

[Name of Document] Description

[Title of Invention] METHOD OF STABILIZING PROTEIN
CONTAINED IN SPECIMEN AND SOLUTION FOR STABILIZING PROTEIN
5 CONTAINED IN SPECIMEN

[Technical Field]

[0001]

10 The present invention relates to a method for
stabilizing a protein contained in a specimen derived from
a living body, a solution for stabilizing a protein contained
in a specimen derived from a living body, and a method and
a kit for detecting a protein contained in a specimen derived
from a living body.

15

[Background Art]

[0002]

20 Detection of proteins contained in specimens such as
feces, urine, and saliva is useful for diagnosis of many
diseases. For example, a fecal occult blood test of
detecting blood in a fecal specimen enables acquisition of
important information in the diagnosis of gastrointestinal
diseases such as colon cancer. Known methods of detecting
blood proteins or the like such as hemoglobin, haptoglobin,
25 and a hemoglobin-haptoglobin complex contained in a specimen
such as feces include an immunological measurement method
for detection using an antibody which reacts with these
proteins.

[0003]

30 A specimen to be subjected for an occult blood test is
usually collected by a subject in a container containing a
preservation solution, and is sent to an inspection
institution such as a hospital. In many cases, the

preservation solution (sample) containing a specimen (the preservation solution containing a specimen will be referred to as a sample herein) is often exposed to unfavorable temperature conditions for preservation because its transportation requires several days and temperature management during the transportation is generally difficult. If proteins such as blood proteins contained in a specimen are denatured due to temperature conditions during the transportation and the like or decomposed or modified by bacteria or enzymes contained in the specimen to change the structure of the epitope or its vicinity, then the antibody cannot recognize the proteins contained in the feces, and accurate measurement by the immunological measurement method will be difficult. In particular, hemoglobin is unstable in the solution and liable to be denatured or decomposed under high temperature conditions.

[0004]

As a technique for stabilizing hemoglobin in the preservation solution, for example, various methods have been proposed, including a method of adding an antibacterial agent such as thimerosal or chlorhexidine (e.g., Patent Document 1), a method of adding a protease inhibitor (e.g., Patent Document 2), a method of adding a glycosidase-type lytic enzyme (e.g., Patent Document 3), a method of adding an enzymatic decomposition product of hemoglobin (e.g., Patent Document 4), a method of adding an organic acid such as malic acid (e.g., Patent Document 5), a method of adding iminocarboxylic acid (e.g., Patent Document 6), and a method of adding haloalkanesulfonic acid (e.g., Patent Document 7).

[0005]

Furthermore, there has been known a method of adding haptoglobin to stabilize hemoglobin (e.g., Patent Document 8). It is known that haptoglobin exists in blood of a wide

variety of animals, rapidly binds to hemoglobin, and forms a stable hemoglobin-haptoglobin complex (Hb-Hp complex). By preliminarily adding haptoglobin to the preservation solution or the like which preserves a specimen such as feces, 5 when the specimen such as feces is added to the preservation solution, the hemoglobin contained in the specimen derived from a living body can be made to a stable hemoglobin-haptoglobin complex.

[0006]

10 However, because hemoglobin is extremely unstable, even such methods of stabilizing hemoglobin have not yet sufficiently prevented the denaturation or decomposition. In this context, a method of measuring transferrin which is more excellent in the stability than hemoglobin is also known 15 as a method of detecting the fecal occult blood (e.g., Patent Document 9), but the transferrin exists in blood only at about 1/60 as compared with hemoglobin, and the problem is therefore that the sensitivity is low.

[Prior Art Documents]

20 [Patent Documents]

[0007]

[Patent Document 1] JP63-271160A

[Patent Document 2] JP3-279859A

[Patent Document 3] JP63-246667A

25 [Patent Document 4] JP11-218533A

[Patent Document 5] JP2003-14768A

[Patent Document 6] JP2009-097956A

[Patent Document 7] JP2016-191580A

[Patent Document 8] JP10-132824A

30 [Patent Document 9] JP63-246668A

[Summary of the Invention]

[Problems to be solved by the Invention]

[0008]

A considerable number of bacteria and enzymes that cause decomposition and modification of proteins such as hemoglobin exist in a specimen derived from a living body,
5 such as feces, urine, or saliva, and particularly in feces; therefore, even proteins having relatively high stability, such as a hemoglobin-haptoglobin complex, may be decomposed or modified.

An object of the present invention is therefore to
10 provide a method of enhancing the stability of a protein contained in a specimen derived from a living body even under unfavorable temperature conditions in which decomposition, denaturation, and the like are likely to occur.

[Means for solving the Problems]

15 [0009]

(1) A method of stabilizing a protein contained in a specimen derived from a living body, the method including a step of causing the protein contained in the specimen derived from the living body to coexist with an arylboronic acid,
20 wherein

the protein contained in the specimen derived from the living body is at least one type selected from the group consisting of hemoglobin, haptoglobin, and a hemoglobin-haptoglobin complex.

25 (2) The method according to (1), wherein the arylboronic acid is at least one type selected from the group consisting of phenylboronic acid and derivatives thereof.

(3) The method according to (1)(2), wherein the arylboronic acid is at least one type selected from the group consisting
30 of phenylboronic acid, hydroxyphenylboronic acid, carboxyphenylboronic acid, aminophenylboronic acid, and salts thereof.

(4) The method according to (1) to (3), wherein

the step is a step of dispersing the protein contained in the specimen derived from the living body in a solution containing the arylboronic acid, and

the concentration of the arylboronic acid in the
5 solution is 0.1 mmol/L or more.

(5) The method according to (1) to (4), wherein the step is a step of causing the protein contained in the specimen derived from the living body to coexist with the arylboronic acid and a sugar.

10 (6) The method according to (5), wherein the sugar is at least one type selected from the group consisting of sugar alcohol, monosaccharide, and disaccharide.

(7) The method according to (5) (6), wherein the sugar is at least one type selected from the group consisting of sorbitol,
15 glucose, mannitol, fructose, xylitol, erythritol, sucrose, trehalose, lactose, and maltose.

(8) The method according to (5) to (7), wherein
the step is a step of dispersing the protein contained in the specimen derived from the living body in a solution
20 containing the arylboronic acid and the sugar, and

the concentration of the sugar in the solution is 5 mmol/L or more.

(9) The method according to (1) to (8), wherein
the specimen derived from the living body contains at
25 least hemoglobin, and

the method includes a step of bringing the hemoglobin and haptoglobin into contact with each other to form a complex of hemoglobin and haptoglobin.

(10) The method according to (1) to (9), wherein the specimen
30 derived from the living body is feces, saliva, or urine.

[0010]

(11) A stabilizing solution for stabilizing a protein contained in a specimen derived from a living body, wherein

the stabilizing solution contains an arylboronic acid,
and

the protein contained in the specimen derived from the
living body is at least one type selected from the group
5 consisting of hemoglobin, haptoglobin, and a hemoglobin-
haptoglobin complex.

(12) The stabilizing solution according to (11), wherein the
arylboronic acid is at least one type selected from the group
consisting of phenylboronic acid and derivatives thereof.

10 (13) The stabilizing solution according to (11) (12), wherein
the arylboronic acid is at least one type selected from the
group consisting of phenylboronic acid, hydroxyphenylboronic
acid, carboxyphenylboronic acid, aminophenylboronic acid,
and salts thereof.

15 (14) The stabilizing solution according to (11) to (13),
containing a sugar.

(15) The stabilizing solution according to (14), wherein the
sugar is at least one type selected from the group consisting
of sorbitol, glucose, mannitol, fructose, xylitol,
20 erythritol, sucrose, trehalose, lactose, and maltose.

(16) The stabilizing solution according to (11) to (15),
containing haptoglobin.

(17) The stabilizing solution according to (11) to (16),
wherein the specimen is feces, saliva, or urine.

25 (18) The stabilizing solution according to (11) to (17),
wherein the stabilizing solution is a solution for preserving
the specimen derived from the living body.

[0011]

(19) A method of detecting a protein in a specimen derived
30 from a living body, the method comprising:

a step of adding the specimen derived from the living
body to the stabilizing solution according to (11) to (18)
to obtain a sample containing the specimen; and

a step of detecting the protein in the sample by an immunological measurement method, wherein

the protein in the specimen derived from the living body is at least one type selected from the group consisting
5 of hemoglobin, haptoglobin, and a hemoglobin-haptoglobin complex.

(20) The method according to (19), wherein

the specimen derived from the living body contains at least hemoglobin, and

10 the hemoglobin in the sample forms a complex together with haptoglobin.

(21) The method according to (20), wherein the stabilizing solution is the stabilizing solution according to (16).

[0012]

15 (22) A kit for detecting a protein contained in a specimen derived from a living body, the kit including:

the stabilizing solution according to (11) to (18); and

a reagent containing an antibody that recognizes the protein, wherein

20 the protein is at least one type selected from the group consisting of hemoglobin, haptoglobin, and a hemoglobin-haptoglobin complex.

[Advantageous Effect of the Invention]

[0013]

25 According to the present invention, the protein such as blood protein contained in the specimen derived from a living body can be stabilized. In other words, according to the present invention, it is possible to prevent denaturation, decomposition, or modification of the protein such as blood
30 protein contained in the specimen derived from a living body. According to the present invention, therefore, it is possible to accurately measure the protein contained in the specimen derived from a living body by an immunological measurement

method.

[Embodiments for Carrying out the Invention]

[0014]

5 Hereinafter, one or more preferred embodiments of the present invention will be described.

[0015]

(Method of stabilizing protein contained in specimen derived from living body and stabilizing solution for protein)

10 The method of stabilizing a protein contained in a specimen derived from a living body according to an embodiment of the present invention includes a step of causing a protein contained in the specimen derived from a living body to coexist with an arylboronic acid. In the
15 present embodiment, the protein contained in the specimen derived from a living body may be at least one type selected from the group consisting of hemoglobin, haptoglobin, and a hemoglobin-haptoglobin complex.

[0016]

20 By causing the protein contained in the specimen derived from a living body to coexist with an arylboronic acid, the stability of the protein contained in the specimen derived from the living body can be enhanced. The protein-containing specimen derived from a living body may be feces, saliva, or
25 urine and may be feces.

[0017]

The method of causing the protein contained in the specimen derived from a living body to coexist with an arylboronic acid is not particularly limited, but examples
30 of the method include a method of dispersing the protein contained in the specimen derived from a living body in a solution containing an arylboronic acid. Here, "dispersion" includes dissolution and suspension.

Examples of the solution containing an arylboronic acid include a preservation solution for preserving the specimen derived from a living body, a diluent solution for further diluting a sample in which the specimen is dispersed in a preservation solution, and a reaction solution in a kit or the like for detecting a protein in the specimen. In particular, the preservation solution for a specimen can be preferably used because it can significantly improve the stability of a protein contained in the specimen derived from a living body according to the present embodiment.

[0018]

The arylboronic acid can be appropriately selected from known ones. The arylboronic acid may be at least one type selected from the group consisting of phenylboronic acid and derivatives thereof, may be at least one type selected from the group consisting of phenylboronic acid, hydroxyphenylboronic acid, carboxyphenylboronic acid, aminophenylboronic acid, and salts thereof, may be at least one type selected from the group consisting of phenylboronic acid, 3-hydroxyphenylboronic acid, 2-carboxyphenylboronic acid, 3-carboxyphenylboronic acid, 4-carboxyphenylboronic acid, 3-aminophenylboronic acid, and salts thereof, and may particularly be at least one type selected from the group consisting of phenylboronic acid, 3-hydroxyphenylboronic acid, 3-carboxyphenylboronic acid, 3-aminophenylboronic acid, and salts thereof.

[0019]

The lower limit of the concentration of the arylboronic acid in the above solution may be preferably 0.1 mmol/L or more, 0.2 mmol/L or more, or 0.5 mmol/L or more. When the concentration of the arylboronic acid is the above lower limit or more, the effect of stabilizing the protein contained in the specimen derived from a living body is more

excellent.

From another aspect, the upper limit of the concentration of the arylboronic acid in the above solution may be preferably 100 mmol/L or less, 50 mmol/L or less, or
5 30 mmol/L or less. If the concentration of the arylboronic acid is unduly high, the apparent recovery ratio may decrease when the protein contained in the specimen derived from a living body is measured by an immunological measurement method. This appears because the stabilizing effect of the
10 protein contained in the specimen derived from the living body does not decrease, but the high concentration of arylboronic acid adversely effects the immunological measurement. Fortunately, however, when the concentration of the arylboronic acid is the above upper limit or less,
15 the adverse effects on the immunological measurement method are suppressed, and more accurate measurement can be performed.

It is to be noted, however, that even when the solution contains a high concentration of arylboronic acid, if it
20 coexists with a high concentration of sugar, which will be described later, the arylboronic acid and the sugar form a complex thereby to suppress the adverse effects on the immunological measurement method due to the high concentration of arylboronic acid. Thus, provided that the
25 arylboronic acid coexists with a high concentration of sugar, even when the concentration of the arylboronic acid is about 50 mmol/L or further about 100 mmol/L, accurate measurement by the immunological measurement method is ensured.

[0020]

30 In a more specific aspect of the present embodiment, the arylboronic acid can be contained in a solution (stabilizing solution) for stabilizing the protein contained in the specimen derived from a living body. For example,

when the stabilizing solution does not contain haptoglobin, which will be described later, the lower limit of the concentration of the arylboronic acid in the stabilizing solution can be 0.1 mmol/L or more, 0.2 mmol/L or more, or
5 0.5 mmol/L or more. From another aspect, the upper limit of the concentration of the arylboronic acid in the stabilizing solution can be 20 mmol/L or less, 10 mmol/L or less, or 5 mmol/L or less.

[0021]

10 The above step can be a step of causing the protein contained in the specimen derived from a living body to coexist with a sugar together with the above arylboronic acid. By coexisting with a sugar in addition to the arylboronic acid, the stability of the protein contained in
15 the specimen derived from a living body can be further enhanced. Examples of the method of causing the protein contained in the specimen derived from a living body to coexist with a sugar include a method of causing the sugar to be further contained in a solution that contains the above
20 arylboronic acid.

[0022]

The sugar can be appropriately selected from known ones, and examples of the sugar include sugar alcohols such as sorbitol, mannitol, xylitol, and erythritol; monosaccharides
25 such as glucose, fructose, mannose, and galactose; disaccharides such as sucrose, trehalose, lactose, and maltose; and oligosaccharide.

The sugar may be at least one type selected from the group consisting of sugar alcohols, monosaccharides, and
30 disaccharides, may be at least one type selected from the group consisting of sorbitol, glucose, mannitol, fructose, xylitol, erythritol, sucrose, trehalose, lactose, and maltose, and may be at least one type selected from the group

consisting of sorbitol, mannitol, fructose, and sucrose.

[0023]

However, sugars (reducing sugars) such as glucose and fructose that form aldehyde groups or ketone groups in a solution react with proteins contained in the specimen derived from a living body or with albumins or the like added to the solution as stabilizers for these proteins (Maillard reaction) to modify the proteins and generate a brown substance (melanoidin) and, therefore, a sugar that does not react with proteins may be preferred. If the epitope or its vicinity of a protein contained in the specimen derived from a living body is modified by a reducing sugar to change the structure, some antibodies cannot recognize such proteins contained in the specimen derived from a living body, so that accurate measurement by an immunological measurement method may not be possible. In a more specific aspect of the present embodiment, therefore, it is more preferred to use a non-reducing sugar that does not react with proteins. The non-reducing sugar may be at least one type selected from the group consisting of sorbitol, mannitol, xylitol, erythritol, trehalose, sucrose, and lactose, and may be at least one type selected from the group consisting of sorbitol, mannitol, and sucrose.

[0024]

The lower limit of the sugar concentration may be preferably 5 mmol/L or more, 10 mmol/L or more, or 25 mmol/L or more. When the sugar concentration is the above lower limit or more, the sugar acts synergistically with an arylboronic acid, and the effect of stabilizing the protein contained in the specimen derived from a living body is further excellent.

The upper limit of the sugar concentration may be 1000 mmol/L or less, 500 mmol/L or less, or 100 mmol/L or less

for sugar alcohols and monosaccharides, and may be 500 mmol/L or less, 250 mmol/L or less, or 100 mmol/L or less for disaccharides. When the sugar concentration is the above upper limit or less, the viscosity of the stabilizing solution is not unduly high, so the measurement may be performed without any problem.

[0025]

It suffices that the stabilizing solution for preserving the protein contained in the specimen derived from a living body is a buffer solution that can keep the pH at 5 to 10 or preferably 6 to 8, and the stabilizing solution may be a buffer solution that contains a Good buffer such as 2-morpholinoethanesulfonic acid (MES), hydroxyethylpiperazine-2-ethanesulfonic acid (HEPES), or piperazine-bis(2-ethanesulfonic acid) (PIPES), and may be a phosphate buffer solution, a tris buffer solution, or a glycine buffer solution.

[0026]

The stabilizing solution may further contain additives such as an antibacterial agent, a pH adjuster, a salt for adjusting the ionic strength, a surfactant, an agglutination promoter, and a known stabilizing agent used when preserving proteins. Examples of the antibacterial agent include sodium azide, an antibiotic, and a lytic enzyme. Examples of the additives include known substances that are known to have a protein stabilizing action, such as histidine, lysine, and other amino acids, albumin, a protease inhibitor, and ethylenediaminetetraacetic acid (EDTA) and other chelating agents.

[0027]

According to the above-described stabilizing method or stabilizing solution, the stability of the protein contained in the specimen derived from a living body can be enhanced

by the action of the arylboronic acid or the synergistic action of the arylboronic acid and the sugar. In other words, according to the above-described stabilizing method or stabilizing solution, it is possible to prevent denaturation, decomposition, or modification of the protein contained in the specimen derived from a living body and maintain the structure of the epitope and its surrounding region of the protein contained in the specimen derived from the living body. Thus, when detecting the protein contained in the specimen derived from a living body by an immunological measurement method, improvement in the detection accuracy can be expected.

[0028]

A more specific aspect of the present embodiment may include a step of bringing the specimen derived from a living body containing at least hemoglobin into contact with haptoglobin thereby to form a hemoglobin-haptoglobin complex. In this case, the specimen derived from a living body containing hemoglobin may be feces, saliva, or urine and may be feces. The method of the present embodiment is distinctly useful because feces contain a particularly considerable number of bacteria and enzymes that cause decomposition and modification of hemoglobin.

[0029]

The specimen derived from a living body containing hemoglobin may be brought into contact with the haptoglobin in any manner, but it may be preferred to add the specimen derived from a living body containing hemoglobin to the previously described preservation solution containing haptoglobin. Hemoglobin contained in the specimen derived from a living body rapidly reacts with the haptoglobin in the preservation solution to form a hemoglobin-haptoglobin complex. Then, the preservation solution to which the

specimen derived from a living body is added may be preserved without any treatment, and the hemoglobin-haptoglobin complex can thereby be stably preserved. In the formation of a complex of hemoglobin and haptoglobin, the hemoglobin
5 dissociates from a tetramer ($\alpha_2\beta_2$) having two α chains and two β chains associated with each other into two dimers ($\alpha\beta$), but this phenomenon does not represent the "decomposition" or "denaturation" in the present specification.

[0030]

10 The stabilizing solution for stabilizing the protein contained in the specimen derived from a living body containing hemoglobin according to the present embodiment may preferably be a solution obtained by further adding haptoglobin to the above-described stabilizing solution
15 which contains an arylboronic acid or contains an arylboronic acid and a sugar. The concentration of haptoglobin in the stabilizing solution depends on the amount of the specimen derived from a living body, but may be, for example, 0.05 units/L to 50 units/L, 0.1 units/L to 10 units/L, or 0.2
20 units/L to 2 units/L. Here, one unit represents the amount of haptoglobin that binds to 1 mg of hemoglobin. The haptoglobin concentration in the above range is a concentration sufficient to convert all hemoglobin in the specimen derived from a living body into a hemoglobin-
25 haptoglobin complex.

[0031]

Here, when the stabilizing solution contains haptoglobin, which will be described later, the lower limit of the concentration of the above arylboronic acid in the
30 stabilizing solution can be 0.1 mmol/L or more, 0.2 mmol/L or more, 0.5 mmol/L or more, 1 mmol/L or more, or 5 mmol/L or more. When the concentration of the arylboronic acid is the above lower limit or more, the stabilizing effect of the

arylboronic acid on the hemoglobin contained in the specimen derived from a living body is more remarkable in corporation with the stabilizing effect of the haptoglobin.

From another aspect, the upper limit of the
5 concentration of the arylboronic acid in the stabilizing solution can be 100 mmol/L or less, 50 mmol/L or less, or 30 mmol/L or less. When the concentration of the arylboronic acid is the above upper limit or less, adverse effects on an immunological measurement method are suppressed, and more
10 accurate measurement is possible.

[0032]

According to the stabilizing method or stabilizing solution of the above-described aspect, the hemoglobin contained in the specimen derived from a living body can be
15 stably preserved in the form of a hemoglobin-haptoglobin complex. In other words, according to the above-described stabilizing method or stabilizing solution, it is possible to prevent denaturation, decomposition, or modification of the hemoglobin contained in the specimen derived from a
20 living body and maintain the structure of the epitope and its surrounding region of the hemoglobin. Thus, when measuring the hemoglobin contained in the specimen derived from a living body by an immunological measurement method, improvement in the detection accuracy can be expected.

25 [0033]

(Method of detecting protein contained in specimen derived from living body and detection kit)

The method of detecting a protein contained in the specimen derived from a living body, which is provided by an
30 embodiment of the present invention, includes a step of adding the specimen derived from the living body to the above-described stabilizing solution for stabilizing the protein to obtain a sample containing the specimen derived

from the living body and a step of detecting the protein in the sample by an immunological measurement method.

The kit for detecting a protein contained in the specimen derived from a living body, which is provided by
5 another embodiment of the present invention, includes the above-described stabilizing solution and a reagent containing an antibody that recognizes the protein contained in the specimen derived from the living body.

In the above detection method or detection kit, the
10 protein contained in the specimen derived from the living body may be at least one type selected from hemoglobin, haptoglobin, and a hemoglobin-haptoglobin complex.

[0034]

Examples of the stabilizing solution used in the present
15 embodiment include a preservation solution for preserving the specimen derived from a living body, a diluent solution for further diluting a sample in which the specimen is dispersed in a preservation solution, and a reaction solution in a kit or the like for detecting the protein in the specimen.
20 Examples of the reaction solution in a kit or the like include a solution containing an antibody in an immunological measurement method, which will be described later, and a solution for being mixed with a sample to adjust the measurement environment.

25 The immunological measurement method is a method utilizing an antibody which reacts with a protein contained in the specimen derived from a living body, and a known immunological measurement method can be used. The immunological measurement method may be, for example, an
30 immunoagglutination method such as a latex agglutination method or a gold colloid agglutination method, an immunochromatography method, or an ELISA method.

[0035]

The antibody reacting with the protein contained in the specimen derived from a living body may be, but is not limited to, a polyclonal antibody, a monoclonal antibody, or a fragment of an antibody reacting with the protein contained
5 in the specimen derived from a living body, which fragment is capable of recognizing the protein contained in the specimen derived from the living body.

It suffices that the antibody reacting with the protein contained in the specimen derived from a living body is an
10 antibody that recognizes the protein to be measured, and the antibody may be an anti-hemoglobin antibody, an anti-haptoglobin antibody, or an anti-hemoglobin-haptoglobin complex antibody. These antibodies can be made by commonly-used methods.

15 [0036]

As an example, detection of the protein contained in the specimen derived from a living body, such as detection of hemoglobin, can be performed as follows. First, the specimen is added to a container containing a preservation
20 solution to prepare a sample. The specimen may be preserved in the container for an arbitrary time, or the preservation solution containing the specimen may be filtered to prepare a sample. Then, the hemoglobin in the sample is detected by an immunological measurement method such as a latex
25 agglutination method. More specifically, a reagent containing latex particles having surfaces immobilizing an anti-hemoglobin antibody is added to the sample. Before adding the reagent containing the latex particles, the sample may be diluted with a diluent, or a reaction solution may be
30 added. In the present aspect, the above-described stabilizing solution containing an arylboronic acid may be any of a preservation solution, a diluent solution, and a reaction solution. It is particularly preferred that the

preservation solution be the above-described stabilizing solution. In this case, the diluent solution and/or reaction solution may or may not contain an arylboronic acid.

In the specimen derived from a living body, hemoglobin
5 may form a complex together with haptoglobin in the specimen or may exist as free hemoglobin. Thus, preferably, the anti-hemoglobin antibody used for the detection of hemoglobin is capable of recognizing the epitope of the free hemoglobin and the epitope of hemoglobin in the hemoglobin-haptoglobin
10 complex and does not cross-react with haptoglobin.

When hemoglobin exists in a sample, the anti-hemoglobin antibody recognizes the hemoglobin, and the latex particles immobilizing the antibody agglutinate. The change in turbidity due to agglutination is measured, and the
15 hemoglobin concentration in the sample may be obtained from the calibration curve created using a calibrator that contains hemoglobin of a known concentration. Additionally or alternatively, the concentration of hemoglobin in the sample can be obtained from the calibration curve created
20 based on the concentration of hemoglobin in the calibrator.

[0037]

When the above stabilizing solution contains haptoglobin, detection of hemoglobin can be performed, for example, as follows. First, the specimen is added to a
25 container containing a preservation solution to prepare a sample. The specimen may be preserved in the container for an arbitrary time, or the preservation solution containing the specimen may be filtered to prepare a sample. Then, the hemoglobin in the sample is detected by an immunological
30 measurement method such as a latex agglutination method. More specifically, a reagent containing latex particles having surfaces immobilizing an anti-hemoglobin antibody is added to the sample. Before adding the reagent containing

the latex particles, the sample may be diluted with a diluent, or a reaction solution may be added.

In the present aspect, the stabilizing solution containing an arylboronic acid and haptoglobin may be any of
5 a preservation solution, a diluent solution, and a reaction solution.

It is particularly preferred that the preservation solution be the stabilizing solution containing an arylboronic acid and haptoglobin. In this case, the diluent
10 solution and/or reaction solution may or may not contain haptoglobin and may or may not contain an arylboronic acid.

In the present aspect, when hemoglobin exists in the specimen, the hemoglobin reacts with haptoglobin contained in the stabilizing solution to form a hemoglobin-haptoglobin
15 complex. It is not necessary for all hemoglobin in the specimen to form a complex, and hemoglobin that does not form a complex together with haptoglobin may exist in the stabilizing solution (sample) containing the specimen (the preservation solution containing a specimen will be referred
20 to as a sample herein), but preferably, all hemoglobin in the specimen forms a complex together with haptoglobin.

Preferably, the anti-hemoglobin antibody is capable of recognizing the epitope of hemoglobin in the hemoglobin-haptoglobin complex and does not cross-react with
25 haptoglobin.

When hemoglobin exists in the sample, the anti-hemoglobin antibody recognizes the hemoglobin (including hemoglobin that forms a complex with haptoglobin), and the latex particles immobilizing the antibody agglutinate. The
30 change in turbidity due to agglutination is measured, and the hemoglobin concentration in the sample may be obtained from the calibration curve created using a calibrator that contains a hemoglobin-haptoglobin complex of a known

hemoglobin concentration. Additionally or alternatively, the concentration of the hemoglobin-haptoglobin complex in the sample can be obtained from the calibration curve created based on the concentration of the hemoglobin-haptoglobin
5 complex in the calibrator.

[0038]

It should be appreciated that the embodiments heretofore explained are described to facilitate understanding of the present invention and are not described
10 to limit the present invention. It is therefore intended that the elements disclosed in the above embodiments include all design changes and equivalents to fall within the technical scope of the present invention.

[Examples]

15 [0039]

Example 1

Preservation solutions were prepared with the addition of 40 mmol/L HEPES (pH 6.8), 0.1% BSA, 0.1% NaN₃, 1 unit/L haptoglobin, and 0 to 100 mmol/L phenylboronic acid. Samples
20 obtained by adding hemoglobin-added fecal specimens to the preservation solutions so that the fecal concentration would be 0.5% were preserved at 37°C for 0, 7, 14, and 21 days. The fecal specimens were added with hemoglobin having an amount such that the hemoglobin concentration in the samples
25 would be about 300 µg/L. Instead of the fecal specimens to which hemoglobin was added, samples containing no fecal specimens, in which hemoglobin was added to the preservation solutions so that the hemoglobin concentration in the samples would be 300 µg/L, were similarly preserved. The hemoglobin
30 (Hb) concentrations (µg/L) in the preserved samples were measured by the latex agglutination method.

[0040]

The concentrations of hemoglobin were measured using

"OC-Hemodia (registered trademark) Auto III 'EIKEN'"
(available from EIKEN CHEMICAL CO., LTD.) as a measurement
reagent and "OC-sensor DIANA" (available from EIKEN CHEMICAL
CO., LTD.) as a measurement device. The above measurement
5 reagent contains latex particles immobilizing an anti-human
hemoglobin rabbit polyclonal antibody.

[0041]

From the measured concentrations of hemoglobin, the
recovery ratios (%) were calculated with respect to the
10 hemoglobin concentrations immediately after the fecal
specimens were added to the preservation solutions (i.e.,
concentrations 0 days after the fecal specimens were added).
The results are listed in Table 1. As clearly understood
from Table 1, in any of samples of Feces 1, Feces 2, and
15 Feces 3, the recovery ratio of hemoglobin in the samples was
improved by adding phenylboronic acid at a concentration of
0.5 mmol/L or more. The recovery ratio of hemoglobin was
improved depending on the phenylboronic acid concentration
and reached the maximum at a phenylboronic acid concentration
20 of 15 mmol/L, and the apparent recovery ratio decreased with
the addition of 50 mmol/L or more. In the samples containing
no fecal specimens, the improvement of recovery ratio by
addition of phenylboronic acid was not observed. These
results indicate that the phenylboronic acid stabilizes the
25 hemoglobin in the samples containing feces. The hemoglobin
in the samples exists as a hemoglobin-haptoglobin complex
react to haptoglobin contained in the preservation solution;
therefore, the above results mean that the phenylboronic
acid stabilized the hemoglobin-haptoglobin complex.

30 [0042]

[Table 1]

	Phenylboronic acid (mmol/L)	Hb concentration ($\mu\text{g/L}$)				Recovery ratio with respect to Hb concentration after 0 days (%)			
		Number of days for preservation at 37°C				Number of days for preservation at 37°C			
		0 days	7 days	14 days	21 days	0 days	7 days	14 days	21 days
Feces 1	0	282	135	99	71	100	48	35	25
	0.5	279	181	147	129	100	65	53	46
	1	275	182	148	125	100	66	54	45
	2.5	289	207	175	152	100	72	61	53
	15	302	243	239	224	100	80	79	74
	50	290	230	204	185	100	79	70	64
	100	271	186	137	97	100	69	51	36
Feces 2	0	292	111	68	50	100	38	23	17
	0.5	271	147	113	91	100	54	42	34
	1	284	166	136	116	100	58	48	41
	2.5	288	195	159	139	100	68	55	48
	15	283	249	214	191	100	88	76	67
	50	269	214	174	149	100	80	65	55
	100	250	139	80	36	100	56	32	14
Feces 3	0	286	93	60	51	100	33	21	18
	0.5	283	133	104	93	100	47	37	33
	1	281	159	131	115	100	57	47	41
	2.5	290	189	160	145	100	65	55	50
	15	288	224	200	185	100	78	69	64
	50	274	204	176	158	100	74	64	58
	100	247	156	88	53	100	63	36	21
No feces	0	268	243	238	239	100	91	89	89
	0.5	257	248	243	246	100	96	95	96
	1	265	244	241	244	100	92	91	92
	2.5	272	249	244	258	100	92	90	95
	15	286	262	253	264	100	92	88	92
	50	260	242	228	235	100	93	88	90
	100	239	198	183	178	100	83	77	74

[0043]

Example 2

5 Preservation solutions were prepared by adding 2-carboxyphenylboronic acid (2-CPBA), 3-carboxyphenylboronic acid (3-CPBA), 4-carboxyphenylboronic acid (4-CPBA), 3-hydroxyphenylboronic acid (3-HPBA), and 3-aminophenylboronic acid (3-APBA) each at 15 mmol/L as substitute for the

10 phenylboronic acid in the preservation solutions of Example 1, and testing was conducted in the same manner as in Example 1. For comparative examples, preservation solutions to which no arylboronic acid was added were prepared, and testing was

15 conducted in the same manner. The results are listed in Table 2. As clearly understood from Table 2, also when other arylboronic acids were used, the recovery ratio of hemoglobin

in the sample was improved in any of fecal specimens of Feces 1, Feces 2, and Feces 3 as compared with the comparative examples in which no arylboronic acid was added.

[0044]

5 [Table 2]

	Arylboronic acid (15mmol/L)	Hb concentration ($\mu\text{g/L}$)			Recovery ratio with respect to Hb after 0 days (%)		
		Number of days for preservation at 37°C			Number of days for preservation at 37°C		
		0 days	7 days	14 days	0 days	7 days	14 days
Feces 1	No addition	315	154	119	100	49	38
	2C-PBA	315	196	150	100	62	48
	3C-PBA	309	249	239	100	81	77
	4C-PBA	312	252	234	100	81	75
	3H-PBA	327	269	268	100	82	82
	3A-PBA	339	275	260	100	81	77
Feces 2	No addition	313	108	78	100	34	25
	2C-PBA	311	157	103	100	50	33
	3C-PBA	309	264	240	100	85	78
	4C-PBA	315	239	227	100	76	72
	3H-PBA	326	277	264	100	85	81
	3A-PBA	330	287	261	100	87	79
Feces 3	No addition	304	90	63	100	30	21
	2C-PBA	300	124	76	100	41	25
	3C-PBA	300	213	200	100	71	67
	4C-PBA	300	219	194	100	73	65
	3H-PBA	313	213	206	100	68	66
	3A-PBA	324	227	209	100	70	64
No feces	No addition	295	276	267	100	94	91
	2C-PBA	292	272	264	100	93	90
	3C-PBA	293	281	276	100	96	94
	4C-PBA	279	275	271	100	98	97
	3H-PBA	303	294	296	100	97	98
	3A-PBA	278	275	272	100	99	98

[0045]

10 Example 3

The concentration of phenylboronic acid in the preservation solutions of Example 1 was fixed to 15 mmol/L, preservation solutions to which a sugar (sorbitol, sucrose, trehalose, glucose, fructose, or mannitol) was further added at 50 mmol/L or 100 mmol/L or preservation solutions to which no sugar was added were prepared, and testing was conducted

in the same manner as in Example 1. For comparative examples, preservation solutions to which the phenylboronic acid and sugar were not added were prepared, and testing was conducted in the same manner. The results are listed in Table 3. As
5 clearly understood from Table 3, when sorbitol, mannitol, sucrose, or fructose was further added to the phenylboronic acid, the recovery ratio of hemoglobin in the sample was further improved in any of fecal specimens of Feces 1, Feces 2, and Feces 3 and remarkably improved particularly with any
10 of sorbitol and mannitol. With trehalose or glucose, however, fecal specimens (Feces 3) in which the recovery ratios were not improved were also recognized. These results indicate that the stability of hemoglobin in the samples containing feces can be further improved by adding a sugar to the
15 phenylboronic acid, but the effects differ depending on the type of a sugar added. Among sorbitol, sucrose, trehalose, glucose, fructose, and mannitol, the sorbitol and mannitol had remarkable effects, and in particular, the sorbitol exhibited no decrease in the recovery ratios in the fecal
20 specimens (Feces 1).

[0046]

[Table 3]

	Phenylboronic acid (mmol/L)	Sugar (mmol/L)	Hb concentration ($\mu\text{g/L}$)				Recovery ratio with respect to Hb concentration after 0 days (%)			
			Number of days for preservation at 37°C				Number of days for preservation at 37°C			
			0 days	7 days	14 days	21 days	0 days	7 days	14 days	21 days
Feces 1	No addition	No addition	282	135	99	71	100	48	35	25
	15	No addition	302	243	239	224	100	80	79	74
		Sorbitol 50	291	300	300	296	100	103	103	102
		100	287	292	294	290	100	102	102	101
		Sucrose 50	291	281	274	268	100	97	94	92
		100	288	272	270	258	100	95	94	90
		Trehalose 50	299	261	247	241	100	87	83	81
		100	291	249	238	230	100	86	82	79
		Glucose 50	283	255	242	239	100	90	86	84
		100	291	251	236	230	100	86	81	79
		Fructose 50	297	294	285	280	100	99	96	94
		100	287	276	247	228	100	96	86	79
		Mannitol 50	288	278	270	—	100	96	94	—
		100	281	279	276	—	100	99	98	—
Feces 2	No addition	No addition	292	111	68	50	100	38	23	17
	15	No addition	283	249	214	191	100	88	76	67
		Sorbitol 50	281	280	252	222	100	100	90	79
		100	274	276	246	219	100	101	90	80
		Sucrose 50	273	266	232	212	100	97	85	78
		100	267	257	236	219	100	96	88	82
		Trehalose 50	284	257	223	201	100	90	79	71
		100	269	251	227	206	100	93	84	77
		Glucose 50	275	260	230	205	100	95	84	75
		100	281	246	223	203	100	88	79	72
		Fructose 50	270	275	243	222	100	102	90	82
		100	280	264	235	212	100	94	84	76
		Mannitol 50	296	291	280	—	100	98	95	—
		100	290	290	286	—	100	100	99	—
Feces 3	No addition	No addition	286	93	60	51	100	33	21	18
	15	No addition	288	224	200	185	100	78	69	64
		Sorbitol 50	283	250	235	223	100	88	83	79
		100	278	244	226	219	100	88	81	79
		Sucrose 50	286	234	209	195	100	82	73	68
		100	272	230	201	187	100	85	74	69
		Trehalose 50	282	221	197	178	100	78	70	63
		100	281	213	192	179	100	76	68	64
		Glucose 50	285	217	196	184	100	76	69	65
		100	276	210	188	174	100	76	68	63
		Fructose 50	272	238	218	203	100	88	80	75
		100	276	244	222	204	100	88	80	74
		Mannitol 50	293	247	238	—	100	84	81	—
		100	288	243	240	—	100	85	84	—
No feces	No addition	No addition	268	243	238	239	100	91	89	89
	15	No addition	286	262	253	264	100	92	88	92
		Sorbitol 50	281	261	251	265	100	93	89	94
		100	276	252	244	255	100	91	88	92
		Sucrose 50	271	253	246	257	100	93	91	95
		100	287	247	241	260	100	93	90	97
		Trehalose 50	288	253	255	257	100	94	95	96
		100	289	248	251	251	100	92	93	93
		Glucose 50	282	254	263	260	100	90	93	92
		100	266	251	253	257	100	94	95	97
		Fructose 50	286	255	261	275	100	89	91	96
		100	281	245	251	262	100	87	89	93
		Mannitol 50	270	263	254	—	100	98	94	—
		100	269	260	252	—	100	97	94	—

[0047]

Example 4

5 Preservation solutions in which sorbitol, sucrose, trehalose, glucose, fructose, or mannitol was added at 100

mmol/L to the preservation solutions of Example 1 containing no phenylboronic acid were prepared, and testing was conducted in the same manner as in Example 1. For comparison, the same testing was conducted without adding these sugars.

5 The results are listed in Table 4. As clearly understood from Table 4, addition of sorbitol, sucrose, trehalose, glucose, or fructose to the preservation solutions containing no phenylboronic acid does not improve the recovery ratio of hemoglobin in the samples containing fecal
10 specimens. This result indicates that a sugar such as sorbitol, sucrose, trehalose, glucose, or fructose alone does not stabilize the hemoglobin in the samples containing feces and also indicates that the phenylboronic acid and a sugar have to exist together.

15 [0048]

[Table 4]

	Phenylboronic acid	Sugar (100mmol/L)	Hb concentration ($\mu\text{g/L}$)				Recovery ratio with respect to Hb concentration after 0 days (%)			
			Number of days for preservation at 37°C				Number of days for preservation at 37°C			
			0 days	7 days	14 days	21 days	0 days	7 days	14 days	21 days
Feces 1	No addition	No addition	282	135	99	71	100	48	35	25
		Sorbitol	283	143	102	97	100	51	36	34
		Sucrose	264	115	70	80	100	44	27	30
		Trehalose	266	121	80	44	100	45	30	17
		Glucose	276	135	99	59	100	49	36	21
		Fructose	285	127	85	81	100	45	30	28
		Mannitol	276	156	130	—	100	57	47	—
Feces 2	No addition	No addition	292	111	68	59	100	38	23	20
		Sorbitol	277	113	77	51	100	41	28	18
		Sucrose	270	96	49	31	100	36	18	11
		Trehalose	264	106	81	41	100	40	23	16
		Glucose	276	105	54	37	100	38	20	13
		Fructose	273	100	56	35	100	37	21	13
		Mannitol	284	97	81	—	100	34	28	—
Feces 3	No addition	No addition	286	93	60	51	100	33	21	18
		Sorbitol	278	98	62	56	100	35	22	20
		Sucrose	267	89	55	40	100	33	21	15
		Trehalose	267	91	56	47	100	34	21	18
		Glucose	272	93	55	46	100	34	20	17
		Fructose	265	83	41	39	100	31	15	15
		Mannitol	282	93	78	—	100	33	28	—
No feces	No addition	No addition	268	243	238	239	100	91	89	89
		Sorbitol	255	239	235	236	100	94	92	93
		Sucrose	245	228	223	222	100	93	91	91
		Trehalose	243	229	225	222	100	94	93	91
		Glucose	245	231	223	223	100	94	91	91
		Fructose	250	215	196	177	100	86	78	71
		Mannitol	261	251	244	—	100	96	93	—

[0049]

Example 5

The concentration of phenylboronic acid in the
5 preservation solutions of Example 1 was fixed to 15 mmol/L,
preservation solutions to which sorbitol was added at 10 to
500 mmol/L or sucrose was added at 10 to 250 mmol/L or
preservation solutions to which no sugar was added were
prepared, and testing was conducted in the same manner as in
10 Example 1. For comparative examples, preservation solutions
to which the phenylboronic acid and sugar were not added
were prepared, and testing was conducted in the same manner.
The results are listed in Table 5. As clearly understood
from Table 5, in any of the samples of Feces 1, Feces 2, and
15 Feces 3, the recovery ratio of hemoglobin in the samples
containing feces was improved depending on the added
concentration of sorbitol or sucrose and became constant
with addition at 25 mmol/L or more.

[0050]

20 [Table 5]

	Phenylboronic acid (mmol/L)	Sugar (mmol/L)	Hb concentration ($\mu\text{g/L}$)				Recovery ratio with respect to Hb concentration after 0 days (%)			
			Number of days for preservation at 37°C				Number of days for preservation at 37°C			
			0 days	7 days	14 days	21 days	0 days	7 days	14 days	21 days
Feces 1	No addition	No addition	282	135	99	71	100	48	35	25
	15	No addition	302	243	239	224	100	80	79	74
		Sorbitol 10	305	280	269	259	100	92	88	85
		25	301	288	289	276	100	96	96	92
		50	291	300	300	296	100	103	103	102
		100	287	292	294	290	100	102	102	101
		500	251	251	256	251	100	100	102	100
		Sucrose 10	304	273	264	249	100	90	87	82
		25	287	281	266	261	100	98	93	91
		50	291	281	274	268	100	97	94	92
		100	286	272	270	258	100	95	94	90
		250	258	250	241	232	100	97	93	90
Feces 2	No addition	No addition	292	111	68	50	100	38	23	17
	15	No addition	283	249	214	191	100	88	76	67
		Sorbitol 10	289	262	225	197	100	91	78	68
		25	283	277	245	213	100	98	87	75
		50	281	280	252	222	100	100	90	79
		100	274	276	246	219	100	101	90	80
		500	256	250	226	204	100	98	88	80
		Sucrose 10	286	270	237	213	100	94	83	74
		25	287	274	241	223	100	95	84	78
		50	273	266	232	212	100	97	85	78
		100	267	257	236	219	100	96	88	82
		250	245	235	216	193	100	96	88	79
Feces 3	No addition	No addition	286	93	60	51	100	33	21	18
	15	No addition	288	224	200	185	100	78	69	64
		Sorbitol 10	279	233	210	201	100	84	75	72
		25	285	240	225	213	100	84	79	75
		50	283	250	235	223	100	88	83	79
		100	278	244	226	219	100	88	81	79
		500	246	221	203	199	100	90	83	81
		Sucrose 10	286	227	205	195	100	79	72	68
		25	272	228	203	192	100	84	75	71
		50	286	234	209	195	100	82	73	68
		100	272	230	201	187	100	85	74	69
		250	248	213	189	176	100	86	76	71
No feces	No addition	No addition	268	243	238	239	100	91	89	89
	15	No addition	286	262	253	264	100	92	88	92
		Sorbitol 10	284	261	249	257	100	92	88	90
		25	287	261	250	265	100	91	87	92
		50	281	261	251	265	100	93	89	94
		100	276	252	244	255	100	91	88	92
		500	242	227	218	230	100	94	90	95
		Sucrose 10	274	258	251	268	100	94	92	98
		25	277	262	252	268	100	95	91	97
		50	271	253	246	257	100	93	91	95
		100	267	247	241	260	100	93	90	97
		250	238	227	221	235	100	95	93	99

[0051]

Example 6

- 5 Preservation solutions were prepared through adding 3-carboxyphenylboronic acid (3-CPBA), 3-hydroxyphenylboronic acid (3-HPBA), and 3-aminophenylboronic acid (3-APBA) each at 15 mmol/L as substitute for the phenylboronic acid in the preservation solutions of Example 1 and adding sorbitol,

sucrose, or mannitol at 100 mmol/L, and testing was conducted in the same manner as in Example 1. For comparative examples, preservation solutions to which no arylboronic acid was added were prepared, and testing was conducted in the same manner.

5 The results are listed in Table 6. As clearly understood from Table 6, also when other arylboronic acids were used, the recovery ratio of hemoglobin in the sample was further improved in any of fecal specimens of Feces 1, Feces 2, and Feces 3 if sorbitol, sucrose, or mannitol was further added,

10 and it has been recognized that the stability of hemoglobin in the samples containing feces can be synergistically enhanced.

[0052]

[Table 6]

	Arylboronic acid (15mmol/L)	Sugar (100mmol/L)	Hb concentration ($\mu\text{g/L}$)			Recovery ratio with respect to Hb after 0 days (%)		
			Number of days for preservation at 37°C			Number of days for preservation at 37°C		
			0 days	7 days	14 days	0 days	7 days	14 days
Feces 1	No addition	No addition	315	154	119	100	49	38
	3C-PBA	No addition	309	249	239	100	81	77
	3C-PBA	Sorbitol	305	299	305	100	98	100
	3C-PBA	Sucrose	285	260	268	100	91	94
	3C-PBA	Mannitol	301	280	306	100	93	102
	3H-PBA	No addition	327	269	268	100	82	82
	3H-PBA	Sorbitol	310	309	303	100	100	98
	3H-PBA	Sucrose	311	267	278	100	86	89
	3H-PBA	Mannitol	314	302	298	100	96	95
	3A-PBA	No addition	339	275	260	100	81	77
Feces 2	No addition	No addition	313	108	78	100	34	25
	3C-PBA	No addition	309	264	240	100	85	78
	3C-PBA	Sorbitol	302	283	260	100	94	86
	3C-PBA	Sucrose	286	260	240	100	91	84
	3C-PBA	Mannitol	304	290	282	100	95	93
	3H-PBA	No addition	326	277	264	100	85	81
	3H-PBA	Sorbitol	313	304	288	100	97	92
	3H-PBA	Sucrose	310	272	262	100	88	84
	3H-PBA	Mannitol	315	300	297	100	95	94
	3A-PBA	No addition	330	287	261	100	87	79
Feces 3	No addition	No addition	304	90	63	100	30	21
	3C-PBA	No addition	300	213	200	100	71	67
	3C-PBA	Sorbitol	293	251	239	100	85	81
	3C-PBA	Sucrose	283	226	214	100	80	76
	3C-PBA	Mannitol	294	241	234	100	82	80
	3H-PBA	No addition	313	213	206	100	68	66
	3H-PBA	Sorbitol	295	241	229	100	82	78
	3H-PBA	Sucrose	289	226	210	100	78	73
	3H-PBA	Mannitol	299	248	241	100	83	81
	3A-PBA	No addition	324	227	209	100	70	64
No feces	No addition	No addition	295	276	267	100	94	91
	3C-PBA	No addition	293	281	276	100	96	94
	3C-PBA	Sorbitol	288	280	271	100	97	94
	3C-PBA	Sucrose	271	263	257	100	97	95
	3C-PBA	Mannitol	285	271	267	100	95	94
	3H-PBA	No addition	303	294	296	100	97	98
	3H-PBA	Sorbitol	300	292	291	100	97	97
	3H-PBA	Sucrose	283	279	278	100	99	98
	3H-PBA	Mannitol	296	289	288	100	98	97
	3A-PBA	No addition	278	275	272	100	99	98
	No addition	No addition	278	275	272	100	99	98
	3C-PBA	No addition	278	275	272	100	99	98
	3C-PBA	Sorbitol	278	275	272	100	99	98
	3C-PBA	Sucrose	278	275	272	100	99	98
	3C-PBA	Mannitol	278	275	272	100	99	98
	3H-PBA	No addition	278	275	272	100	99	98
	3H-PBA	Sorbitol	278	275	272	100	99	98
	3H-PBA	Sucrose	278	275	272	100	99	98
	3H-PBA	Mannitol	278	275	272	100	99	98
	3A-PBA	No addition	278	275	272	100	99	98
	3A-PBA	Sorbitol	278	275	272	100	99	98

[0053]

Example 7

- 5 Preservation solutions were prepared through setting the concentration of phenylboronic acid in the preservation

solutions of Example 1 to 0 to 50 mmol/L and adding sorbitol or mannitol at 100 mmol/L, and testing was conducted in the same manner as in Example 1. The results are listed in Table 7. As clearly understood from Table 7, in the preservation solutions to which a sugar was added, decrease in the apparent recovery ratios was not observed even when the phenylboronic acid was added at 50 mmol/L. This appears to be because the arylboronic acid has the property of inhibiting the immunoagglutination reaction (at high concentrations), but the existence of a high concentration of the arylboronic acid adversely affects the immunological measurement method to deteriorate the apparent recovery ratio, while on the other hand, when a high concentration of sugar further coexists, the arylboronic acid and the sugar form a complex thereby to suppress the adverse effects of a high concentration of the arylboronic acid on the immunological measurement method.

[0054]

[Table 7]

	Phenylboronic acid (mmol/L)	Sugar (100mmol/L)	Hb concentration ($\mu\text{g/L}$)			Recovery ratio with respect to Hb after 0 days (%)		
			Number of days for preservation at 37°C			Number of days for preservation at 37°C		
			0 days	7 days	14 days	0 days	7 days	14 days
Feces 1	No addition	No addition	315	154	119	100	49	38
	0.5	Sorbitol	310	206	178	100	88	57
	15		301	297	295	100	99	98
	50		281	274	275	100	98	98
	15	Mannitol	301	288	287	100	96	95
	50		270	257	255	100	95	95
Feces 2	No addition	No addition	313	108	78	100	34	25
	0.5	Sorbitol	301	173	154	100	57	51
	15		299	300	298	100	100	100
	50		275	279	284	100	101	103
	15	Mannitol	298	284	284	100	95	95
	50		268	263	274	100	98	102
Feces 3	No addition	No addition	304	90	63	100	30	21
	0.5	Sorbitol	294	163	145	100	55	49
	15		292	246	233	100	84	80
	50		273	247	230	100	90	84
	15	Mannitol	288	231	220	100	80	76
	50		254	233	226	100	92	89
No feces	No addition	No addition	295	276	267	100	94	91
	0.5	Sorbitol	291	277	273	100	95	94
	15		288	274	268	100	95	93
	50		290	295	293	100	102	101
	15	Mannitol	287	272	269	100	95	94
	50		254	242	241	100	95	95

[0055]

Example 8

- 5 Preservation solutions were prepared with the addition of 40 mmol/L HEPES (pH 6.8), 0.1% BSA, 0.1% NaN_3 , and 0 to 2.5 mmol/L phenylboronic acid. In addition, preservation solutions were also prepared by adding of 0.5 mmol/L 3-carboxyphenylboronic acid (3-CPBA), 3-hydroxyphenylboronic acid (3-HPBA), and 3-aminophenylboronic acid (3-APBA) respectively as substitute for the phenylboronic acid.
- 10 Samples obtained by adding hemoglobin-added fecal specimens to the preservation solutions so that the fecal concentration would be 0.5% were preserved at 37°C for 0, 16, 38, and 62
- 15 hours. The fecal specimens were added with hemoglobin having an amount such that the hemoglobin concentration in the samples would be about 300 $\mu\text{g/L}$. Instead of the fecal specimens to which hemoglobin was added, samples containing

no fecal specimens, in which hemoglobin was added to the preservation solutions so that the hemoglobin concentration in the samples would be 300 µg/L, were similarly preserved. The hemoglobin (Hb) concentrations (µg/L) in the preserved
5 samples were measured by the latex agglutination method using the same measurement reagent and measurement device as in Example 1.

[0056]

In the present example, the preservation solutions
10 contain no haptoglobin, so the hemoglobin is decomposed earlier than in Examples 1 to 7, but the stabilizing effect of the arylboronic acid on the hemoglobin was also recognized in the present example. That is, as clearly understood from Table 8, in any of samples of Feces 1, Feces 2, and Feces 3,
15 the recovery ratio of hemoglobin in the sample was improved by adding arylboronic acid at a concentration of 0.25 mmol/L or more. Most of the hemoglobin in the samples is recognized to exist without forming a complex with haptoglobin because no haptoglobin is contained in the preservation solutions
20 unlike Examples 1 to 7. The above results therefore mean that the arylboronic acid also stabilized the hemoglobin which did not form a complex with haptoglobin.

[0057]

[Table 8]

	Arylboronic acid (mmol/L)	Hb concentration ($\mu\text{g/L}$)				Recovery ratio with respect to Hb after 0 days (%)			
		Preservation time at 37°C				Preservation time at 37°C			
		0 h	16 h	38 h	62 h	0 h	16 h	38 h	62 h
Feces 1	No addition	309	146	39	2	100	47	13	1
	PBA 0.25	295	172	74	24	100	58	25	8
	0.5	300	174	74	17	100	58	25	6
	1	298	182	92	30	100	61	31	10
	2.5	294	177	80	23	100	60	27	8
	3-CPBA 0.5	296	163	68	20	100	55	23	7
	3-HPBA 0.5	298	171	79	25	100	57	26	8
	3-APBA 0.5	318	178	92	31	100	56	29	10
Feces 2	No addition	282	54	0	0	100	19	0	0
	PBA 0.25	298	103	10	0	100	35	3	0
	0.5	299	103	10	0	100	34	3	0
	1	299	119	17	0	100	40	6	0
	2.5	299	124	18	0	100	41	6	0
	3-CPBA 0.5	288	90	8	0	100	31	3	0
	3-HPBA 0.5	295	95	11	0	100	32	4	0
	3-APBA 0.5	303	89	4	0	100	29	1	0
Feces 3	No addition	277	36	0	0	100	13	0	0
	PBA 0.25	284	92	8	0	100	32	3	0
	0.5	289	92	8	0	100	32	3	0
	1	287	112	14	0	100	39	5	0
	2.5	293	119	18	0	100	41	6	0
	3-CPBA 0.5	281	95	5	0	100	34	2	0
	3-HPBA 0.5	295	106	9	0	100	36	3	0
	3-APBA 0.5	298	94	4	0	100	31	1	0
No feces	No addition	303	274	252	240	100	91	83	79
	PBA 0.25	303	281	263	265	100	93	87	88
	0.5	295	284	270	263	100	96	91	89
	1	292	276	261	259	100	95	90	89
	2.5	291	273	257	259	100	94	88	89
	3-CPBA 0.5	299	279	264	266	100	94	88	89
	3-HPBA 0.5	306	282	263	264	100	92	86	86
	3-APBA 0.5	312	291	274	274	100	93	88	88

[0058]

Example 9

- 5 The concentration of phenylboronic acid in the preservation solutions of Example 8 was fixed to 0.5 mmol/L, preservation solutions to which sorbitol or sucrose was further added at 10 to 250 mmol/L or trehalose, glucose,

fructose, or mannitol was further added at 50 to 100 mmol/L were prepared, and testing was conducted in the same manner as in Example 8. In addition, preservation solutions to which the phenylboronic acid was added but no sugar was added
5 were prepared, preservation solutions to which the phenylboronic acid and sugar were not added were prepared for the comparative examples, and testing was conducted in the same manner. The results are listed in Tables 9A and 9B. As clearly understood from Tables 9A and 9B, even in
10 the preservation solutions containing no haptoglobin, when the phenylboronic acid was further added with sorbitol, sucrose, trehalose, glucose, fructose, or mannitol, the recovery ratio of hemoglobin in the sample was further improved in any of fecal specimens of Feces 1, Feces 2, and
15 Feces 3. Moreover, even when a sugar is added to the preservation solutions containing no phenylboronic acid, the recovery ratio of hemoglobin in the samples containing fecal specimens is not improved. These results indicate that even with the preservation solutions containing no haptoglobin,
20 a synergistic effect between the phenylboronic acid and various sugars can be obtained as in Examples 2 to 7.

[0059]

[Table 9A]

	Phenylboronic acid (mmol/L)	Sugar (mmol/L)	Hb concentration (μg/L)				Recovery ratio with respect to Hb after 0 days (%)				
			Preservation time at 37℃				Preservation time at 37℃				
			0 h	16 h	38 h	62 h	0 h	16 h	38 h	62 h	
Feces 1	No addition	No addition	309	146	39	2	100	47	13	1	
	0.5	No addition	300	174	74	17	100	58	25	6	
	0.5	Sorbitol	10	300	179	81	20	100	60	27	7
	0.5		50	290	175	81	21	100	61	28	7
	0.5		100	289	177	90	28	100	61	31	10
	0.5		250	277	182	105	45	100	65	38	16
	No addition	100	290	146	39	1	100	50	13	0	
	0.5	Sucrose	10	294	169	79	28	100	57	27	9
	0.5		50	284	173	92	34	100	61	33	12
	0.5		100	273	166	88	31	100	61	32	11
	0.5		250	249	167	97	43	100	67	39	17
	No addition	100	271	137	45	10	100	51	16	4	
	0.5	Trehalose	50	285	168	81	26	100	59	28	9
	0.5		100	272	164	78	27	100	61	29	10
	No addition		100	268	133	41	8	100	50	15	3
	0.5	Glucose	50	282	176	84	27	100	63	30	10
	0.5		100	278	178	92	32	100	64	33	12
	No addition		100	281	136	32	0	100	49	12	0
	0.5	Fructose	50	286	182	102	41	100	64	36	14
	0.5		100	290	185	105	46	100	64	36	16
	No addition		100	281	134	35	0	100	48	12	0
	0.5	Mannitol	50	279	176	90	34	100	63	32	12
	0.5		100	277	173	91	32	100	62	33	12
	No addition		100	276	131	29	1	100	48	10	0
Feces 2	No addition	No addition	282	54	0	0	100	19	0	0	
	0.5	No addition	299	103	10	0	100	34	3	0	
	0.5	Sorbitol	10	299	102	8	0	100	34	3	0
	0.5		50	292	107	10	0	100	37	4	0
	0.5		100	288	110	15	0	100	38	5	0
	0.5		250	275	117	20	0	100	43	7	0
	No addition		100	275	61	0	0	100	22	0	0
	0.5	Sucrose	10	297	100	15	0	100	34	5	0
	0.5		50	282	106	17	0	100	38	6	0
	0.5		100	276	107	19	0	100	39	7	0
	0.5		250	249	107	23	0	100	43	9	0
	No addition		100	255	57	3	0	100	22	1	0
	0.5	Trehalose	50	278	97	14	0	100	35	5	0
	0.5		100	267	102	15	0	100	38	6	0
	No addition		100	254	54	1	0	100	21	0	0
	0.5	Glucose	50	281	102	10	0	100	36	4	0
	0.5		100	278	105	8	0	100	38	3	0
	No addition		100	256	54	0	0	100	21	0	0
	0.5	Fructose	50	290	114	20	0	100	39	7	0
	0.5		100	283	116	21	0	100	41	7	0
	No addition		100	268	60	1	0	100	22	0	0
	0.5	Mannitol	50	287	115	21	0	100	40	7	0
	0.5		100	284	116	23	0	100	41	8	0
	No addition		100	266	55	1	0	100	21	0	0

[0060]

[Table 9B]

	Phenylboronic acid (mmol/L)	Sugar (mmol/L)	Hb concentration ($\mu\text{g/L}$)				Recovery ratio with respect to Hb after 0 days (%)			
			Preservation time at 37°C				Preservation time at 37°C			
			0 h	16 h	38 h	62 h	0 h	16 h	38 h	62 h
Feces 3	No addition	No addition	277	36	0	0	100	13	0	0
	0.5	No addition	289	92	8	0	100	32	3	0
	0.5	Sorbitol	294	105	12	0	100	36	4	0
	0.5		296	111	15	0	100	38	5	0
	0.5		285	124	19	1	100	43	7	0
	0.5		274	134	25	2	100	49	9	1
	No addition	100	277	49	1	0	100	18	0	0
	0.5	Sucrose	294	114	13	0	100	39	4	0
	0.5		286	110	11	0	100	38	4	0
	0.5		268	102	9	0	100	38	3	0
	0.5		244	114	17	0	100	47	7	0
	No addition	100	257	67	0	0	100	26	0	0
	0.5	Trehalose	279	96	8	0	100	34	3	0
	0.5		264	91	7	0	100	35	3	0
	No addition	100	260	46	0	0	100	19	0	0
	0.5	Glucose	285	112	15	0	100	39	5	0
	0.5		276	110	16	0	100	40	6	0
	No addition	100	270	46	1	0	100	17	0	0
	0.5	Fructose	286	119	16	0	100	42	6	0
	0.5		288	130	22	0	100	45	8	0
	No addition	100	263	51	0	0	100	19	0	0
	0.5	Mannitol	287	80	3	0	100	28	1	0
	0.5		288	96	6	0	100	33	2	0
	No addition	100	269	57	0	0	100	21	0	0
No feces	No addition	No addition	303	274	252	240	100	91	83	79
	0.5	No addition	295	284	270	263	100	96	91	89
	0.5	Sorbitol	296	277	263	259	100	94	89	87
	0.5		290	273	250	252	100	94	86	87
	0.5		289	266	247	255	100	92	86	88
	0.5		276	262	245	245	100	95	89	89
	No addition	100	300	263	245	235	100	88	82	79
	0.5	Sucrose	304	271	255	258	100	89	84	85
	0.5		293	272	251	251	100	93	86	86
	0.5		278	260	244	249	100	93	86	89
	0.5		258	241	228	226	100	93	88	88
	No addition	100	278	245	229	224	100	88	83	81
	0.5	Trehalose	284	260	249	253	100	91	88	89
	0.5		276	254	246	242	100	92	89	88
	No addition	100	280	241	228	219	100	86	81	78
	0.5	Glucose	292	272	260	257	100	93	89	88
	0.5		287	267	255	254	100	93	89	89
	No addition	100	283	256	230	218	100	90	81	77
	0.5	Fructose	296	271	254	256	100	91	86	86
	0.5		292	265	254	262	100	91	87	90
	No addition	100	284	246	233	230	100	86	82	81
	0.5	Mannitol	292	273	255	259	100	94	87	89
	0.5		285	266	250	259	100	93	87	91
	No addition	100	281	254	237	235	100	91	84	84

[0061]

Preservation solutions were prepared through fixing the concentration of phenylboronic acid in the preservation solutions of Example 8 to 0.5 mmol/L, adding of 0.5 mmol/L 3-carboxyphenylboronic acid (3-CPBA), 3-
5 hydroxyphenylboronic acid (3-HPBA), and 3-aminophenylboronic acid (3-APBA) respectively as substitute for the phenylboronic acid, and adding sorbitol or sucrose at 100 mmol/L, and testing was conducted in the same manner as in Example 8. For comparative examples, preservation solutions
10 to which no arylboronic acid was added were prepared, and testing was conducted in the same manner. The results are listed in Table 10. As clearly understood from Table 10, even with the preservation solutions containing no haptoglobin, the combined use of various arylboronic acids
15 and sugars further improve the recovery ratio of hemoglobin in the samples, and it has been recognized that the stability of hemoglobin in the samples containing feces can be synergistically enhanced.

[0062]

20 [Table 10]

	Arylboronic acid (0.5mmol/L)	Sugar (100mmol/L)	Hb concentration ($\mu\text{g/L}$)				Recovery ratio with respect to Hb after 0 days (%)			
			Preservation time at 37°C				Preservation time at 37°C			
			0 h	16 h	38 h	62 h	0 h	16 h	38 h	62 h
Feces 1	No addition	No addition	309	146	39	2	100	47	13	1
	PBA	No addition	300	174	74	17	100	58	25	6
		Sorbitol	289	177	90	28	100	61	31	10
		Sucrose	273	166	88	31	100	61	32	11
	3-CPBA	No addition	296	163	68	20	100	55	23	7
		Sorbitol	290	173	89	31	100	59	30	11
		Sucrose	274	160	64	15	100	58	23	6
	3-HPBA	No addition	298	171	79	25	100	57	26	8
		Sorbitol	295	195	118	56	100	66	40	19
		Sucrose	278	170	86	28	100	61	31	10
	3-APBA	No addition	318	178	92	31	100	56	29	10
		Sorbitol	293	177	97	36	100	60	33	12
		Sucrose	277	168	75	21	100	61	27	8
Feces 2	No addition	No addition	282	54	0	0	100	19	0	0
	PBA	No addition	299	103	10	0	100	34	3	0
		Sorbitol	288	110	15	0	100	38	5	0
		Sucrose	276	107	19	0	100	39	7	0
	3-CPBA	No addition	288	90	8	0	100	31	3	0
		Sorbitol	283	99	13	0	100	35	4	0
		Sucrose	265	86	6	0	100	32	2	0
	3-HPBA	No addition	295	95	11	0	100	32	4	0
		Sorbitol	288	100	14	0	100	35	5	0
		Sucrose	262	95	9	0	100	36	3	0
	3-APBA	No addition	303	89	4	0	100	29	1	0
		Sorbitol	286	103	14	0	100	36	5	0
		Sucrose	270	91	9	0	100	34	3	0
Feces 3	No addition	No addition	277	36	0	0	100	13	0	0
	PBA	No addition	289	92	8	0	100	32	3	0
		Sorbitol	285	124	19	1	100	43	7	0
		Sucrose	268	102	9	0	100	38	3	0
	3-CPBA	No addition	281	95	5	0	100	34	2	0
		Sorbitol	283	117	15	0	100	41	5	0
		Sucrose	267	92	9	0	100	34	4	0
	3-HPBA	No addition	295	106	9	0	100	36	3	0
		Sorbitol	287	113	12	0	100	39	4	0
		Sucrose	266	94	8	0	100	35	3	0
	3-APBA	No addition	298	94	4	0	100	31	1	0
		Sorbitol	284	116	10	0	100	41	4	0
		Sucrose	273	99	13	0	100	36	5	0
No feces	No addition	No addition	303	274	252	240	100	91	83	79
	PBA	No addition	295	284	270	263	100	96	91	89
		Sorbitol	289	266	247	255	100	92	86	88
		Sucrose	278	260	244	249	100	93	88	89
	3-CPBA	No addition	299	279	264	266	100	94	88	89
		Sorbitol	287	271	253	254	100	94	88	89
		Sucrose	281	254	246	247	100	91	88	88
	3-HPBA	No addition	306	282	263	264	100	92	86	86
		Sorbitol	294	273	259	259	100	93	88	88
		Sucrose	276	261	248	248	100	95	90	90
	3-APBA	No addition	312	291	274	274	100	93	88	88
		Sorbitol	300	279	265	268	100	93	88	89
		Sucrose	293	277	261	257	100	94	89	88

[Name of Document] Claims

1. A method of stabilizing a protein contained in a specimen derived from a living body, the method comprising
5 a step of causing the protein contained in the specimen derived from the living body to coexist with an arylboronic acid, wherein

 the protein contained in the specimen derived from the living body is at least one type selected from a group
10 consisting of hemoglobin, haptoglobin, and a hemoglobin-haptoglobin complex.

2. The method according to claim 1, wherein the arylboronic acid is at least one type selected from a group consisting
15 of phenylboronic acid and derivatives thereof.

3. The method according to claim 1 or 2, wherein the arylboronic acid is at least one type selected from a group consisting of phenylboronic acid, hydroxyphenylboronic acid,
20 carboxyphenylboronic acid, aminophenylboronic acid, and salts thereof.

4. The method according to any one of claims 1 to 3, wherein
25 the step is a step of dispersing the protein contained in the specimen derived from the living body in a solution containing the arylboronic acid, and

 a concentration of the arylboronic acid in the solution is 0.1 mmol/L or more.

30

5. The method according to any one of claims 1 to 4, wherein the step is a step of causing the protein contained in the specimen derived from the living body to coexist with

the arylboronic acid and a sugar.

6. The method according to claim 5, wherein the sugar is at least one type selected from a group consisting of sugar
5 alcohol, monosaccharide, and disaccharide.

7. The method according to claim 5 or 6, wherein the sugar is at least one type selected from a group consisting of sorbitol, glucose, mannitol, fructose, xylitol, erythritol,
10 sucrose, trehalose, lactose, and maltose.

8. The method according to any one of claims 5 to 7, wherein

the step is a step of dispersing the protein contained
15 in the specimen derived from the living body in a solution containing the arylboronic acid and the sugar, and

a concentration of the sugar in the solution is 5 mmol/L or more.

20 9. The method according to any one of claims 1 to 8, wherein

the specimen derived from the living body contains at least hemoglobin, and

the method comprises a step of bringing the hemoglobin
25 and haptoglobin into contact with each other to form a complex of hemoglobin and haptoglobin.

10. The method according to any one of claims 1 to 9, wherein the specimen derived from the living body is feces,
30 saliva, or urine.

11. A stabilizing solution for stabilizing a protein contained in a specimen derived from a living body, wherein

the stabilizing solution comprises an arylboronic acid,
and

the protein contained in the specimen derived from the
living body is at least one type selected from a group
5 consisting of hemoglobin, haptoglobin, and a hemoglobin-
haptoglobin complex.

12. The stabilizing solution according to claim 11, wherein
the arylboronic acid is at least one type selected from a
10 group consisting of phenylboronic acid and derivatives
thereof.

13. The stabilizing solution according to claim 11 or 12,
wherein the arylboronic acid is at least one type selected
15 from a group consisting of phenylboronic acid,
hydroxyphenylboronic acid, carboxyphenylboronic acid,
aminophenylboronic acid, and salts thereof.

14. The stabilizing solution according to any one of claims
20 11 to 13, comprising a sugar.

15. The stabilizing solution according to claim 14, wherein
the sugar is at least one type selected from a group
consisting of sorbitol, glucose, mannitol, fructose, xylitol,
25 erythritol, sucrose, trehalose, lactose, and maltose.

16. The stabilizing solution according to any one of claims
11 to 15, comprising haptoglobin.

30 17. The stabilizing solution according to any one of claims
11 to 16, wherein the specimen is feces, saliva, or urine.

18. The stabilizing solution according to any one of claims

11 to 17, wherein the stabilizing solution is a solution for preserving the specimen derived from the living body.

19. A method of detecting a protein in a specimen derived
5 from a living body, the method comprising:

a step of adding the specimen derived from the living body to the stabilizing solution according to any one of claims 11 to 18 to obtain a sample containing the specimen; and

10 a step of detecting the protein in the sample by an immunological measurement method, wherein

the protein in the specimen derived from the living body is at least one type selected from a group consisting of hemoglobin, haptoglobin, and a hemoglobin-haptoglobin
15 complex.

20. The method according to claim 19, wherein

the specimen derived from the living body contains at least hemoglobin, and

20 the hemoglobin in the sample forms a complex together with haptoglobin.

21. The method according to claim 20, wherein the stabilizing solution is the stabilizing solution according
25 to claim 16.

22. A kit for detecting a protein contained in a specimen derived from a living body, the kit comprising:

the stabilizing solution according to any one of claims
30 11 to 18; and

a reagent containing an antibody that recognizes the protein, wherein

the protein is at least one type selected from a group

consisting of hemoglobin, haptoglobin, and a hemoglobin-haptoglobin complex.

[Name of Document] Abstract

[Abstract]

 The present invention provides a method of stabilizing
a protein. The method includes a step of causing a protein
5 contained in a specimen derived from a living body to coexist
with an arylboronic acid. The protein contained in the
specimen derived from the living body is at least one type
selected from the group consisting of hemoglobin,
haptoglobin, and a hemoglobin-haptoglobin complex.
10 According to the present invention, it is possible to
stabilize a protein such as a blood protein contained in the
specimen derived from a living body. The present invention
further provides a stabilizing solution for stabilizing a
protein contained in a specimen derived from a living body
15 and a method and a kit for detecting a protein contained in
a specimen derived from a living body.