{125}I labeled TGF-β1 and PSK were added to the in vitro binding assay system of the fetal mink lung cell line Mv1Lu, as carried out in Example 4.

Figure 11 is a graph showing a dose-dependency of the cell binding inhibitory by PSK, in the experiments wherein the ^{125}I labeled TGF-β1 and PSK were added to the in vitro binding system of the mouse T cell line CTLL-2, as carried out in Example 4.

Figure 12 is a graph showing the effect by the differences of the tumor sizes, when TGF-β1 and/or PSK were administered to the leukemic cells-implanted mice, as carried out in Example 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The protein-bound polysaccharide used as an active ingredient

in the binding agent of the present invention is disclosed in, for example, Japanese Examined Patent Publications (Kokai) No. 46-17149, No. 51-36322, No. 56-14274, No. 5614275, and No. 56-14276. The protein-bound polysaccharide is an extract from mycelia, broth, or fruit bodies that is obtained by culturing the fungus belonging to Coriolus, which belongs to Basidiomycetes. The protein-bound polysaccharide contains about 18 to 38 % by weight of proteins, and has a molecular weight of not less than 5,000, preferably 5000 to 3000,000. Further, the protein-bound polysaccharide is described in "Saikin no Shinyaku (Recent New Medicines)", Vol. 28, 14-16, 1977; and Vol. 29, 96-101, 1978; and "Iyakuhin Yoran (Handbook of Medicines)", 6th Ed., 1346, 1979, published by Yakuji Jiho Publishing Co.

A typical example of the protein-bound polysaccharide is called PSK, which is commercially available as "Krestin" (trade mark) from Sankyo Co., Ltd.

The properties of PSK are as follows:

PSK may be prepared by extracting the mycelia of Coriolus versicolor (Fr.) Quél [FERM-P2412 (ATCC20547)] with hot water, purifying and then drying the extract. The average molecular weight (ultracentrifugal method) is about 100,000. The sugar portion in the major fractions is β-D-glucan. The glucan has a branched structure containing 1→3, 1→4 and 1→6 bonds, and mainly comprises glucose (74.6 % by weight) and mannose (15.5 % by weight). In the amino acid composition of the proteins, there are many acidic amino acids, such as aspartic and glutamic acids, many neutral amino acids, such as valine and leucine, but a few basic amino acids, such as lysine and arginine. PSK is soluble in water, but hardly soluble in methanol, pyridine, chloroform, benzene or hexane. PSK begins to be gradually decomposed at about 120°C.

The protein-bound polysaccharide is extremely safe, because

of very low toxicity and few side-effects. The acute toxicity of PSK is shown in the following Table 1.

Table 1

Animal sp.	Route	LD50 (mg/kg) Male	Female
Mice	per os	>20000	>20000
Rats	per os	>20000	>20000

The acute toxicity shown in Table 1 was determined by the following method. The 4- or 5-week-old ICR-JCL mice (21 to 24 g) and the 4- or 5-week-old Donryu rats (100 to 150 g) were used. The agent was orally administered as shown in Table 1. The protein-bound polysaccharide was dissolved in physiological saline and the solution was administered. Death and body weight were observed for 7 days. Thereafter, the animals were sacrificed for autopsy. No death was observed in mice and rats even by the maximum administrable doses, and thus, the determination of LD50 was substantially impossible.

The protein-bound polysaccharide used as an active ingredient in the binding agent of the present invention selectively binds to TGF-β and PDGF, but does not bind to various cytokines including growth factors other than TGF-β and PDGF. For example, as shown in Examples 1 and 2, the protein-bound polysaccharide does not bind to epidermal growth factor (EGF); interleukin (IL)-1α, IL-1β, IL-2, IL-3, IL-4, IL-6, IL-7, IL-8, or IL-10; tumor necrosis factor (TNF)-α or TNF-β; interferon (IFN)-α, IFN-β, or IFN-γ; granulocyte colony-stimulating factor (G-CSF); or granulocyte-macrophage colony-stimulating factor (GM-CSF)

The TGF-β which binds to the protein-bound polysaccharide is not limited, but includes, for example, TGF-β1, TGF-β2, TGFβ3, TGF-β4, and TGF-β5.

The protein-bound polysaccharide used as an active ingredient in the binding agent of the present invention inhibits the

physiological activity of TGF-β and PDGF by selectively binding thereto. This will be concretely demonstrated in Examples 3 and 4 (in vitro) and Example 5 (in vivo), respectively. More particularly, when TGF-B is added to an in vitro growth reaction culture of cells highly sensitive to TGF-β (i.e., the fetal mink lung cell line Mv1Lu and the mouse T cell line CTLL-2), the growth of the cells is inhibited. If the protein-bound polysaccharide is added in advance to the in vitro growth reaction culture, the inhibitory action of TGF-β is reduced. The binding of TGF-β to the cells is also inhibited. Further, in the in vivo experiment of mice to which leukemic cells are implanted, the tumor growth promoted by administering TGF-β is inhibited by administering.PSK.

As above, the protein-bound polysaccharide selectively binds only to the particular growth factors, i.e., TGF-β and PDGF, and thus, the function of the protein-bound polysaccharide is limited to the inhibition of the physiological activities of bound TGF-β and PDGF only. Therefore, it is believed that no side-effect caused by any inhibition of functions of other growth factors is produced. Further, the protein-bound polysaccharide has extremely low toxicity, and has been clinically proved to hardly produce side-effect. Thus, it may be safely administered for a long period of time.

When the binding agent of the present invention is administered to an animal including human as an inhibitor of TGF-β and/or PDGF, the binding agent may be formulated into a composition for various routes, such as a composition for oral administration, injections for subcutaneous, intravenous, or intramuscular administration, or a suppository for rectal administration. The composition for oral administration is, for example, tablet, granule, powder, or capsule. The composition may contain a binder, excipient, lubricant, disintegrating agent, or wetting agent. The oral liquid composition may be in the form of

mixture for internal use, shaking mixture, suspension, emulsion, or syrup, or in the form of a dry product which should be re-dissolved when used. Further, the above oral liquid composition may contain an additive or preservating agent. A parenteral composition, such as injection, suppository, or ointment, may contain an additive, such as a stabilizing agent, buffer, preservating agent, or isotonicity. The composition may be in the form of an aqueous solution, suspension, solution, or emulsion in oily or aqueous vehicle. Alternatively, the active ingredient may be in the form of powder which should be re-dissolved in a suitable vehicle, such as sterilized water without a pyrogenic substance, when used.

The dose of the binding agent may vary with administration routes, ages, individual differences, or symptoms, but in general, 0.5 to 1000 mg/kg weight/day. In an oral administration, a dose of 20 to 1000 mg may be administered once or divided into two or three.

Examples

The present invention will now be further illustrated by, but is no means limited to, the following Examples.

Example 1

To a vial containing 1 μg of lyophilized human TGF-β_1 (Takara Shuzo), 5 mM HCl (100 μl) containing bovine serum albumin (2 mg/ml) was added to dissolve human TGF-β_1. Then, 9.9 ml of phosphate buffered physiological saline (pH 7.4) containing bovine serum albumin (2 mg/ml) was added thereto to prepare a TGF-β_1 solution (100 ng/ml).

Further, PSK (Trademark "Krestin"; Sankyo) was dissolved in phosphate buffered physiological saline (pH 7.4) containing bovine serum albumin (2 mg/ml) to prepare PSK solutions containing 0.1 μg/ml, 0.5 μg/ml, 1.0 μg/ml, 5.0 μg/ml, 10 μg/ml, 50 μg/ml, 100 μg/ml, 500 μg/ml or 1000 μg/ml of PSK.

The above TGF-β_1 (100 ng/ml) solution (100 μl) and the

PSK (0.1 to 1000 μg/ml) solution (100 μl) were mixed in a test tube, and reaction was performed at 22 °C for 3 hours.

After the reaction was completed, the TGF-β_1 content in the mixed solution was measured by a commercial available Enzyme Immunoassay kit (TGF-β_1 ELISA System; Amersham Japan). The results are shown by closed circle (●) in Fig. 1. Further, the results by radioimmunoassay using ^{125}I labeled anti-TGF-β_1 antibodies are shown by open circle (○) in Fig. 1. The binding ratio (%) in the axis of Fig. 1 is calculated from the equation (I):

$$\text{Binding ratio (\%)} = (Cc - Cp) / Cc \times 100 \qquad \text{(I)}$$

wherein Cc is a measured content of TGF-β_1 in control groups, and Cp is a measured content of TGF-β_1 in PSK-addition groups.

As apparent from Fig. 1, the TGF-β_1 content in PSK-addition groups is dose-dependently lowered in comparison with that in control groups. Thus, it is manifest that PSK binds to the epitope of TGF-β_1.

The binding activities of PSK and various cytokines and growth factors other than TGF-β were measured, using commercially available assay kit. The results in Table 2 clearly show that PDGF binds to PSK, as is the case with TGF-β, but PSK does not bind to other cytokines or growth factors. The binding ratio (%) in Table 2 were calculated from the equation (I).

Table 2: Binding ratio (%)

Growth factor/Cytokine (available from)	PSK concentration (μg/ml) 1	10	100
rhTGF-β_1 (1)	32	68	96
nhTGF-β_1 (1)	20	67	83
rhTGF-α (2)	0	0	0
rhEGF (3)	0	0	0
rhPDGF (3)	11	26	54
rhIL-1α (2)	0	0	0
rhIL-1β (3)	0	0	0
rhIL-2 (3)	0	0	0
rhIL-3 (3)	0	0	0
rhIL-4 (2)	0	0	0
rhIL-6 (2)	0	0	0
rhIL-7 (2)	0	0	0
rhIL-8 (2)	0	0	0
rmIL-10 (2)	0	0	0
rhTNF-α (2)	0	0	0
rhTNF-β (3)	0	0	0
rhIFN-β (2)	0	0	0
rhIFN-γ (4)	0	0	0
rhG-CSF (2)	0	0	0
rhGM-CSF (5)	0	0	0

n = natural; r = recombinant; h = human; m = mouce

Makers of enzyme immunoassay kit

(1) = Amersham Japan

(2) = R & D (USA)

(3) = kit from Otsuka Seiyaku

(4) = kit from Toray-Fuji

(5) = Oncogene Science

Example 2

To a vial containing 370 kBq (10 μCi) of ^{125}I labeled human recombinant TGF-β_1 (74 - 167 TBq/mmol; Daiichi Kagaku Yakuhin), 1.0 ml of phosphate buffered physiological saline (pH 7.4) containing bovine serum albumin (2 mg/ml) was added to prepare a solution of ^{125}I labeled TGF-β_1.

Then, PSK (Sankyo) was dissolved in phosphate buffered physiological saline (pH 7.4) containing bovine serum albumin (2 mg/ml) to prepare a solution of PSK (200 μg/ml).

In a test tube, 500 μl of the ^{125}I labeled TGF-β_1 solution and 500 μl of the solution of PSK (200 μg/ml) or phosphate buffered physiological saline (pH 7.4) containing bovine serum albumin (2 mg/ml). Then, the reaction was performed at 22 °C for 3 hours.

After the reaction was completed, the reaction mixture was applied on a gel filtration column (diameter = 1 cm; height = 50 cm) filled with Bio-GelP-60 (Nihon Bio-Rad Laboratories) to carry out gel filtration chromatography. As an eluting solution, phosphate buffered physiological saline (pH 7.4) containing 0.1 % bovine serum albumin was used. Each of the eluates was collected in 1 ml portions by a fraction collector, and the radioactivities were measured by a gamma counter.

The results were shown in Fig. 2 (groups to which only TGF-β_1 was added) and Fig. 3 (groups to which PSK and TGF-β_1 were added). In the control groups (Fig. 2), i.e., the groups to which only TGF-β_1 was added, the radioactivities were eluated mainly in fraction number 40 (molecular weight = about 25000, i.e., the molecular weight of the active TGF-β). In the groups wherein PSK was reacted (Fig. 3), the radioactivities were observed in the fraction numbers 10 to 18 (eluating position of PSK). Therefore, the results of gel filtration chromatography show the binding of PSK and TGF-β.

Example 3

The fetal mink lung cell line Mv1Lu (Dainippon Pharmaceutical) or the mouse T cell line CTLL-2 (Rikagaku Kenkyusho) was suspended in the culture medium as mentioned below so that the concentration became 5 x 10^5 cells/ml, and 100 µl of the suspension was poured in each well of 96-well culture plate (Falcon 3072; Becton-Dickinson Labware, New Jersey, USA). Then, a TGF-β_1 solution prepared from the lyophilized human TGF-β_1 (Takara Shuzo) as in Example 1 was added to each well so that the concentration thereof became 50 ng/ml. The cells were cultured in a 5 % CO_2 incubator at 37 °C for 48 hours. As the culture medium for the cell line Mv1Lu, Eagle's minimum essential medium containing 10 % fetal bovine serum, 2 mM glutamine and 0.1 mM non-essential amino acids was used. As the culture medium for the cell line CTLL-2, the RPMI 1640 medium containing 10 % fetal bovine serum, 20 units/ml mouse interleukin-2, and 2 mM glutamine was used. At 4 hours before the end of the cultivation, 15 µl of MTT reagent [i.e., a solution prepared by dissolving 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl-tetrazolium bromide in phosphate buffered physiological saline so that the concentration became 5 mg/ml] was poured to each well. After the cultivation was completed, formazan formed in cells was dissolved in 200 µl of 40 mM HCl acidic isopropanol, and the absorbance at 570 nm was measured by a plate reader (control culture test).

Further, the experiments wherein a PSK solution prepared as in Example 1 was added to said culture system were carried out.

In the test (A) for the fetal mink lung cell line Mv1Lu, the PSK solution was added to each well to which the Mv1Lu suspension had been poured as in the control culture test, so that the concentration of PSK became 100 µg/ml, then TGF-β_1 was added so that the concentration became 50

ng/ml, and thereafter the procedure of the control culture test was repeated. In the test (B) for the fetal mink lung cell line Mv1Lu, after the PSK solution was added as in the test (A), the cells were thoroughly washed with the culture medium to remove unbound PSK, then TGF-β_1 was added so that the concentration became 50 ng/ml, and thereafter the procedure of the control culture test was repeated. The results are shown in Fig. 4. In Fig. 4, "PSK(-)" is the results of the control culture test wherein PSK was not added, "A" is the results of the test (A) wherein after PSK was added, TGF-β_1 was added without washing, and "B" is the results of the test (B) wherein after PSK was added and the unbound PSK was removed by washing, TGF-β_1 was added.

Further, the procedure of the test (A) was repeated, except that PSK was added so that the concentration thereof became 1 µg/ml, 10 µg/ml, and 100 µg/ml. The results are shown in Fig. 5.

In the test (A) for the mouse T cell line CTLL-2, the PSK solution was added to each well to which the CTLL-2 suspension had been poured as in the control culture test, so that the concentration of PSK became 100 µg/ml, then TGF-β_1 was added so that the concentration became 50 ng/ml, and thereafter the procedure of the control culture test was repeated. In the test (B) for the mouse T cell line CTLL-2, TGF-β_1 was added to each well to which the CTLL-2 suspension had been poured as in the control culture test, so that the concentration became 50 ng/ml, then the PSK solution was added so that the concentration of PSK became 100 µg/ml, and thereafter the procedure of the control culture test was repeated. In the test (C) for the mouse T cell line CTLL-2, after the PSK solution was added as in the test (A), the cells were thoroughly washed with the culture medium to remove unbound PSK, then TGF-β_1 was added so that the concentration became 50 ng/ml, and thereafter the procedure

of the control culture test was repeated. The results are shown in Fig. 6. In Fig. 6, "PSK(-)" is the results of the control culture test wherein PSK was not added, "A" is the results of the test (A) wherein after PSK was added, TGF-β_1 was added without washing, "B" is the results of the test (B) wherein after TGF-β_1 was added, PSK was added without washing, and "C" is the results of the test (C) wherein after PSK was added and the unbound PSK was removed by washing, TGF-β_1 was added.

Further, the procedure of the test (A) was repeated, except that PSK was added so that the concentration thereof became 1 μg/ml, 10 μg/ml, and 100 μg/ml. The results are shown in Fig. 7.

In Figs. 4 to 7, growth inhibitory ratio (%) was calculated from the equation (II):

$$\text{Growth inhibitory ratio (\%)} = (Ac - Ap) / Ac \times 100 \qquad \text{(II)}$$

wherein Ac is an absorbance at 570 nm of formazan formed in the control culture test, Ap is an absorbance at 570 nm of formazan formed in the test wherein TGF-β_1 was added, or TGF-β_1 and PSK were added.

As shown in the above Figures, the growth of the cell lines was inhibited by TGF-β_1. When PSK was added before adding TGF-β_1, the inhibitory action by TGF-β_1 was lowered in each cell line. Further, the function of PSK is dose-dependent. Therefore, it is manifest that the direct binding of PSK and TGF-β_1 brings about the reduction of TGF-β_1 activity.

Example 4

The fetal mink lung cell line Mv1Lu (Dainippon Pharmaceutical) or the mouse T cell line CTLL-2 (Rikagaku Kenkyusho) was suspended in the culture medium for the binding tests [i.e., Dulbecco's minimum essential medium

containing 0.1 % bovine serum albumin and 25 mM Hepes] so that the concentration became 1 x 10^6 cells/ml. The cells were precultured in a 5 % CO_2 incubator at 37 °C for 2 hours. After the cultivation was completed, the cells were washed with the culture medium for the binding tests three times to adjust the cell concentration to 1 x 10^6 cells/ml. To the resulting cell suspension, a solution of ^{125}I labeled human recombinant TGF-β_1 (74 - 167 TBq/mmol; Daiichi Kagaku Yakuhin) prepared as in Example 2 so that the concentration thereof became 1 ng/ml, 5 ng/ml, 10 ng/ml, or 50 ng/ml. The cells were cultured at 22 °C for 3 hours. After the cells were washed by centrifuging, radioactivities bound to cells were measured by a gamma counter. Non-specific bindings of cells were examined in the presence of non-labeled TGF-β_1. The results are shown in Fig. 8 (the fetal mink lung cell line Mv1Lu) and Fig. 9 (the mouse T cell line CTLL-2). As clear from Figs. 8 and 9, the radioactivity bound to cells were dependent on the concentration of TGF-β_1 added.

Then, the experiments wherein PSK was added to the above cultivating system were carried out. More particularly, PSK was added to the above cell suspension so that the concentration of PSK became 1 μg/ml, 10 μg/ml, or 100 μg/ml, then TGF-β_1 was added without washing so that the concentration of TGF-β_1 became 50 ng/ml, and thereafter the above procedure was repeated. The results are shown in Fig. 10 (the fetal mink lung cell line Mv1Lu) and Fig. 11 (the mouse T cell line CTLL-2). When PSK was added before TGF-β_1 was added, the binding of TGF-β_1 to the cells was inhibited. The function of PSK was dose-dependent. Therefore, it is clear that the action of PSK is caused by the direct binding to TGF-β_1.

In Figs. 10 and 11, the binding inhibitory ratio (%) was calculated from the equation (III):

Binding inhibitory ratio (%) = (Rc - Rp) / Rc X 100 (III)
wherein Rc is the radioactivity (dpm) when PSK is not added, and Rp is the radioactivity (dpm) when PSK is added.

Example 5

EL4 leukemia cells (distributed from Microbiology department in National Defense Medical College, Saitama, Japan) were subcutaneously implanted to 8-week-old female C57BL/6 mice (Charles River Japan) (a group consists of 5 mice) in an amount of 1×10^6 cells. The size of the tumor was measured by a slide caliper with time. The TGF-β1 solution prepared as in Example 1 was intraperitoneally administered at a dose of 1 μ per a mouse for 4 days in succession after the implantation of the tumor. Further, the PSK solution prepared as in Example 1 was intraperitoneally administered at a dose of 100 mg/kg for 4 days in succession after the implantation of the tumor. The tumor sizes at the 9th day after the implantation are shown in Fig. 12, wherein "(-)" means not-administered, and "(+)" means administered. In comparison with the non-treatment group, the growth promotion of the tumor was clearly observed in the group wherein TGF-β1 was administered, but PSK was not administered, whereas in the group wherein TGF-β1 and PSK were administered, no promotion was observed and the size was almost same as that in the non-treatment group. When PSK was added to the group wherein TGF-β1 was not administered, the growth of the tumor was not influenced. Therefore, it is apparent that the function of PSK is caused by the direct action to TGF-β1.

As explained above, the protein-bound polysaccharide used in the present invention can selectively inhibit only the biological activities of TGF-β1 and/or PDGF, without an allergic reaction when an antibody preparation (anti-TGF-β1 or PDGF antibody) is administered in a living body, or without lowering the activity of the antibody preparation when a

neutralizing antibody to the preparation is formed. Further, the protein-bound polysaccharide used in the present invention has been clinically used as a carcinostatic agent and proved to hardly produce side-effects.

Although the present invention has been described with reference to specific embodiments, various changes and modifications obvious to those skilled in the art are deemed to be within the sprit, scope, and concept of the invention.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of treatment or prevention of a disease or condition selected from the list comprising fibroid lung, hepatic fibrosis, glomerulonephritis and scleroderma, wherein said disease or condition is directly or indirectly caused by transforming growth factor-β (TGF-β) or platelet-derived growth factor (PDGF), said method comprising administering to a mammal an effective amount of a protein-bound polysaccharide which is obtained from a fungus belonging to *Coriolus*, and contains about 18 to 38% by weight of proteins.

2. The method according to claim 1, wherein the protein-bound polysaccharide is an extract from mycelia, broth or fruit bodies obtained by culturing a fungus belonging to *Coriolus*.

3. The method according to claim 1, wherein the protein-bound polysaccharide is prepared by extracting mycelia of *Coriolus* versicolor (Fr.) Quél with hot water, purifying and then drying a resulting extract.

4. A protein-bound polysaccharide obtained from *Coriolus* which contains about 18 to 38% by weight of proteins when used to bind transforming growth factor-β (TGF-β) or platelet- derived growth factor (PDGF) substantially as hereinbefore described with reference to the Examples and/or drawings.

5. A protein-bound polysaccharide obtained from *Coriolus* which contains about 18 to 38% by weight of proteins when used to reduce or prevent or delay the TGF-β-induced or PDGF-induced inhibition of growth of a mammalian cell substantially as hereinbefore described with reference to the Example and/or drawings.

6. A protein-bound polysaccharide obtained from *Coriolus* which contains about 18 to 38% by weight of proteins when used to prevent or delay or reduce TGF-β-induced or PDGF-induced growth of a tumour substantially as hereinbefore described with reference to the Examples and/or drawings.

AUSTRALIA PATENT OFFICE

7 A method of delaying or preventing a TGF-β-induced or PDGF-induced phenotype in a mammalian cell or mammal comprising administration thereto of an effective amount of a protein-bound polysaccharide obtained from *Coriolus* substantially as hereinbefore described with reference to the Examples and/or drawings.

DATED this Twelfth day of May, 1997

Kureha Chemical Industry Co., Ltd

by DAVIES COLLISON CAVE
Patent Attorneys for the applicant(s)

AUSTRALIA PATENT OFFICE

BINDING AGENT FOR GROWTH FACTOR

ABSTRACT

A binding agent for a growth factor selected from the group consisting of transforming growth factor-β (TGF-β) and platelet-derived growth factor (PDGF), comprising a protein-bound polysaccharide which is obtained from a fungus belonging to Coriolus, and contains about 18 to 38 % by weight of proteins, and a pharmaceutically acceptable carrier or dilute is disclosed.

Fig. 1

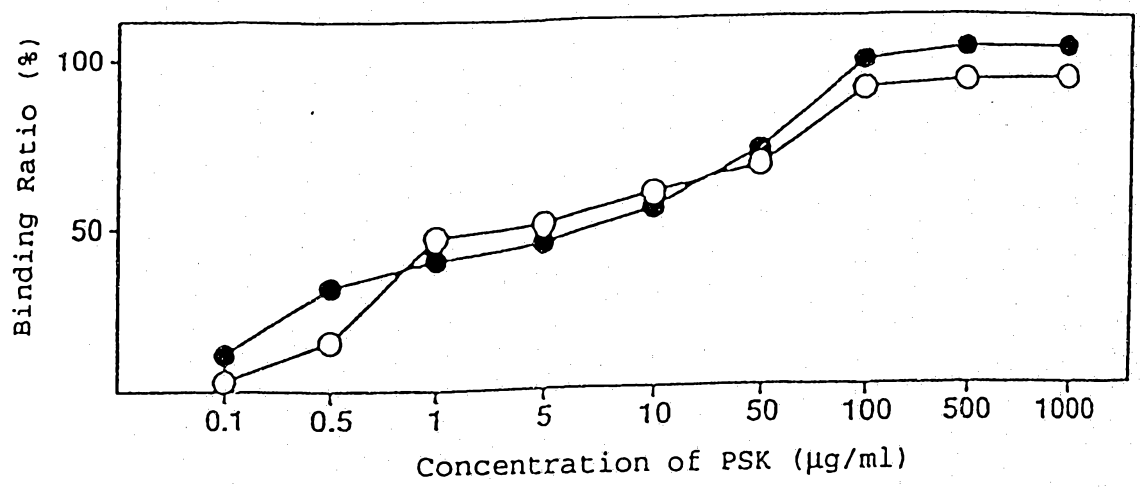


Fig. 2

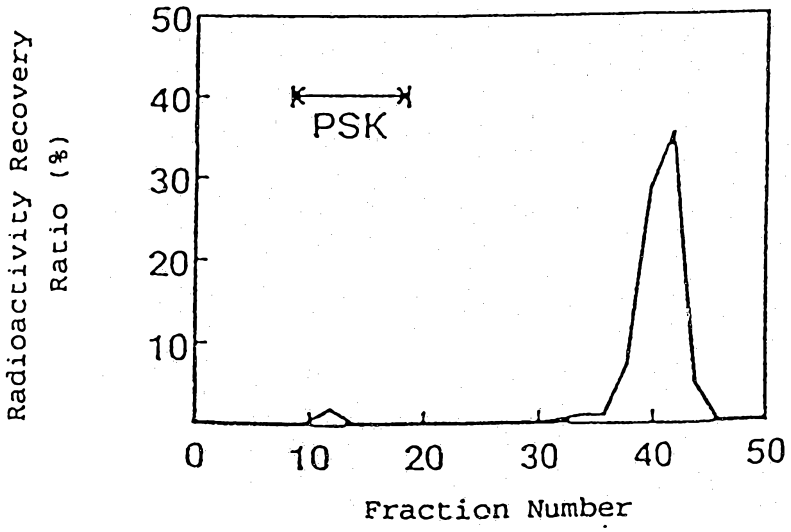


Fig. 3

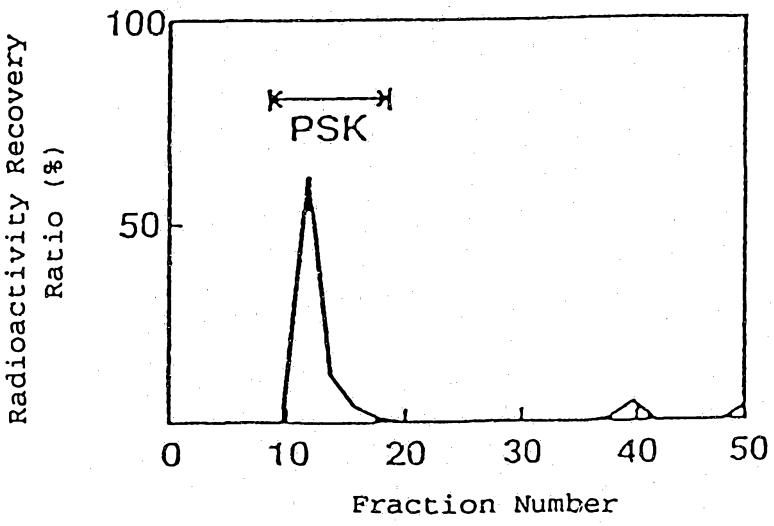


Fig. 4

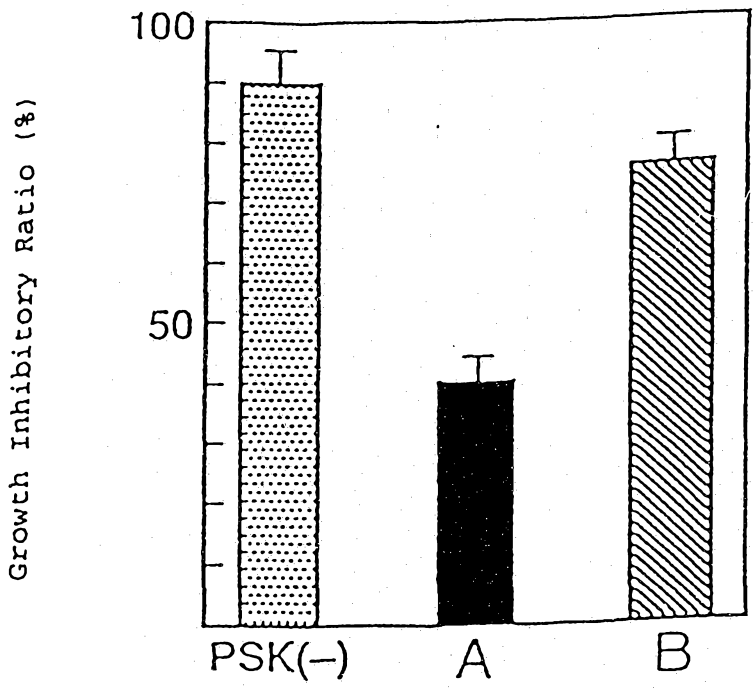

100
50
Growth Inhibitory Ratio (%)
PSK(–)
A
B

Fig. 5

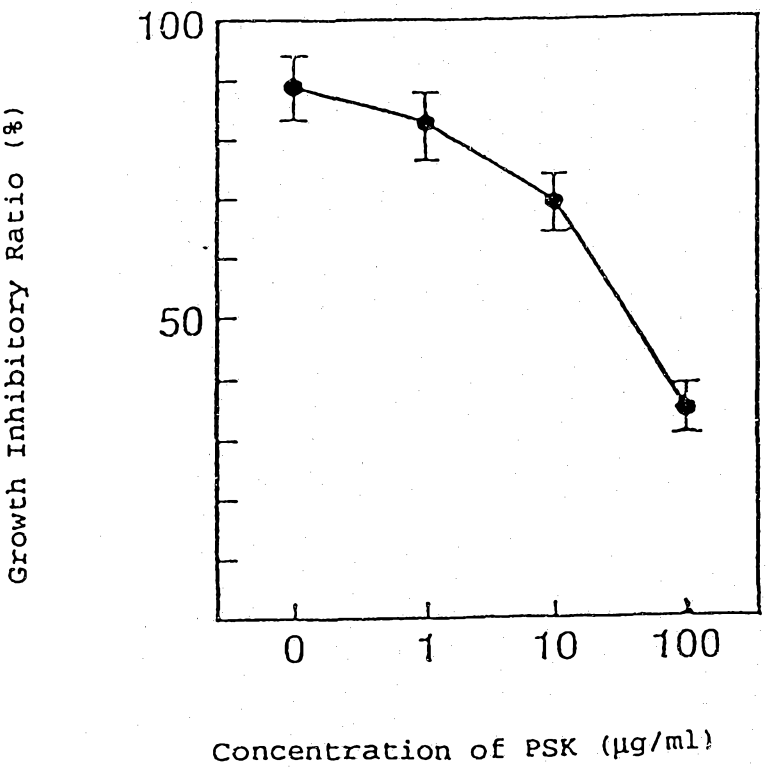

100
50
Growth Inhibitory Ratio (%)
0
1
10
100
Concentration of PSK (μg/ml)

Fig. 6

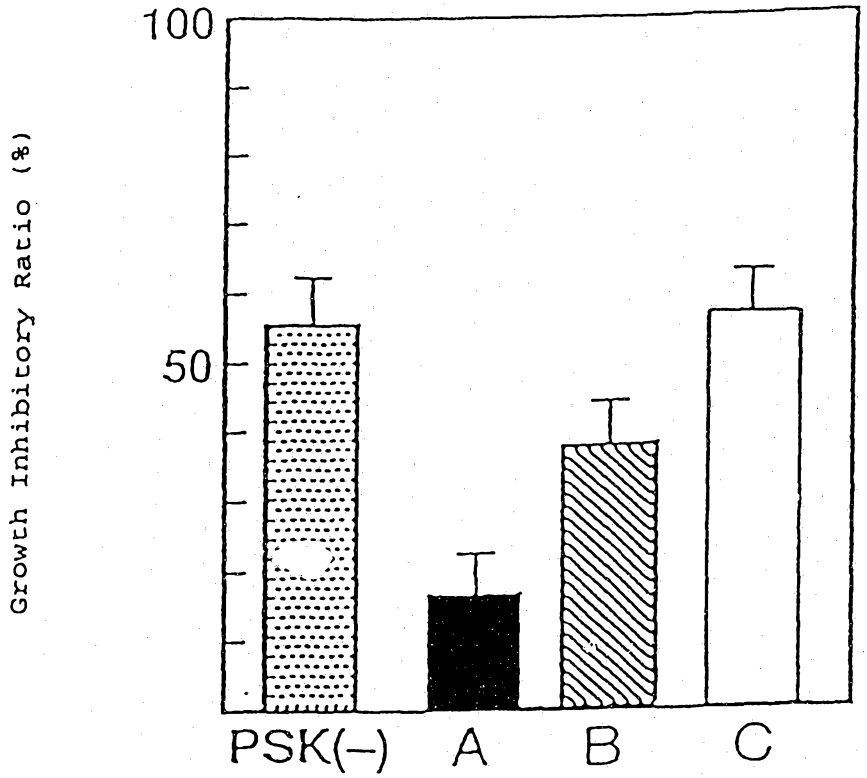

100
50
Growth Inhibitory Ratio (%)
PSK(-)
A
B
C

Fig. 7

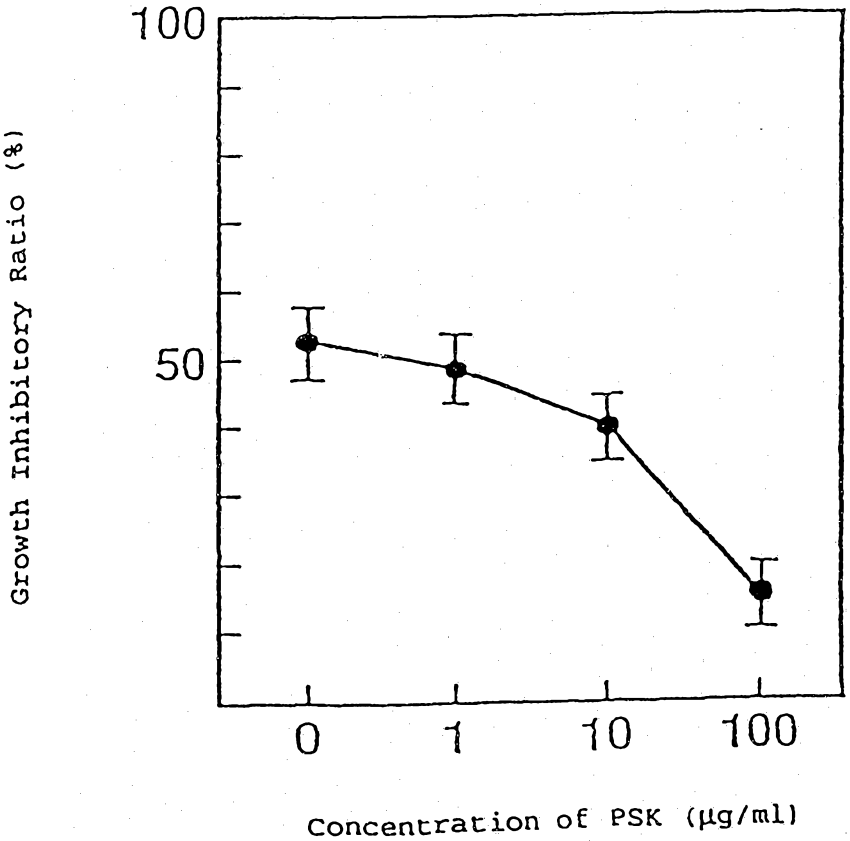

100
50
Growth Inhibitory Ratio (%)
0
1
10
100
Concentration of PSK (μg/ml)

Fig. 8

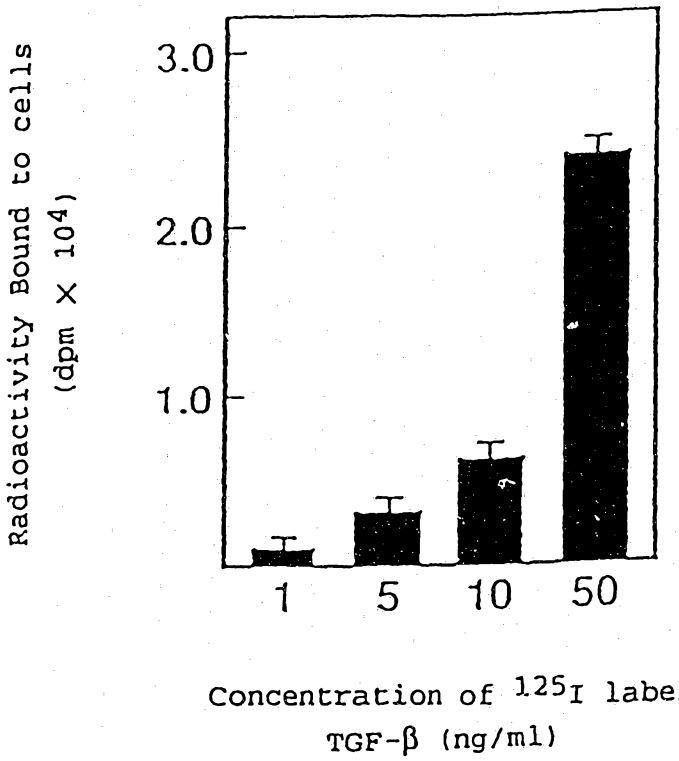

Radioactivity Bound to cells
(dpm × 10⁴)
3.0
2.0
1.0
1
5
10
50
Concentration of 125I labeled
TGF-β (ng/ml)

Fig. 9

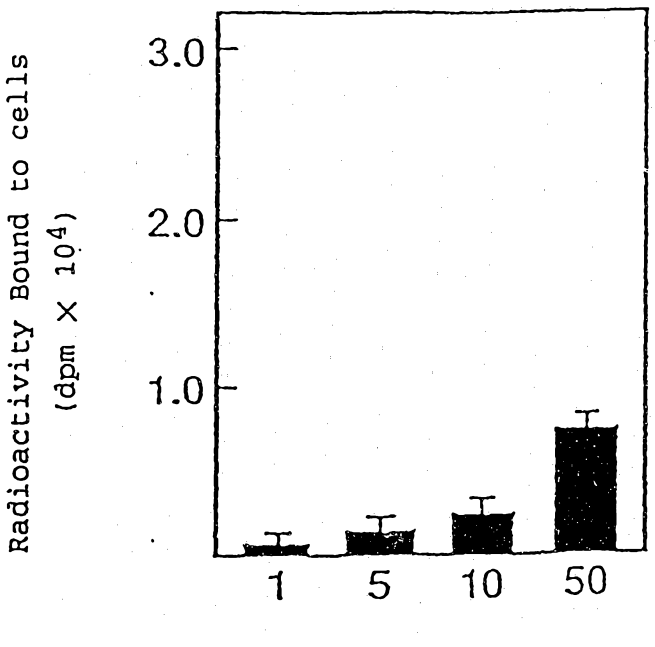

Radioactivity Bound to cells
(dpm × 10⁴)
3.0
2.0
1.0
1
5
10
50
Concentration of 125I labeled
TGF-β (ng/ml)

Fig. 10

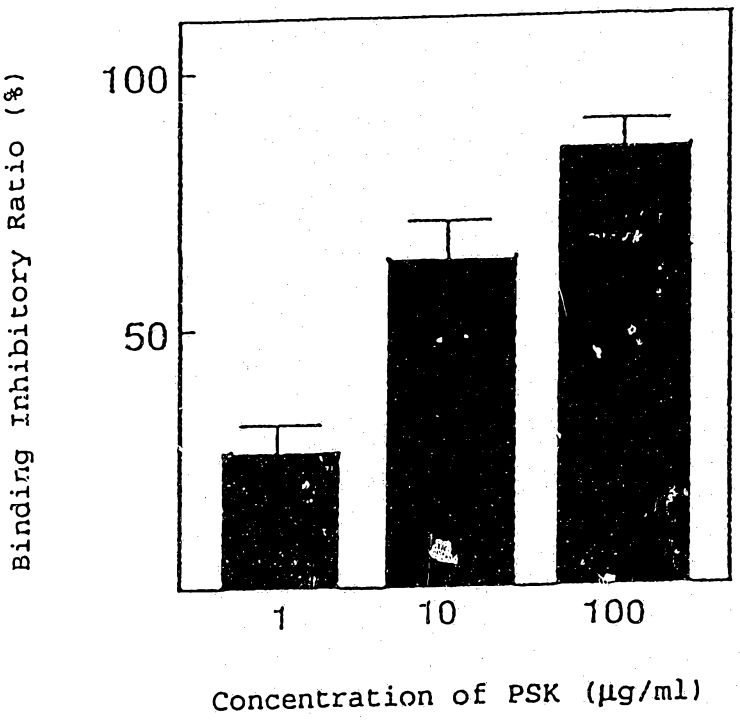

Binding Inhibitory Ratio (%)
100
50
1
10
100
Concentration of PSK (μg/ml)

Fig. 11

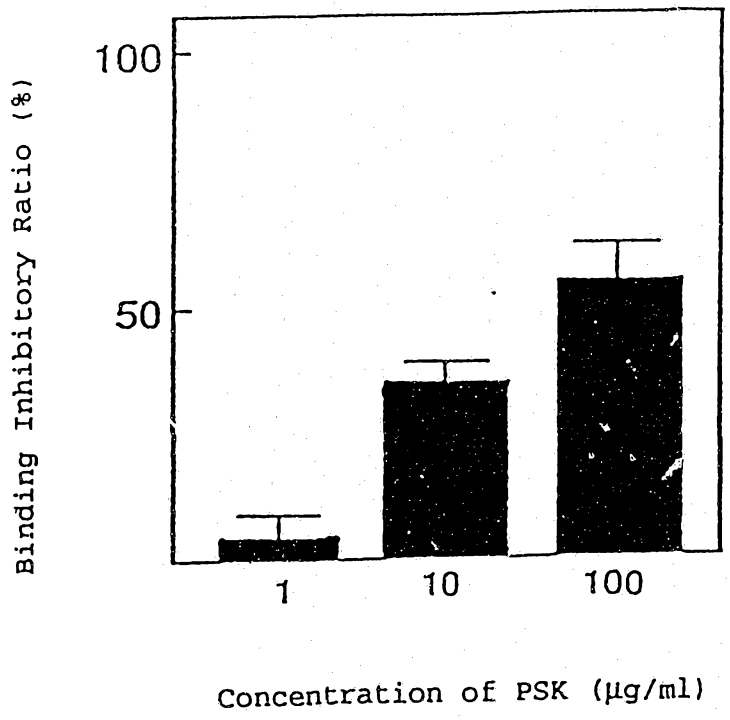

Binding Inhibitory Ratio (%)
100
50
1
10
100
Concentration of PSK (μg/ml)

Fig. 12

