mannose-6-phoshpate phosphatase (M6PP), wherein the M6PP comprises an amino acid sequence having at least 90% sequence identity with SEQ ID NO: 1, and wherein the M6PP has a higher activity compared to that of M6PP from *Sulfurivirga caldicuralii* (Uniprot ID A0A1N6FCW3).

[007a] In one example, the disclosure provides an improved D-mannose preparation method capable of enzymatically converting saccharides (e.g., polysaccharides, oligosaccharides, disaccharides, sucrose, D-glucose, and D-fructose) into D-mannose. An improved process of the disclosure for the production of mannose from a saccharide includes a step of converting mannose-6-phosphate (M6P) to mannose, catalyzed by mannose-6-phoshpate phosphatase (M6PP), wherein the M6PP comprises an amino acid sequence having at least 90% sequence identity with SEQ ID NO: 1.

[008] In some processes of the disclosure, mannose is prepared in a process with a step of converting fructose 6-phosphate (F6P) to mannose 6-phosphate (M6P), where the step is catalyzed by mannose 6-phosphate isomerase (M6PI). In some examples, the process includes converting glucose 6-phosphate (G6P) to the F6P, where the step is catalyzed by phosphoglucoisomerase (PGI). In further examples, G6P is converted to F6P then converted to M6P by one enzyme: bifunctional phosphoglucose/phosphomannose isomerase (PGPMI). In other examples, a process for mannose synthesis also includes the step of converting glucose 1-phosphate (G1P) to the G6P, and this conversion step is catalyzed by phosphoglucomutase (PGM).

[009] The saccharides used in any of the processes can be selected from the group consisting of a starch or its derivative, cellulose or its derivative, and sucrose. The starch or its derivative can be amylose, amylopectin, soluble starch, amylodextrin, maltodextrin, maltose, or glucose. In some improved processes of the disclosure, the process for preparing mannose involves converting starch to a starch derivative by enzymatic hydrolysis or by acid hydrolysis of starch. In other processes, a starch derivative is prepared by enzymatic hydrolysis of starch catalyzed by isoamylase, pullulanase, alpha-

What is claimed is:

1. An improved process for the production of mannose from a saccharide, the improvement comprising converting M6P to mannose using a mannose-6-phoshpate phosphatase (M6PP), wherein the M6PP comprises an amino acid sequence having at least 90% sequence identity with SEQ ID NO: 1, and wherein the M6PP has a higher activity compared to that of M6PP from *Sulfurivirga caldicuralii* (Uniprot ID A0A1N6FCW3).

2. The process of claim 1, further comprising a step of converting fructose-6-phosphate (F6P) to mannose 6-phopsphate (M6P) using a mannose 6-phosphate isomerase (M6PI).

3. The process of claim 2, further comprising a step of converting glucose 6-phosphate (G6P) to the F6P, wherein the step is catalyzed by a phosphoglucose isomerase (PGI).

4. The process of claim 3, further comprising the step of converting glucose 1-phosphate (G1P) to the G6P, wherein the step is catalyzed by a phosphoglucomutase (PGM).

5. The process of claim 4, further comprising the step of converting a saccharide to the G1P, wherein the step is catalyzed by at least one enzyme, wherein the saccharide is selected from the group consisting of a starch or derivative thereof, cellulose or a derivative thereof, and sucrose, wherein the starch derivative is selected from the group consisting of amylose, amylopectin, soluble starch, amylodextrin, maltodextrin, maltotriose, maltose, glucose, and a combination thereof, and wherein the cellulose derivative is selected from the group consisting of pretreated biomass, regenerated amorphous cellulose, cellodextrin, cellobiose, fructose, and glucose.

6. The process of claim 5, wherein the at least one enzyme is selected from the group consisting of alpha-glucan phosphorylase (αGP), maltose phosphorylase, sucrose phosphorylase, cellodextrin phosphorylase, cellobiose phosphorylase, and cellulose phosphorylase.

7. The process of claim 5, further comprising the step of converting starch to a starch derivative wherein the starch derivative is prepared by enzymatic hydrolysis of starch or by acid hydrolysis of starch.

8. The process of claim 7, wherein a 4-glucan transferase (4GT) is added to the process.

9. The process of claim 8, wherein the starch derivative is prepared by enzymatic hydrolysis of starch catalyzed by an isoamylase, a pullulanase, an alpha-amylase, or a combination thereof.

10. The process of claim 1, further comprising:

the step of converting fructose to the F6P, wherein the step is catalyzed by at least one enzyme; and

optionally, the step of converting sucrose to the fructose, wherein the step is catalyzed by at least one enzyme.

11. The process of claim 3, further comprising:

the step of converting glucose to the G6P, wherein the step is catalyzed by at least one enzyme, and

optionally, the step of converting sucrose to the glucose, wherein the step is catalyzed by at least one enzyme.

12. The process of claim 1, wherein the process is an enzymatic process for the production of mannose comprising the steps of:

(i) converting a saccharide to glucose 1-phosphate (G1P) using one or more enzymes, wherein the saccharide is selected from the group consisting of starch, one or more derivatives of starch, or a combination thereof;

(ii) converting G1P to glucose 6-phosphate (G6P) using a phosphoglucomutase (PGM);

(iii) converting G6P to fructose 6-phosphate (F6P) using a phosphoglucoisomerase (PGI);

(iv) converting the F6P to mannose 6-phopsphate (M6P) using a mannose 6-phosphate isomerase (M6PI), and

(v) converting the M6P to mannose using a mannose 6-phosphate phosphatase (M6PP), wherein the M6PP comprises an amino acid sequence having at least 90% sequence identity with SEQ ID NO: 1;

wherein process steps (i)-(v) are conducted in a single reaction vessel.

13. The process of claim 12, wherein the process steps are conducted under at least one of the following process conditions:

at a temperature ranging from 37˚C to 85˚C,

at a pH ranging from 5.0 to 9.0, or

for 1 hour to 48 hours.

14. The process of any one of claims 12 or 13, wherein the process steps are conducted under at least one of the following process conditions:

without adenosine triphosphate (ATP) as a source of phosphate,

without nicotinamide adenosine dinucleotide,

at a phosphate concentration from 0.1 mM to 150 mM,

at a Mg^{2+} concentration from 0.1 mM to 50 mM

where phosphate is recycled, and

where at least one step of the process involves an energetically favorable chemical reaction.

15. The process of claim 14, wherein phosphate is recycled, wherein phosphate ions produced by M6PP dephosphorylation of M6P are used in the process step of converting a saccharide to G1P.

16. The process of claim 14, wherein the step of converting M6P to mannose is an energetically favorable, irreversible phosphatase reaction.

17. The process of any one of claims 12-16, further comprising the step of separating recovering the mannose produced, wherein the separation recovery is not via chromatography separation.

18. The process of claim 12, wherein the derivatives of starch are selected from the group consisting of amylose, amylopectin, soluble starch, amylodextrin, maltodextrin, maltotriose, maltose, and glucose.

19. The process of any one of claims 1-18, further comprising a step of adding the mannose to a consumable product.

20. The process of any one of claims 1-18, wherein the M6PP comprises an amino acid sequence according to SEQ ID NO: 1.