CLAIMS

1. A method for producing an L-lactate salt from a combined recycling of polylactic acid (PLA) and organic waste, the method comprising the steps of:
   (a) hydrolyzing PLA waste with a metal oxide or a hydroxide to obtain a PLA hydrolysis slurry comprising L- lactate monomers and a first counterion;
   (b) fermenting organic waste with a lactic acid-producing microorganism in a fermenter in the presence of an alkaline compound to obtain a fermentation broth comprising L- lactate monomers and a second counterion,
   wherein the first and second counterions are the same; or wherein at least one of the first and second counterions is subjected to ion exchange thereby obtaining a first and second counterions which are the same;
   (c) optionally contacting the PLA hydrolysis slurry of step (a), the fermentation broth of step (b), or a mixture comprising the PLA hydrolysis slurry of step (a) and the fermentation broth of step (b) with a D-lactic acid degrading enzyme or a D-lactic acid-utilizing microorganism to eliminate D-lactate monomers thereby obtaining L-lactate monomers; and
   (d) purifying a mixture comprising the PLA hydrolysis slurry of step (a) and the fermentation broth of step (b) or the L-lactate monomers of step (c) thereby obtaining an L-lactate salt.

2. The method of claim 1, wherein step (a) and step (b) are performed in any order or simultaneously.

3. The method of claim 1, wherein the mixture comprising the PLA hydrolysis slurry of step (a) and the fermentation broth of step (b) is obtained by gradually adding the PLA hydrolysis slurry to the lactic acid fermenter during fermentation.

4. The method of ~~any one of~~ claim~~s~~ 1 ~~to 3~~, wherein step (a) is performed at a temperature in the range of about 50°C to about 90°C or wherein step (a) is performed for a period of time in the range of about 1 to about 12 hours or about 12 to about 36 hours.

5. ~~The method of any one of claims 1 to 4, wherein step (a) is performed for a period of time in the range of about 1 to about 12 hours.~~

~~6. The method of any one of claims 1 to 4, wherein step (a) is performed for a period of time in the range of about 12 to about 36 hours.~~

~~7.~~5. The method of ~~any one of~~ claim~~s~~ 1 ~~to 6~~, wherein the metal oxide or hydroxide of step (a) and the alkaline compound of step (b) are the same compound.

~~8.~~6. The method of ~~any one of~~ claim~~s~~ 1 ~~to 6~~, wherein the first and second counterions are different.

~~9.~~7. The method of claim ~~8~~6, wherein at least one of the hydroxide slurry of step (a) and the fermentation broth of step (b) are subjected to ion exchange thereby resulting in a first and second counterions which are the same.

~~10. The method of any one of claims 1 to 9, wherein the alkaline compound in step (a) is a metal oxide, a carbonate, or a hydroxide.~~

~~11.~~8. The method of claim 1 ~~or claim 10~~, wherein the metal oxide or alkaline compound comprise~~s~~ at least one of MgO, CaO, and a mixture or combination thereof.

~~12. The method of claim 10, wherein the carbonate comprises at least one of $CaCO_3$, $MgCO_3$, and a mixture or combination thereof.~~

~~13.~~9. The method of claim 1 ~~or claim 10~~, wherein the hydroxide or alkaline compound comprise~~s~~ at least one of NaOH, KOH, NH_4OH, $Ca(OH)_2$, $Mg(OH)_2$, and a mixture or combination thereof.

~~14.~~10. The method of claim ~~13~~9, wherein the hydroxide is $Mg(OH)_2$.

~~15.~~11. The method of ~~any one of~~ claim~~s~~ 1 ~~to 14~~, wherein the lactate salt is magnesium L-lactate salt.

~~16. The method of claim 15, wherein the magnesium L-lactate is in crystalline form.~~

~~17.~~12. The method of ~~any one of~~ claim~~s~~ 1 ~~to 16~~, further comprising pretreatment of the PLA waste prior to step (a), wherein pretreatment comprises mechanical pretreatment selected from the group consisting of grinding, chipping, shredding, milling, and a combination thereof.

~~18. The method of claim 17, wherein pretreatment comprises mechanical pretreatment selected from the group consisting of grinding, chipping, shredding, milling, and a combination thereof.~~

~~19.~~13. The method of ~~any one of~~ claim~~s~~ 1 ~~to 18~~, further comprising subjecting the PLA hydrolysis slurry obtained in step (a) to solid-liquid separation.

~~20.~~14. The method of ~~any one of~~ claim~~s~~ 1 ~~to 19~~, wherein the organic waste comprises endogenous D-lactic acid, L-lactic acid or both; or wherein the organic waste is selected from the group consisting of food waste, municipal waste, agricultural waste, plant material, and a mixture or combination thereof.

~~21. The method of any one of claims 1 to 20, wherein the organic waste is selected from the group consisting of food waste, municipal waste, agricultural waste, plant material, and a mixture or combination thereof.~~

~~22.~~15. The method of ~~any one of~~ claim~~s~~ 1 ~~to 21~~, wherein the PLA waste comprises poly L-lactic acid (PLLA) and poly D-lactic acid (PDLA).

~~23.~~16. The method of ~~any one of~~ claim~~s~~ 1 ~~to 22~~, wherein step (c) is performed and wherein the D-lactic acid degrading enzyme in step (c) is a D-lactate oxidase.

~~24. The method of claim 23, wherein the D-lactic acid degrading enzyme in step (c) is a D-lactate oxidase.~~

~~25.~~17. The method of ~~any one of~~ claim~~s~~ 1 ~~to 24~~, wherein the obtained L-lactate salt is purified by at least one of crystallization, recrystallization, distillation, partitioning, silica gel chromatography, preparative HPLC, and combinations thereof.

~~26.~~18. The method of ~~any one of~~ claim~~s~~ 1 ~~to 25~~, wherein the obtained L-lactate salt is acidified to form L-lactic acid for subsequent polylactic acid formation.

~~27.~~19. A method for producing magnesium L-lactate salt by recycling of polylactic acid (PLA) waste, the method comprising the steps of:

(a) hydrolyzing PLA waste with a base selected from sodium, potassium and ammonium hydroxide to obtain a PLA hydrolysis slurry comprising L-lactate monomers and a counterion selected from sodium, potassium and ammonium;

(b) optionally performing at least one of neutralizing the PLA hydrolysis slurry with an acid and removing unhydrolyzed PLA waste; and

(c) adding a magnesium salt to the PLA hydrolysis slurry of step (a) or (b) to thereby precipitate magnesium L-lactate salt.

~~28.~~20. The method of claim ~~27~~19, wherein the base is sodium hydroxide.

~~29.~~21. The method of claim ~~27 or 28~~19, wherein step (a) is performed at a temperature in the range of about 50°C to about 90°C; or wherein step (a) is performed for a period of time in the range of about 1 to about 24 hours or about 1 to about 12 hours.

~~30. The method of any one of claims 27 to 29, wherein step (a) is performed for a period of time in the range of about 1 to about 24 hours.~~

~~31. The method of any one of claims 27 to 29, wherein step (a) is performed for a period of time in the range of about 1 to about 12 hours.~~

~~32. The method of any one of claims 27 to 31, wherein the base is in excess of the PLA waste.~~

~~33. The method of any one of claims 27 to 31, wherein the PLA waste is in excess of the base.~~

~~34.~~22. The method of ~~any one of~~ claim~~s~~ ~~27~~ 19~~to 33~~, wherein step (b) is performed and wherein the acid is selected from hydrochloric acid, hydrobromic acid, phosphoric acid, sulfuric acid, and combinations thereof~~.~~; or wherein step (b) is performed and wherein removing unhydrolyzed PLA waste comprises solid-liquid separation.

~~35. The method of any one of claims 27 to 34, wherein step (b) is performed and wherein removing unhydrolyzed PLA waste comprises solid-liquid separation.~~

~~36.~~23. The method of ~~any one of~~ claim~~s 27 to 35~~19, wherein the magnesium salt in step (c) is added in solid form or as an aqueous solution.

~~37. The method of any one of claims 27 to 35, wherein the magnesium salt in step (c) is added as an aqueous solution.~~

~~38.~~24. The method of ~~any one of~~ claim~~s 27 to 37~~19, wherein the magnesium salt in step (c) is magnesium sulfate.

~~39.~~25. The method of ~~any one of~~ claim~~s 27 to 38~~19, wherein the obtained magnesium L-lactate salt is further subjected to subsequent purification~~.~~; or wherein the magnesium L-lactate salt is combined with magnesium L-lactate salt derived from fermentation of organic waste followed by subsequent purification.

~~40. The method of any one of claims 27 to 39, wherein the magnesium L-lactate salt is combined with magnesium L-lactate salt derived from fermentation of organic waste followed by subsequent purification.~~