

In addition, the sucrose PTS is known to be composed of five factors, i.e., scrA (which incorporates sucrose); scrY (which phosphorylates sucrose); scrB (which decomposes sucrose in microorganisms); scrR (which controls the expressions of scrA, Y, and B), and scrK (which phosphorylates fructose).

[0005] When ability that a microorganism does not have should be introduced into the microorganism, introduction of a gene expressing the ability is generally studied. In the case of sucrose assimilation ability, the DNAs of the above factors have sizes of from 900 to 1500 bp, and the total DNA size required for expressing genes of four enzymes (thiolase, CoA transferase, acetoacetate decarboxylase, and isopropyl alcohol dehydrogenase) required for high production of isopropyl alcohol is approximately 4800 bp. In other words, introduction of a DNA having a size of approximately 9300 bp would be necessary in order to impart both the sucrose assimilation ability and the IPA-producing ability to *Escherichia coli*.

[0006] However, simultaneous introduction thereof into *Escherichia coli* is extremely difficult since the size of the DNA to be introduced would exceed the upper limit of the DNA size which the plasmid can accommodate. Even if two kinds of plasmid vector were used so as to reduce the DNA size of each plasmid to be 10000 bp or smaller, either or both of the two kinds of plasmid introduced into *Escherichia coli* would usually be likely to be eliminated during repetitive growth. The *Escherichia coli* would need to be continuously exposed to an expensive antibiotic substance as a selection marker in order to avoid the above problem, and such necessity is not suitable for industrial production.

Accordingly, it was difficult to simultaneously impart both the ability to assimilate sucrose and the ability to highly produce isopropyl alcohol to *Escherichia coli*.

[0007] Can. J. Microbiol., Vol. 45, pp. 18-422 (1999) discloses that as a result of introduction of sucrose hydrolase (cscA) alone into *Escherichia coli*, the *Escherichia coli* could grow using sucrose as a raw material. However, the article also demonstrates that when cscA gene was highly expressed by a genetic recombination technology, almost all of cscA were present in the cells. Thus, cscA (invertase) works inside the cells rather than outside the cells, and it cannot be expected that cscA decomposes sucrose outside the cells.

[0008] An example of material production from sucrose using *Escherichia coli*, which cannot assimilate sucrose, is production of tryptophan using sucrose as a raw material (for example, JP-A No. 2001-346578). However, in this example, it is demonstrated that introduction of a group of genes including at least cscA, cscB, and cscK is necessary in order to impart the ability to produce amino acids from sucrose to *Escherichia coli*.

~~SUMMARY OF INVENTION~~

Technical problem to be solved by ~~invention~~the present disclosure

[0009] As discussed above, it has been extremely difficult to simultaneously impart the ability to assimilate sucrose and the ability to highly produce isopropyl alcohol to *Escherichia coli*, which cannot assimilate sucrose, due to the excessively large size of the DNA to be introduced.

An object of the present ~~invention~~disclosure is to provide an isopropyl alcohol-producing *Escherichia coli* and a method for producing isopropyl alcohol that are useful for efficient production of isopropyl alcohol from sucrose, which is inexpensive and has high industrial utility value.

[0010] The present ~~invention~~disclosure provides an isopropyl alcohol-producing *Escherichia coli* and a method for producing isopropyl alcohol as described below.

Means for Solving Problem

[0010a] In an aspect, there is provided an isopropyl alcohol-producing *Escherichia coli* comprising at least a sucrose hydrolase gene that belongs to a sucrose non-PTS gene group, and an imparted or enhanced isopropyl alcohol production system, wherein the isopropyl alcohol-producing *Escherichia coli* is an *Escherichia coli* to which an acetoacetate decarboxylase activity, an isopropyl alcohol dehydrogenase activity, a CoA transferase activity, and a thiolase activity have been imparted.

[0010b] In another aspect, there is provided a method for producing isopropyl alcohol, comprising producing isopropyl alcohol from a sucrose-containing plant-derived raw material using the isopropyl alcohol-producing *Escherichia coli* as defined herein.

[0011] [1] An isopropyl alcohol-producing *Escherichia coli* including at least a sucrose hydrolase gene that belongs to a sucrose non-PTS gene group, and an imparted or enhanced isopropyl alcohol production system.

[2] The isopropyl alcohol-producing *Escherichia coli* according to [1], including only the sucrose hydrolase gene from among genes belonging to the sucrose non-PTS gene group.

[3] The isopropyl alcohol-producing *Escherichia coli* according to [1] or [2], wherein the isopropyl alcohol-producing *Escherichia coli* is an *Escherichia coli* to which an acetoacetate decarboxylase activity, an isopropyl alcohol dehydrogenase activity, a CoA transferase activity, and a thiolase activity have been imparted.

[4] The isopropyl alcohol-producing *Escherichia coli* according to [3], wherein the acetoacetate decarboxylase activity, the isopropyl alcohol dehydrogenase activity, the CoA transferase activity, and the thiolase activity are obtained by introduction of genes encoding respective enzymes which are derived from at least one selected from the group consisting of bacteria of the genus *Clostridium*, bacteria of the genus *Bacillus*, and bacteria of the genus *Escherichia*.

[5] The isopropyl alcohol-producing *Escherichia coli* according to [3], wherein the acetoacetate decarboxylase activity and the isopropyl alcohol dehydrogenase activity are obtained by introduction of genes encoding respective enzymes which are derived from a bacterium or bacteria of the genus *Clostridium*, and the CoA transferase activity and the thiolase activity are obtained by introduction of genes encoding respective enzymes which are derived from a bacterium or bacteria of the genus *Escherichia*.

[6] The isopropyl alcohol-producing *Escherichia coli* according to [3], wherein the