[DESCRIPTION]

[Title of Invention] PHARMACEUTICAL COMPOSITION CONTAINING 2-{4-[N-(5,6-DIPHENYLPYRAZIN-2-YL)-N-ISOPROPYLAMINO]BUTYLOXY}-N-(METHYLSULFONYL)ACETAMIDE

[Technical Field]

[0001]

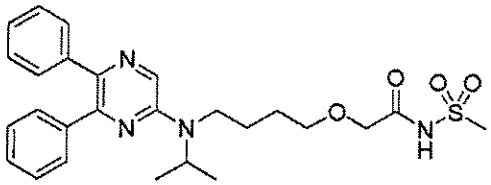
The present invention relates to a stabilized solid preparation containing 2-{4-[N-(5,6-diphenylpyrazin-2-yl)-N-isopropylamino]butyloxy}-N-(methylsulfonyl)acetamide (hereinafter referred to as "Compound (I)").

[Background Art]

[0002]

It is known that Compound (I) represented by the following structural formula has an excellent prostaglandin I_2 (also referred to as PGI_2) receptor agonistic activity and shows various medicinal effects such as a platelet aggregation inhibitory effect, a vasodilating effect, a bronchial smooth muscle dilating effect, a lipid deposition inhibitory effect, and a leukocyte activation inhibitory effect (PTL 1).

[Chem. 1]



(I)

[0003]

In general, as diluents for a solid preparation, lactose, cornstarch, crystalline cellulose, and sugar alcohols such as D-mannitol are used for diluting an active ingredient. In the process for studying the formulation of a solid preparation containing Compound (I), it was found that Compound (I) itself is stable to temperature and humidity, however, depending on the type of D-mannitol, the decomposition of Compound (I) in the solid preparation proceeds, and the content thereof decreases.

[Citation List]

[Patent Literature]

[0004]

[PTL 1] WO 2002/088084

[PTL 2] WO 2009/157396

[PTL 3] WO 2009/107736

[PTL 4] WO 2009/154246

[PTL 5] WO 2009/157397

[PTL 6] WO 2009/157398

[PTL 7] WO 2009/154246

[PTL 8] WO 2009/157397

[Non Patent Literature]

[0005]

[NPL 1] Hepatology, 2007, Vol. 45, No. 1, pp. 159-169.

[NPL 2] Folia Pharmacologica Japonica, Vol. 117, No. 2, pp. 123-130, 2001, Abstract.

[NPL 3] International Angiology, 29, Suppl. 1 to No. 2, pp. 49-54, 2010.

[NPL 4] Jpn. J. Clin. Immunol., 16(5), 409-414, 1993.

[NPL 5] Jpn. J. Thromb. Hemost., 1:2, pp. 94-105, 1990, Abstract.

[NPL 6] J. Rheumatol., 2009, 36(10), 2244-2249.

[NPL 7] Japan J. Pharmacol., 43, pp. 81-90, 1987.

[NPL 8] New Engl. J. Med., 2015, 24, 2522-2533.

[NPL 9] CHEST 2003, 123, 1583-1588.

[NPL 10] Br. Heart J., 53, pp. 173-179, 1985.

[NPL 11] The Lancet, 1, 4880, pt 1, pp. 569-572, 1981.

[NPL 12] Eur. J. Pharmacol., 449, pp. 167-176, 2002.

[NPL 13] The Journal of Clinical Investigation,117, pp. 464-472, 2007.

[NPL 14] Am. J. Physiol. Lung Cell Mol. Physiol., 296: L648-L656, 2009.

[Summary of Invention]

[Technical Problem]

[0006]

An object of the present invention is to provide a stabilized solid preparation containing Compound (I). Here, the term "stabilized" means that the decrease in the content of Compound (I) contained in the solid preparation due to decomposition thereof is suppressed.

[Solution to Problem]

[0007]

As a result of intensive studies for achieving the above object, the present inventors found that the stability of Compound (I) in a solid preparation is improved by using D-mannitol having a specific surface area of 1.0 m^2/g or less as a diluent for Compound (I), and thus completed the present invention.

That is, the present invention is as follows.

(A) A solid preparation containing Compound (I) and D-mannitol having a specific surface area of 1.0 m^2/g or less.

(B) The solid preparation described in (A), wherein the amount of D-mannitol is from 5 to 10000 parts by weight with respect to 1 part by weight of Compound (I).

(C) The solid preparation described in (A) or (B), wherein the content of D-mannitol is from 10 to 99 wt% of the total weight of the solid preparation.

(D) The solid preparation described in any one of (A) to (C), wherein D-mannitol accounts for 20 wt% or more of the total weight of diluents contained in the solid preparation.

(E) The solid preparation described in (A), wherein the content of D-mannitol is

(a) such that the weight of D-mannitol is from 5 to 10000 parts by weight with respect to 1 part by weight of Compound (I),

(b) from 10 to 99 wt% of the total weight of the solid preparation, and

(c) 20% or more of the total weight of diluents contained in the solid preparation.

(F) The solid preparation described in any one of (A) to (E), further comprising a diluent other than D-mannitol and a binder.

(G) The solid preparation described in (F), wherein the diluent other than D-mannitol is one type or two types selected from the group consisting of cornstarch, sucrose, and crystalline cellulose.

(H) The solid preparation described in (F), wherein the binder is hydroxypropyl cellulose.

(I) The solid preparation described in any one of (A) to (E), further containing

(a) one type or two types selected from the group consisting of cornstarch, sucrose, and crystalline cellulose, and

(b) hydroxypropyl cellulose.

(J) The solid preparation described in (I), wherein

(a) the content of Compound (I) is from 0.1 to 2 wt% of the total weight of the solid preparation,

(b) the content of D-mannitol is from 20 to 80 wt% of the total weight of the solid preparation,

(c) the content of cornstarch is from 15 to 40 wt% of the total weight of the solid preparation, and

(d) the content of hydroxypropyl cellulose is from 1 to 5 wt% of the total weight of the solid preparation.

(K) The solid preparation described in (J), wherein Compound (I) is a Form-I crystal.

(L) The solid preparation described in any one of (A) to (K), wherein the solid preparation is a tablet or a granule.

(M) The solid preparation described in any one of (A) to (L), which is used for treating diabetic neuropathy, diabetic gangrene, a peripheral circulatory disturbance, chronic arterial occlusion, intermittent claudication, scleroderma, thrombosis, pulmonary hypertension, myocardial infarction, angina pectoris, glomerulonephritis, diabetic nephropathy, chronic renal failure, bronchial asthma, interstitial pneumonia (pulmonary fibrosis), a chronic obstructive pulmonary disease, tubulointerstitial nephritis, an inflammatory bowel disease, or a symptom associated with spinal canal stenosis.

(N) The solid preparation described in (M), which is used for treating pulmonary hypertension.

(O) The solid preparation described in (M), which is used for treating a peripheral circulatory disturbance.

(P) The solid preparation described in (M), which is used for treating chronic arterial occlusion.

(Q) The solid preparation described in (M), which is used for treating intermittent claudication.

(R) The solid preparation described in (M), which is used for treating a symptom associated with spinal canal stenosis.

(S) The solid preparation described in (M), which is used for treating pulmonary fibrosis.

(T) The solid preparation described in (M), which is used for treating scleroderma.

(U) The solid preparation described in (M), which is used for treating chronic renal failure.

(V) The solid preparation described in (M), which is used for treating tubulointerstitial nephritis.

[Brief Description of Drawings]

[0008]

[FIG. 1] FIG. 1 shows a powder X-ray diffraction spectrum chart of a Form-I crystal of Compound (I). The vertical axis represents a peak intensity (cps) and the horizontal axis represents a diffraction angle (2θ [°]).

[FIG. 2] FIG. 2 shows a powder X-ray diffraction spectrum chart of a Form-II crystal of Compound (I). The vertical axis represents a peak intensity (cps) and the horizontal axis

represents a diffraction angle (2θ [°]).

[FIG. 3] FIG. 3 shows a powder X-ray diffraction spectrum chart of a Form-III crystal of Compound (I). The vertical axis represents a peak intensity (cps) and the horizontal axis represents a diffraction angle (2θ [°]).

[Description of Embodiments]

[0009]

(Compound (I))

Compound (I) can be produced in accordance with the method described in, for example, PTL 1 or 2, and the following crystals of three forms are known (PTL 2).

(1) A Form-I crystal of Compound (I), for which a powder X-ray diffraction diagram is obtained using a Cu-Kα radiation (λ=1.54 Å), and which shows diffraction peaks at the following diffraction angles (2θ): 9.4°, 9.8°, 17.2°, and 19.4° in the powder X-ray diffraction spectrum of Compound (I).

(2) A Form-II crystal of Compound (I), for which a powder X-ray diffraction diagram is obtained using a Cu-Kα radiation (λ=1.54 Å), and which shows diffraction peaks at the following diffraction angles (2θ): 9.0°, 12.9°, 20.7°, and 22.6° in the powder X-ray diffraction spectrum of Compound (I).

(3) A Form-III crystal of Compound (I), for which a powder X-ray diffraction diagram is obtained using a Cu-Kα radiation (λ=1.54 Å), and which shows diffraction peaks at the following diffraction angles (2θ): 9.3°, 9.7°, 16.8°, 20.6°, and 23.5° in

the powder X-ray diffraction spectrum of Compound (I).

[0010]

Compound (I) which can be used in the solid preparation of the present invention may be any of the above-mentioned crystals, and further, it may be a mixture of these crystals or may be amorphous. Above all, the Form-I crystal is preferred.

The powder X-ray diffraction spectrum charts of the above-mentioned crystals of three forms are shown in FIGS. 1 to 3 for reference.

The powder X-ray diffraction spectra of these crystals were measured using RINT-Ultima III (manufactured by Rigaku Corporation) (target: Cu, voltage: 40 kV, current: 40 mA, scan speed: 4°/min).

[0011]

The amount of Compound (I) contained in the solid preparation of the present invention is preferably from 0.1 to 12 wt%, more preferably from 0.1 to 2 wt% of the total weight of the solid preparation.

[0012]

(D-mannitol)

As a diluent for the solid preparation of the present invention, D-mannitol having a specific surface area of 1.0 m^2/g or less is used. The specific surface area is more preferably 0.7 m^2/g or less, further more preferably larger

than 0.2 m^2/g and smaller than 0.7 m^2/g.

[0013]

In the present invention, the specific surface area is a value measured by the BET method, and can be measured using, for example, a specific surface area measuring device Macsorb HM model-1220 (Mountech Co., Ltd.).

[0014]

As an example of D-mannitol to be used in the present invention, for example, Mannit C (Mitsubishi Shoji Foodtech Co., Ltd., average particle diameter: 20 μm), Mannit P (Mitsubishi Shoji Foodtech Co., Ltd., 50 μm), Mannit S (Mitsubishi Shoji Foodtech Co., Ltd., average particle diameter: 150 μm), Pearlitol 25C (Roquette Pharma, average particle diameter: 25 μm), Pearlitol 50C (Roquette Pharma, average particle diameter: 50 μm), Pearlitol 160C (Roquette Pharma, average particle diameter: 160 μm), Nonpareil 108 (100) (Freund Corporation, average particle diameter: 100 μm), and Nonpareil 108 (200) (Freund Corporation, average particle diameter: 200 μm) can be exemplified. Among these, Mannit P, Mannit S, Pearlitol 50C, and Pearlitol 160C are preferred.

[0015]

As the diluent for the solid preparation of the present invention, D-mannitol having a specific surface area of 1.0 m^2/g or less is used. The D-mannitol may account for 20 wt% or more, and more preferably accounts for 50 wt% or more of

the total weight of diluents contained in the solid preparation of the present invention. The diluents may be a mixture of two or more types. As the diluents which can be used other than D-mannitol, cornstarch, crystalline cellulose, sucrose, erythritol, isomalt, and the like can be exemplified, and cornstarch, sucrose, and crystalline cellulose are preferred. Cornstarch is more preferred.

The content of cornstarch is preferably from 0.5 to 45%, more preferably 15 to 40% of the total weight of the solid preparation.

[0016]

(Solid Preparation)

The solid preparation of the present invention is a solid preparation containing Compound (I) and D-mannitol, and is characterized in that the amount of D-mannitol is from 5 to 10000 parts by weight, preferably from 10 to 9500 parts by weight with respect to 1 part by weight of Compound (I).

[0017]

The content of D-mannitol in the solid preparation of the present invention is generally from 10 to 99 wt%, and is preferably from 15 to 95 wt%, more preferably from 20 to 80 wt% of the total weight of the solid preparation.

[0018]

In the present invention, unless otherwise specified, the "solid preparation" refers to a solid preparation in a given

form to be orally administered, and includes a conventional tablet, an orally disintegrating tablet, a chewable tablet, a troche tablet, a sublingual tablet, an effervescent tablet, a dispersible tablet, a soluble tablet, a powder, a granule, and a capsule. The solid preparation of the present invention includes a single-layer tablet having a single-layer structure and a multi-layer tablet having a multi-layer structure including two or more layers. The shape of the thus obtained solid preparation is not particularly limited, and can be various shapes such as a circle, an ellipse, a caplet, or a doughnut. In order to control the dissolution property of Compound (I), a sustained release property or an enteric release property may be imparted to the solid preparation of the present invention by a known method. Further, the solid preparation of the present invention may be coated with any of various coating agents or a sugar coating agent by a known method for the purpose of improvement of light stability, improvement of appearance, ensuring of discriminability, release control, or the like. Further, in the solid preparation of the present invention, a pigment may be blended for the purpose of improvement of light stability, ensuring of discriminability, or the like, and also, a taste masking agent and a flavoring agent may be blended for the purpose of improvement of flavor, or the like.

[0019]

In the solid preparation of the present invention, other than the above-mentioned components, pharmaceutically acceptable carriers (excipients) can be blended as long as the effect of the present invention is not inhibited. These excipients can be blended as appropriate in appropriate amounts as, for example, a binder, a disintegrant, a fluidizing agent, a lubricant, a coating agent, a release control agent, a plasticizer, a coloring agent, a taste masking agent, and a flavoring agent. These excipients can be used alone or two or more types thereof can be used in combination.

[0020]

As the binder, for example, gelatin, pullulan, hydroxypropyl cellulose, methyl cellulose, polyvinylpyrrolidone, macrogol, gum Arabic, dextran, polyvinyl alcohol, pregelatinized starch, and hypromellose can be exemplified, and hydroxypropyl cellulose, polyvinyl alcohol, and hypromellose are preferred, and hydroxypropyl cellulose is more preferred.

The amount of the binder is preferably from 0.1 to 10 wt%, more preferably from 1 to 8 wt%, further more preferably from 1 to 5 wt% of the total weight of the solid preparation.

The amount of hydroxypropyl cellulose is preferably from 0.1 to 10 wt%, more preferably from 1 to 8 wt%, further more preferably from 1 to 5 wt% of the total weight of the solid preparation.

[0021]

As the disintegrant, for example, carmellose, carmellose calcium, carmellose sodium, croscarmellose sodium, sodium starch glycolate, crospovidone, a cation exchange resin, partially pregelatinized starch, and low-substituted hydroxypropyl cellulose can be exemplified, and low-substituted hydroxypropyl cellulose is preferred.

The amount of the disintegrant is preferably from 0.1 to 10 wt%, more preferably from 1 to 8 wt% of the total weight of the solid preparation.

The amount of low-substituted hydroxypropyl cellulose is preferably from 0.1 to 10 wt%, more preferably from 1 to 8 wt%, further more preferably from 3 to 7 wt% of the total weight of the solid preparation.

[0022]

As the fluidizing agent, for example, light anhydrous silicic acid, hydrated silicon dioxide, synthetic aluminum silicate, and magnesium aluminometasilicate can be exemplified.

[0023]

As the lubricant, for example, stearic acid, magnesium stearate, calcium stearate, sodium stearyl fumarate, talc, waxes, DL-leucine, sodium lauryl sulfate, magnesium lauryl sulfate, macrogol, and light anhydrous silicic acid can be exemplified, and magnesium stearate is preferred.

The amount of the lubricant is preferably from 0.1 to 10 wt%, more preferably from 0.2 to 5 wt% of the total weight of the solid preparation.

[0024]

The amount of magnesium stearate is preferably from 0.1 to 10 wt%, more preferably from 0.2 to 5 wt%, further more preferably from 0.5 to 3 wt% of the total weight of the solid preparation.

[0025]

As the coating agent, ethyl cellulose, ethyl acrylate-methyl methacrylate copolymer, methacrylic acid copolymer LD, hypromellose acetate succinate, and the like can be exemplified.

[0026]

As the release control agent, for example, hydroxypropyl cellulose, an ethylene-vinyl acetate copolymer, and polyethylene oxide can be exemplified.

[0027]

As the plasticizer, for example, triethyl citrate, propylene glycol, and macrogol can be exemplified, and propylene glycol is preferred.

[0028]

As the coloring agent, for example, titanium oxide, talc, iron sesquioxide, yellow iron sesquioxide, Food Yellow No. 4, and Food Yellow No. 4 Aluminum Lake can be exemplified, and

titanium oxide, iron sesquioxide, yellow iron sesquioxide are preferred.

The content of the coloring agent is preferably less than 0.1 wt% of the total weight of the solid preparation.

[0029]

As the taste masking agent, for example, fructose, xylitol, glucose, and DL-malic acid can be exemplified.

[0030]

As the flavoring agent, for example, L-menthol and peppermint can be exemplified.

[0031]

(Method for Producing Solid Preparation)

The solid preparation of the present invention can be produced by a conventional method in the pharmaceutical field. One example of the production method for the solid preparation will be shown below; however, the present invention is by no means limited to this production method.

The solid preparation of the present invention is produced as follows using a powder of Compound (I) which is the active ingredient.

(1) The powder of Compound (I) is mixed with an excipient such as a diluent, thereby forming a powder, or excipients such as a disintegrant and a binder are added to the resulting mixed powder, and the resulting mixture is granulated by any of various known granulation methods, thereby forming a granule.

(2) The obtained mixed powder or granule is filled into a capsule and formed into a capsule or is compression-molded (tableted) and formed into a tablet, directly or after being mixed with excipients such as a lubricant and a fluidizing agent.

(3) According to need, the surface of the obtained mixed powder, granule, capsule, or tablet is coated with a coating agent or a sugar by a known coating method.

[0032]

The Compound (I) has an excellent PGI_2 receptor agonistic effect and is useful as a preventive agent or a therapeutic agent for a PGI_2-related disease, for example, transient ischemic attack (TIA), diabetic neuropathy (see, for example, NPL 1), diabetic gangrene (see, for example, NPL 1), a peripheral circulatory disturbance (for example, chronic arteriosclerosis, chronic arterial occlusion (see, for example, NPL 2), intermittent claudication (see, for example, NPL 3), peripheral embolism, or Raynaud's disease) (see, for example, NPL 4 or NPL 5), a connective tissue disease (for example, systemic lupus erythematosus or scleroderma) (see, for example, PTL 3 or NPL 6), a mixed connective tissue disease, a vasculitic syndrome, reocclusion/restenosis after percutaneous transluminal coronary angioplasty (PTCA), arteriosclerosis, thrombosis (for example, acute-phase cerebral thrombosis or pulmonary embolism) (see, for example,

NPL 5 or NPL 7), hypertension, pulmonary hypertension such as pulmonary arterial hypertension or chronic thromboembolic pulmonary hypertension (for example, NPL 8 or NPL 9), an ischemic disease (for example, cerebral infarction or myocardial infarction (see, for example, NPL 10)), angina pectoris (for example, stable angina pectoris or unstable angina pectoris) (see, for example, NPL 11), glomerulonephritis (see, for example, NPL 12), diabetic nephropathy (see, for example, NPL 1), chronic renal failure (see, for example, PTL 4), allergy, bronchial asthma (see, for example, NPL 13), ulcer, pressure ulcer (bedsore), restenosis after coronary intervention such as atherectomy or stent implantation, thrombocytopenia by dialysis, a disease in which fibrogenesis in an organ or a tissue is involved [for example, a renal disease (for example, tubulointerstitial nephritis) (see, for example, PTL 3), a respiratory disease (for example, interstitial pneumonia (pulmonary fibrosis) (see, for example, PTL 3), a chronic obstructive pulmonary disease (see, for example, NPL 14), or the like), a digestive disease (for example, hepatocirrhosis, viral hepatitis, chronic pancreatitis, or scirrhous gastric cancer), a cardiovascular disease (for example, myocardial fibrosis), a bone or articular disease (for example, bone marrow fibrosis or rheumatoid arthritis), a skin disease (for example, postoperative cicatrix, burn cicatrix, keloid, or hypertrophic cicatrix), an obstetric disease (for

example, uterine fibroid), a urinary disease (for example, prostatic hypertrophy), other diseases (for example, Alzheimer's disease, sclerosing peritonitis, type I diabetes, or postoperative organ adhesion)], erectile dysfunction (for example, diabetic erectile dysfunction, psychogenic erectile dysfunction, psychotic erectile dysfunction, erectile dysfunction due to chronic renal failure, erectile dysfunction after pelvic operation for resection of the prostate, or vascular erectile dysfunction associated with aging or arteriosclerosis) (see, for example, PTL 7), an inflammatory bowel disease (for example, ulcerative colitis, Crohn's disease, intestinal tuberculosis, ischemic colitis, or intestinal ulcer associated with Behcet disease) (see, for example, PTL 5), gastritis, gastric ulcer, an ischemic eye disease (for example, retinal artery occlusion, retinal vein occlusion, or ischemic optic neuropathy), sudden hearing loss, avascular necrosis of bone, an intestinal damage caused by administration of a non-steroidal anti-inflammatory agent (NSAID) (for example, diclofenac, meloxicam, oxaprozin, nabumetone, indomethacin, ibuprofen, ketoprofen, naproxen, or celecoxib) (there is no particular limitation as long as it is a damage occurring in, for example, the duodenum, small intestine, or large intestine; however, for example, a mucosal damage such as erosion or ulcer occurring in the duodenum, small intestine, or large intestine) (see, for example, PTL 8), or

a symptom (for example, paralysis, dullness in sensory perception, pain, numbness, or a decrease in walking ability) associated with spinal canal stenosis (for example, cervical spinal canal stenosis, thoracic spinal canal stenosis, lumbar spinal canal stenosis, coexisting cervical and lumbar spinal stenosis, or sacral spinal stenosis) (see, for example, PTL 6). In addition, the solid preparation of the present invention is also useful as an accelerating agent for gene therapy or angiogenic therapy such as autologous bone marrow transplantation, or an accelerating agent for angiogenesis in peripheral revascularization or angiogenic therapy.

[Examples]

[0033]

Hereinafter, the present invention will be described in more detail with reference to Comparative Examples, Examples; and Test Examples, however, these are not intended to limit the present invention.

As Compound (I) used in the present invention, the above-mentioned Form-I crystal was used.

Unless otherwise stated, the following excipeints were used in Examples and Comparative Examples. As cornstarch, Nisshoku Cornstarch W (Nihon Shokuhin Kako Co., Ltd.) was used. As crystalline cellulose, Ceolus PH-101 (Asahi Kasei Chemicals Co., Ltd.) was used. As hydroxypropyl cellulose, HPC-SSL (Nippon Soda Co., Ltd.) was used. As low-substituted

hydroxypropyl cellulose, LH-11 (Shin-Etsu Chemical Co., Ltd.) was used. As magnesium stearate, vegetable magnesium stearate (specially manufactured) (Taihei Chemical Industrial Co., Ltd.) was used. As sucrose, T.T.G.H granulated sugar (Toyo Sugar Refining Co., Ltd.) was used. As yellow iron sesquioxide, yellow iron sesquioxide (Kishi Kasei Co., Ltd.) was used. As titanium oxide, Tipaque A-100 (Ishihara Sangyo Kaisha, Ltd.) was used. As propylene glycol, propylene glycol (Asahi Glass Co., Ltd.) was used.

[0034]

(Example 1) Type of D-mannitol and Stability

(1) Preparation of Tablets

Predetermined amounts of Compound (I), each type of D-mannitol, cornstarch, and low-substituted hydroxypropyl cellulose were placed in a fluidized bed granulation/drying machine (MP-01, Powrex Corporation), and a 5% aqueous hydroxypropyl cellulose solution was sprayed thereon while mixing, whereby granules were prepared. In the obtained granules, a predetermined amount of magnesium stearate was mixed, and the resulting mixture was tableted at 800 kg using a rotary tableting machine (Correct, Kikusui Seisakusho, Ltd.), whereby a tablet (diameter: 7 mm, 120 mg/tablet) was prepared. The types of D-mannitol used in the respective Examples and Comparative Examples are shown in Table 1. The bulk density (g/mL) shown in Table 1 means the ratio of the mass of a powder

sample in a state where the powder is not tapped (loosened) to the volume of the powder including the factor of an inter-particle void volume, and it was obtained by weighing 25 g of a sample having passed through a sieve with a mesh size of 1000 μm in advance, placing the sample in a measuring cylinder through a funnel, and measuring the volume at that time, followed by calculation. Further, the tap density (g/mL) shown in Table 1 is a bulk density obtained by mechanically tapping a container in which the powder sample is placed, and specifically, it was obtained by tapping the container until no change in the volume was observed, and measuring the volume at that time, followed by calculation.

The components of each tablet and the contents thereof are as shown in Table 2.

[0035]

[Table 1]

Example	Trade name	Manufacturer	Average particle diameter (μm)	Tap density (g/ml)	Bulk density (g/ml)
Example 1-1	Mannit P	Mitsubishi Shoji Foodtech Co., Ltd.	50	0.86	0.40
Example 1-2	Pearlitol 25C	Roquette Pharma	25	0.71	0.36
Example 1-3	Pearlitol 50C	Roquette Pharma	50	0.78	0.42
Example 1-4	Pearlitol 160C	Roquette Pharma	160	0.78	0.50
Example 1-5	Nonpareil 108 (100)	Freund Corporation	100	0.83	0.64
Comparative Example 1-1	Pearlitol 100SD	Roquette Pharma	100	0.54	0.45
Comparative Example 1-2	Parteck M200	Merck Co., Ltd.	150	0.60	0.49

[0036]

[Table 2]

Component Name	Composition (mg/tablet)
Compound (I)	0.2
D-mannitol (each type)	75.4
Cornstarch	36
Low-substituted hydroxypropyl cellulose	6
Hydroxypropyl cellulose	1.2
Magnesium stearate	1.2
Total	120

(2) Evaluation Method and Results

The obtained tablet was placed in a plastic bottle and stored for 1 month in an uncapped state under open conditions at 40°C/75% RH or under open conditions at 60°C. The related substances of Compound (I) in the tablet were measured before and after the storage using high-performance liquid chromatography, and the increased amount of related substances from the start of the test was evaluated. Incidentally, as the "increased amount of related substances (%)" in the table, the decreased amount (peak area) of Compound (I) contained in the preparation before and after the storage is shown. The results and the specific surface area of each type of D-mannitol used are shown in Table 3. It was shown that the produced amount of the related substances was less than 3% in each of the tablets of Examples 1-1 to 1-5. The specific surface area of D-mannitol used in each of these Examples was 1.0 m^2/g or less, and it

could be confirmed that in a case where D-mannitol having such physical properties was used, the stability of the preparation is improved.

[0037]

[Table 3]

	D-mannitol	Increased amount of related substances (%)		Specific surface area (m^2/g)
		40°C / 75% RH	60°C	
Example 1-1	Mannit P	1.21	1.87	0.37
Example 1-2	Pearlitol 25C	1.51	2.91	0.59
Example 1-3	Pearlitol 50C	1.63	2.92	0.42
Example 1-4	Pearlitol 160C	1.38	2.22	0.28
Example 1-5	Nonpareil 108 (100)	1.57	2.88	0.61
Comparative Example 1-1	Pearlitol 100SD	2.29	3.19	1.56
Comparative Example 1-2	Parteck M200	3.06	5.01	3.32

[0038]

(Example 2) Stability when Blending D-mannitol and Another Diluent

(1) Preparation of Tablet

Predetermined amounts of Compound (I), D-mannitol (Mannit P, Mitsubishi Shoji Foodtech Co., Ltd.), cornstarch, and crystalline cellulose were placed in a fluidized bed granulation/drying machine (MP-01, Powrex Corporation), and a 10% aqueous hydroxypropyl cellulose solution was sprayed thereon while mixing, whereby granules were produced. In the obtained granules, predetermined amounts of low-substituted hydroxypropyl cellulose and magnesium stearate were mixed, and the resulting mixture was tableted at 1000 kg using a rotary

tableting machine (Correct, Kikusui Seisakusho, Ltd.), whereby a tablet (diameter: 8 mm, 190 mg/tablet) was prepared. The contents of the respective components are as shown in Table 4.

[0039]

[Table 4]

Component Name	Composition (mg/tablet)		
	Example 2-1	Example 2-2	Example 2-3
Compound (I)	0.2	0.2	0.2
D-mannitol (Mannit P)	173.4	138.72	138.72
Cornstarch	-	34.68	-
Crystalline cellulose	-	-	34.68
Hydroxypropyl cellulose	5	5	5
Low-substituted hydroxypropyl cellulose	9.5	9.5	9.5
Magnesium stearate	1.9	1.9	1.9
Total	190	190	190

[0040]

(2) Evaluation Method and Results

The tablet prepared in (1) was placed in a plastic bottle along with a desiccant (Dryern tablet PW 2010, Yamani Yakuhin Co., Ltd.) and airtightly sealed, and then, stored for 6 months under conditions of 40°C/75% RH (accelerated test). Further, the tablet was placed in a plastic bottle and stored for 1 month in an uncapped state under conditions of 40°C/75% RH or under conditions of 60°C. The content of Compound (I) in the tablet was measured before and after the storage using high-performance liquid chromatography, and the residual

ratio of Compound (I) relative to the amount at the start of the test was evaluated.

The results are shown in Table 5. Not only in a case where only D-mannitol was used as the diluent (Example 2-1), but also in a case where cornstarch (Example 2-2) or crystalline cellulose (Example 2-3) was blended along with D-mannitol, a high residual ratio was shown.

[0041]

[Table 5]

	Residual ratio of Compound (I) (%)		
	40°C / 75% RH, airtightly sealed 6 months	40°C / 75% RH, Open 1 month	60°C, Open 1 month
Example 2-1	97.8	97.4	97.5
Example 2-2	96.9	98.7	98.1
Example 2-3	97.0	98.1	97.0

[0042]

(Example 3) Stability of Granule

(1) Preparation of Granule

Example 3-1

Predetermined amounts of Compound (I), D-mannitol (Mannit P, Mitsubishi Shoji Foodtech Co., Ltd.), cornstarch, and sucrose (obtained by grinding using a sample mill (AP-S, Hosokawa Micron Corporation, screen diameter: 3 mm)) were placed in a fluidized bed granulation/drying machine (MP-01, Powrex Corporation), and a 10% aqueous hydroxypropyl cellulose solution was sprayed thereon while mixing, whereby a granule

was produced.

Example 3-2

Predetermined amounts of Compound (I), D-mannitol (Mannit P, Mitsubishi Shoji Foodtech Co., Ltd.), and cornstarch were placed in a fluidized bed granulation/drying machine (MP-01, Powrex Corporation), and a 10% aqueous hydroxypropyl cellulose solution in which a predetermined amount of yellow iron sesquioxide was dispersed was sprayed thereon while mixing, whereby a granule was produced.

The components of each granule and the contents thereof are as shown in Table 6.

[0043]

[Table 6]

Component Name	Composition (mg/tablet)	
	Example 3-1	Example 3-2
Compound (I)	0.1	0.1
Cornstarch	9.9	9.9
D-mannitol (Mannit P)	475	950
Sucrose	475	-
Hydroxypropyl cellulose	40	40
Yellow iron sesquioxide	-	1
Total	1000	1001

(2) Evaluation Method and Results

The obtained granule was placed in a plastic bottle along with a desiccant (Dryern tablet PW 2010, Yamani Yakuhin Co.,

Ltd.) and hermetically sealed, and then, stored for 2 months under conditions of 40°C/75% RH (acceleration test) or stored for 1 month in an open state. The content of Compound (I) in the granule was measured before and after the storage using high-performance liquid chromatography, and the residual ratio (%) of Compound (I) relative to the amount at the start of the test was evaluated. The results are shown in Table 7. As a result, it was found that high stability is ensured also in a case where it is formulated into a granule.

[0044]

[Table 7]

	Residual ratio of Compound (I) (%)	
	40°C 75% RH, airtightly sealed 2 months	40°C 75% RH, Open 1 month
Example 3-1	100.7	99.1
Example 3-2	(not measured)	98.2

Industrial Applicability

[0045]

According to the present invention, a solid preparation containing stabilized Compound (I), that is, a solid preparation in which the storage stability as a preparation is improved, and the decrease in the content of the active ingredient due to decomposition of the active ingredient and the production and increase of the decomposed products (related substances) of the active ingredient are suppressed can be

provided.

CLAIMS

1. A solid preparation comprising:

2-{4-[N-(5,6-diphenylpyrazin-2-yl)-N-isopropylamino]butyloxy}-N-(methylsulfonyl)acetamide; and

D-mannitol having a specific surface area of larger than 0.2 m^2/g, and 1.0 m^2/g or less;

wherein the content of D-mannitol is:

(a) such that the weight of D-mannitol is from 5 to 10000 parts by weight with respect to 1 part by weight of 2-{4-[N-(5,6-diphenylpyrazin-2-yl)-N-isopropylamino]butyloxy}-N-(methylsulfonyl)acetamide,

(b) from 10 to 99 wt% of the total weight of the solid preparation, and

(c) 20 wt% or more of the total weight of diluents contained in the solid preparation.

2. The solid preparation according to claim 1, further comprising a diluent other than D-mannitol and a binder.

3. The solid preparation according to claim 2, wherein the diluent other than D-mannitol is one type or two types selected from the group consisting of cornstarch, sucrose, and crystalline cellulose.

4. The solid preparation according to claim 2, wherein the binder is hydroxypropyl cellulose.

5. The solid preparation according to claim 1, further comprising:

(d) one type or two types selected from the group consisting of cornstarch, sucrose, and crystalline cellulose; and

(e) hydroxypropyl cellulose.

6. The solid preparation according to claim 5, wherein

(f) the content of 2-{4-[N-(5,6-diphenylpyrazin-2-yl)-N-isopropylamino]butyloxy}-N-(methylsulfonyl)acetamide is from 0.1 to 2 wt% of the total weight of the solid preparation,

(b) the content of D-mannitol is from 20 to 80 wt% of the total weight of the solid preparation,

(g) the content of cornstarch is from 15 to 40 wt% of the total weight of the solid preparation, and

(h) the content of hydroxypropyl cellulose is from 1 to 5 wt% of the total weight of the solid preparation.

7. The solid preparation according to claim 1, wherein 2-{4-[N-(5,6-diphenylpyrazin-2-yl)-N-isopropylamino]butyloxy}-N-(methylsulfonyl)acetamide is a Form-I crystal, which shows diffraction peaks at the following diffraction angles (2θ): 9.4°, 9.8°, 17.2°, and 19.4° in a powder X-ray diffraction spectrum obtained using a Cu-Kα radiation (λ=1.54 Å).

8. The solid preparation according to claim 1, wherein the solid preparation is a tablet or a granule.

9. Use of the solid preparation according to claim 1 in the manufacture of a medicament for treating diabetic neuropathy, diabetic gangrene, a peripheral circulatory disturbance, chronic arterial occlusion, intermittent claudication, scleroderma, thrombosis, pulmonary hypertension, myocardial infarction, angina pectoris, glomerulonephritis, diabetic nephropathy, chronic renal failure, bronchial asthma, interstitial pneumonia, a chronic obstructive pulmonary disease, tubulointerstitial nephritis, an inflammatory bowel disease, or a symptom associated with spinal canal stenosis.

10. The use according to claim 9, wherein the medicament is for treating pulmonary hypertension.

11. The use according to claim 9, wherein the medicament is for treating a peripheral circulatory disturbance.

12. The use according to claim 9, wherein the medicament is for treating chronic arterial occlusion.

13. The use according to claim 9, wherein the medicament is for treating intermittent claudication.

14. The use according to claim 9, wherein the medicament is for treating a symptom associated with spinal canal stenosis.

15. The use according to claim 9, wherein the medicament is for treating interstitial pneumonia and the interstitial pneumonia is pulmonary fibrosis.

16. The use according to claim 9, wherein the medicament is for treating scleroderma.

17. The use according to claim 9, wherein the medicament is for treating chronic renal failure.

18. The use according to claim 9, wherein the medicament is for treating tubulointerstitial nephritis.

19. The use according to claim 10, wherein the pulmonary hypertension to be treated is pulmonary arterial hypertension.

20. The use according to claim 19, wherein the solid preparation further comprises a diluent other than D-mannitol and a binder.

21. The use according to claim 19, wherein the solid preparation further comprises:

(d) one type or two types selected from the group consisting of cornstarch, sucrose, and crystalline cellulose; and

(e) hydroxypropyl cellulose.

22. The use according to claim 21, wherein the solid preparation comprises cornstarch, and

(f) the content of 2-{4-[N-(5,6-diphenylpyrazin-2-yl)-N-isopropylamino]butyloxy}-N-(methylsulfonyl)acetamide is from 0.1 to 2 wt% of the total weight of the solid preparation,

(b) the content of D-mannitol is from 20 to 80 wt% of the total weight of the solid preparation,

(g) the content of cornstarch is from 15 to 40 wt% of the total weight of the solid preparation, and

(h) the content of hydroxypropyl cellulose is from 1 to 5 wt% of the total weight of the solid preparation.

23. The use according to claim 19, wherein the medicament is a tablet.

24. The use according to claim 23, wherein D-mannitol has a specific surface area of larger than 0.2 m^2/g and smaller than 0.7 m^2/g, and the content of D-mannitol is:

(a) such that the weight of D-mannitol is from 10 to 9500 parts by weight with respect to 1 part by weight of 2-{4-[N-(5,6-diphenylpyrazin-2-yl)-N-isopropylamino]butyloxy}-N-(methylsulfonyl)acetamide,

(b) from 20 to 80 wt% of the total weight of the solid preparation, and

(c) 50 wt% or more of the total weight of diluents contained in the solid preparation.

25. The use according to claim 24, wherein the solid preparation further comprises:

(d) one type or two types selected from the group consisting of cornstarch, sucrose, and crystalline cellulose; and

(e) hydroxypropyl cellulose.

26. The use according to claim 25, wherein the solid preparation comprises cornstarch, and

(f) the content of 2-{4-[N-(5,6-diphenylpyrazin-2-yl)-N-isopropylamino]butyloxy}-N-(methylsulfonyl)acetamide is from 0.1 to 2 wt% of the total weight of the solid preparation,

(g) the content of cornstarch is from 15 to 40 wt% of the total weight of the solid preparation, and

(h) the content of hydroxypropyl cellulose is from 1 to 5 wt% of the total weight of the solid preparation.

27. The solid preparation according to claim 1 for use in treating diabetic neuropathy, diabetic gangrene, a peripheral circulatory disturbance, chronic arterial occlusion, intermittent claudication, scleroderma, thrombosis, pulmonary hypertension, myocardial infarction, angina pectoris, glomerulonephritis, diabetic nephropathy, chronic renal failure, bronchial asthma, interstitial pneumonia, a chronic obstructive pulmonary disease, tubulointerstitial nephritis, an inflammatory bowel disease, or a symptom associated with spinal canal stenosis.

28. The solid preparation for use according to claim 27, wherein the solid preparation is for use in treating pulmonary hypertension.

29. The solid preparation for use according to claim 27, wherein the solid preparation is for use in treating a peripheral circulatory disturbance.

30. The solid preparation for use according to claim 27, wherein the solid preparation is for use in treating chronic arterial occlusion.

31. The solid preparation for use according to claim 27, wherein the solid preparation is for use in treating intermittent claudication.

32. The solid preparation for use according to claim 27, wherein the solid preparation is for use in treating a symptom associated with spinal canal stenosis.

33. The solid preparation for use according to claim 27, wherein the solid preparation is for use in treating interstitial pneumonia and the interstitial pneumonia is pulmonary fibrosis.

34. The solid preparation for use according to claim 27, wherein the solid preparation is for use in treating scleroderma.

35. The solid preparation for use according to claim 27, wherein the solid preparation is for use in treating chronic renal failure.

36. The solid preparation for use according to claim 27, wherein the solid preparation is for use in treating tubulointerstitial nephritis.

37. The solid preparation for use according to claim 28, wherein the pulmonary hypertension to be treated is pulmonary arterial hypertension.

38. The solid preparation for use according to claim 37, wherein the solid preparation further comprises a diluent other than D-mannitol and a binder.

39. The solid preparation for use according to claim 37, wherein the solid preparation further comprises:

(d) one type or two types selected from the group consisting of cornstarch, sucrose, and crystalline cellulose; and

(e) hydroxypropyl cellulose.

40. The solid preparation for use according to claim 39, wherein the solid preparation comprises cornstarch, and

(f) the content of 2-{4-[N-(5,6-diphenylpyrazin-2-yl)-N-isopropylamino]butyloxy}-N-(methylsulfonyl)acetamide is from 0.1 to 2 wt% of the total weight of the solid preparation,

(b) the content of D-mannitol is from 20 to 80 wt% of the total weight of the solid preparation,

(g) the content of cornstarch is from 15 to 40 wt% of the total weight of the solid preparation, and

(h) the content of hydroxypropyl cellulose is from 1 to 5 wt% of the total weight of the solid preparation.

41. The solid preparation for use according to claim 37, wherein the solid preparation is a tablet.

42. The solid preparation for use according to claim 41, wherein D-mannitol has a specific surface area of larger than 0.2 m^2/g and smaller than 0.7 m^2/g, and the content of D-mannitol is:

(a) such that the weight of D-mannitol is from 10 to 9500 parts by weight with respect to 1 part by weight of 2-{4-[N-(5,6-diphenylpyrazin-2-yl)-N-isopropylamino]butyloxy}-N-(methylsulfonyl)acetamide,

(b) from 20 to 80 wt% of the total weight of the solid preparation, and

(c) 50 wt% or more of the total weight of diluents contained in the solid preparation.

43. The solid preparation for use according to claim 42, wherein the solid preparation further comprises:

(d) one type or two types selected from the group consisting of cornstarch, sucrose, and crystalline cellulose; and

(e) hydroxypropyl cellulose.

44. The solid preparation for use according to claim 43, wherein the solid preparation comprises cornstarch, and

(f) the content of 2-{4-[N-(5,6-diphenylpyrazin-2-yl)-N-isopropylamino]butyloxy}-N-(methylsulfonyl)acetamide

is from 0.1 to 2 wt% of the total weight of the solid preparation,

(g) the content of cornstarch is from 15 to 40 wt% of the total weight of the solid preparation, and

(h) the content of hydroxypropyl cellulose is from 1 to 5 wt% of the total weight of the solid preparation.