Enhancement of acetyl-CoA flux for photosynthetic chemical production by pyruvate dehydrogenase complex overexpression in Synechococcus elongatus PCC 7942

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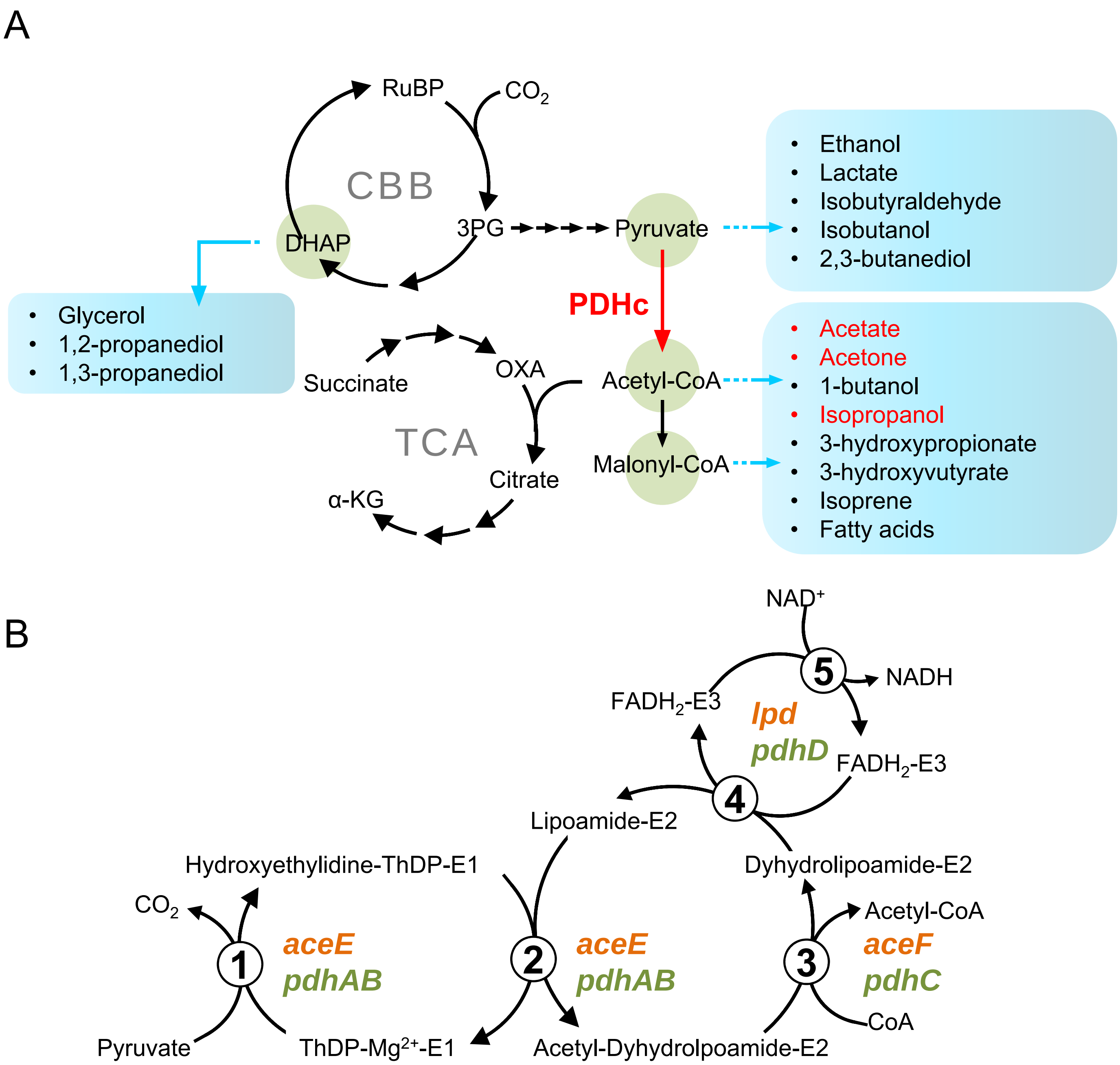

(1) Pyruvate + ThDP-Mg^{2+}-E1 → Hydroxyethylidine-ThDP-Mg^{2+}-E1 + CO_2

(2) Hydroxyethylidine-ThDP-Mg^{2+} -E1+ Lipoamide-E2 → ThDP-Mg^{2+}-E1 + Acetyldihydrolipoamide-E2

(3) Acetyldihydrolipoamide-E2 + CoA → Dihydroxyethylidine-E2 + Acetyl-CoA

(4) Dihydroxyethylidine-E2 + FAD-E3 → Lipoamide-E2 + $FADH_2$-E3

(5) $FADH_2$-E3 + NAD^+ → FAD-E3 + NADH + H^+

Fig. 1. Diagrams of metabolic pathways for chemical production in cyanobacteria and the reaction scheme of PDHc. (A) Summary of the synthetic metabolic pathway and its key intermediates in cyanobacteria. (B) Diagram of reaction catalyzed by PDHc.

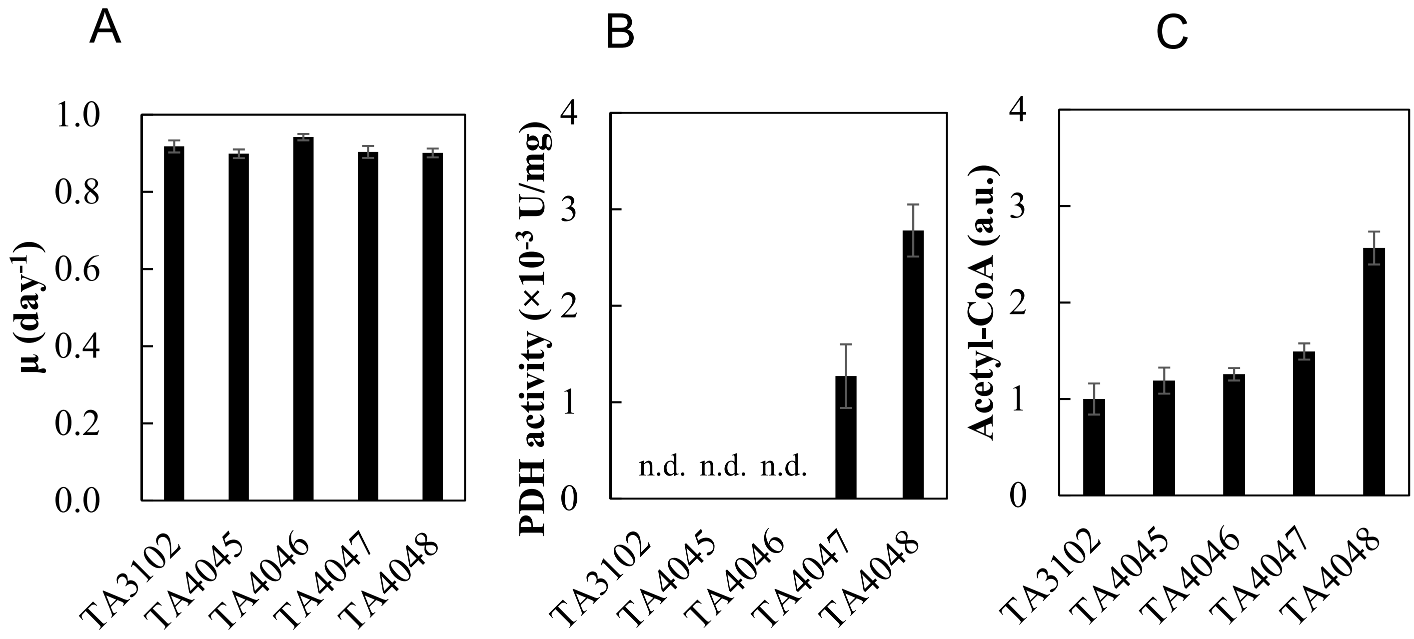

Fig. 2. Overexpression of PDHc in *S. elongatus* PCC 7942 under photosynthetic conditions. (A) Specific cell growth rate of PCC 7942 strains. (B) PDH activities of PCC 7942 strains. (C) Relative comparison of intracellular acetyl-CoA pool. Error bars represent the standard deviation of biological replicates (n=3). "n.d." means "not detected".

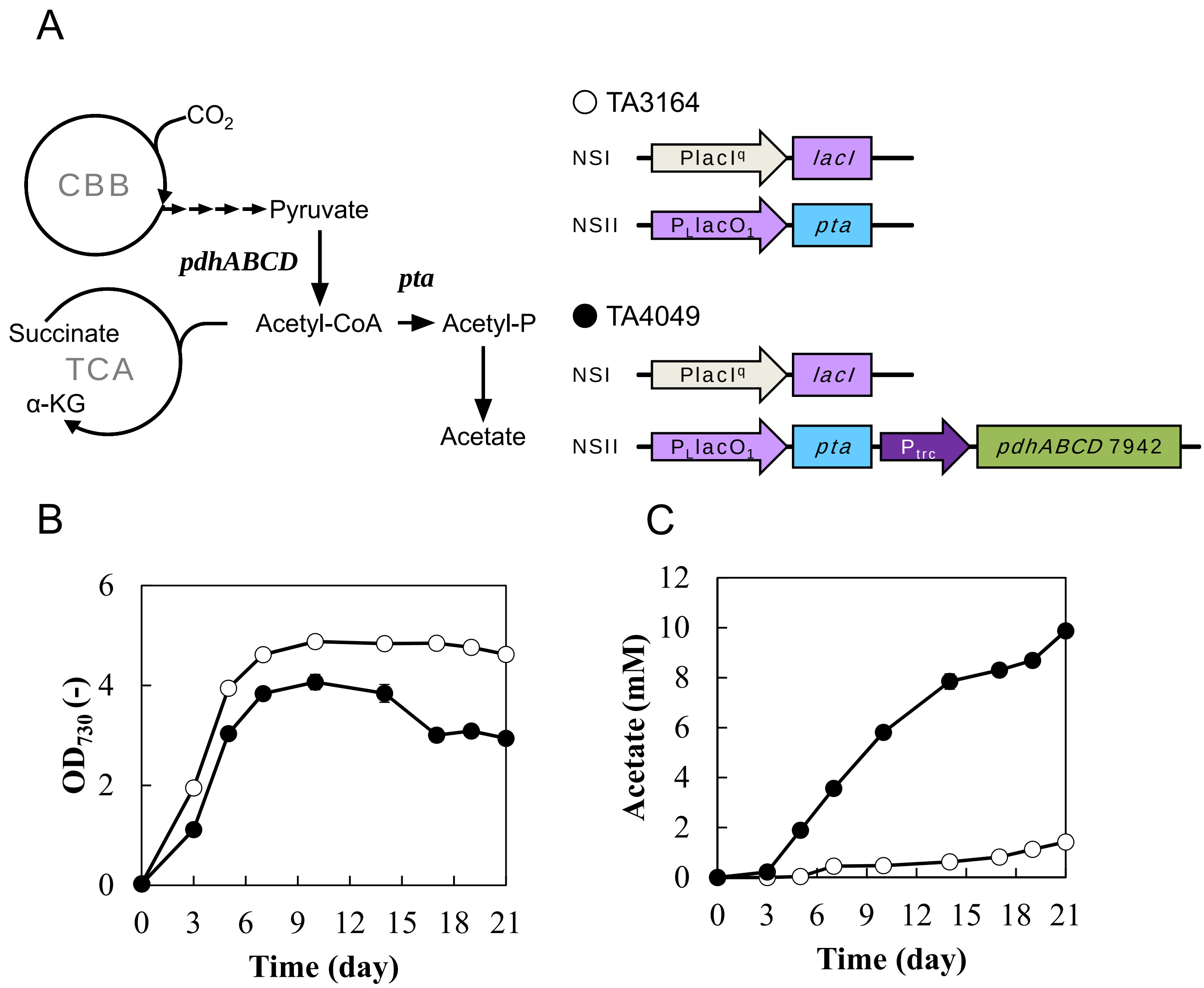

Fig. 3. Photosynthetic acetate production based on enhanced acetyl-CoA pool by PDHc overexpression. (A) Diagram of the metabolic pathway and genetic construct introduced to photosynthetic acetate-producing strains TA3164 and TA4049. (B) Time course of cell growth of TA3164 and TA4049 during photosynthetic acetate production. (C) Time course of the acetate production titer in culture broth of TA3164 and TA4049 under photosynthetic conditions. Open and closed circles indicate TA3164 and TA4049, respectively. Error bars represent the standard deviation of biological replicates (n=3).

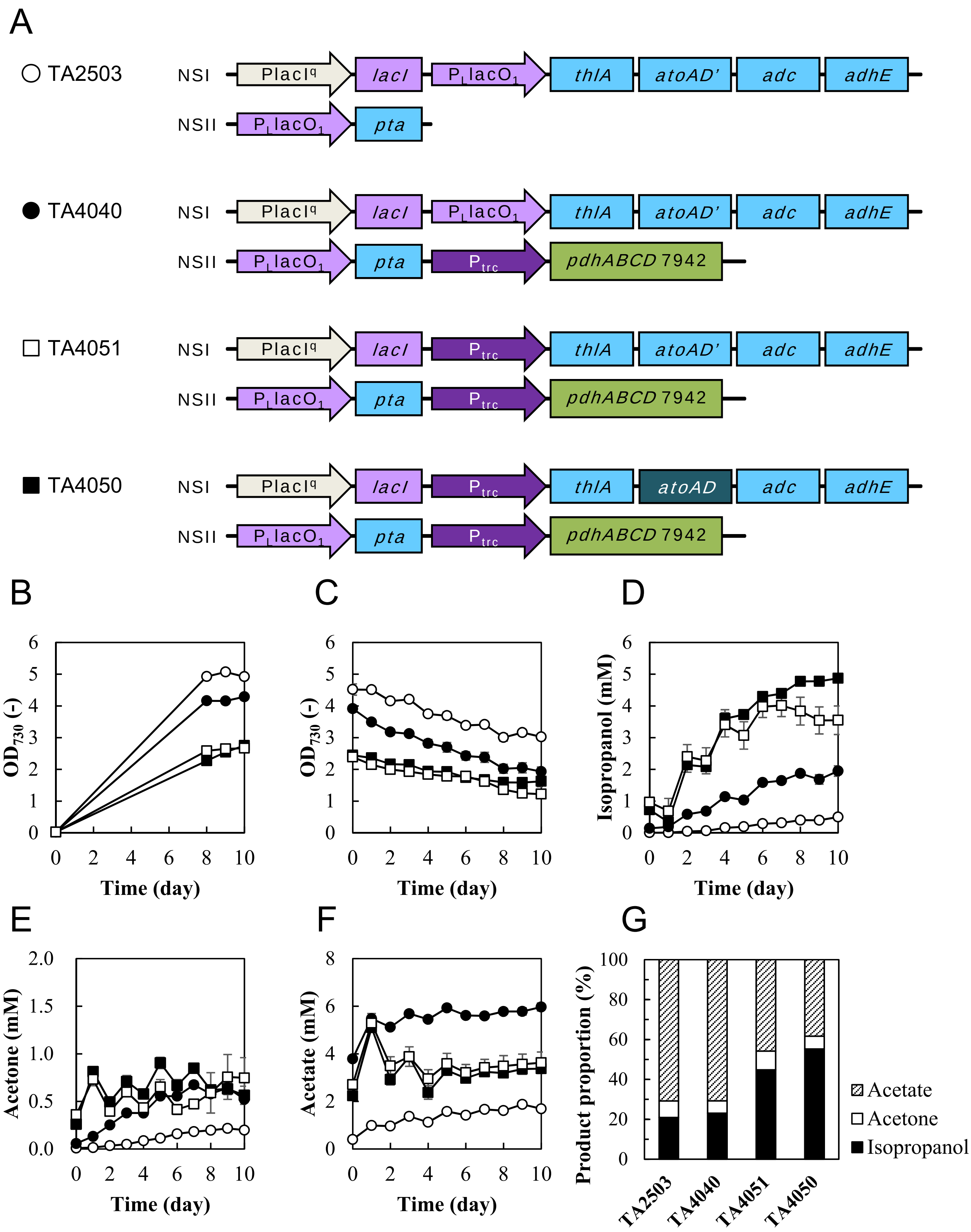

Fig. 4. Photosynthetic isopropanol production based on enhanced acetyl-CoA pool by PDHc overexpression. (A) Diagram of the metabolic pathway and genetic construct introduced to photosynthetic isopropanol-producing strains TA2503, TA4040, TA4051, and TA4050. (B) Time course of cell growth of the isopropanol-producing strains in the pre-cultivation. (C) Time course of cell growth during photosynthetic isopropanol production. (D) Time course of the production titer in culture broth of isopropanol (D), acetone (E), and acetate (F). (G) Proportion of production titers in culture broth at 10th day in the photosynthetic production culture. Open circle, closed circle, open square, and closed square indicate TA2503, TA4040, TA4051, and TA4050, respectively. Error bars represent the standard deviation of biological replicates (n=3).

Fig. S1

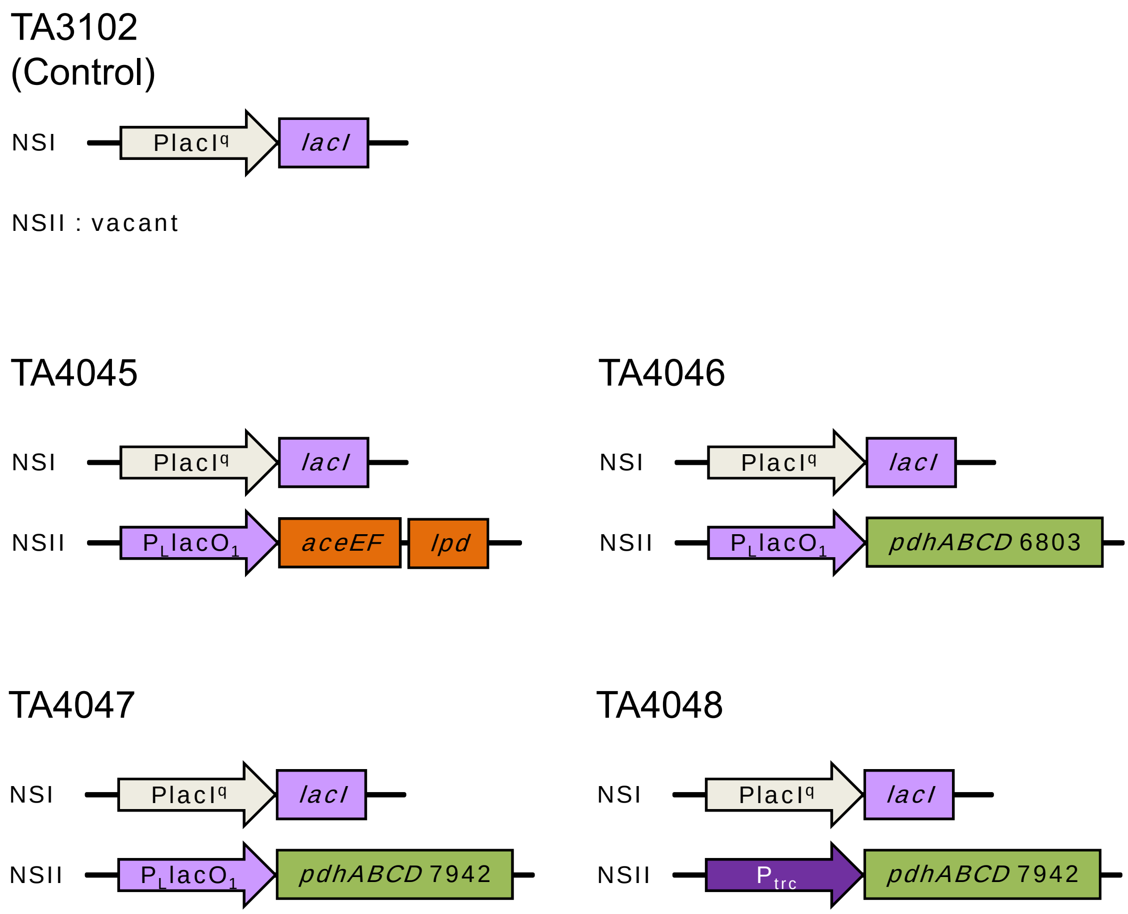

Fig. S1. Diagram of genetic constructs of PDHc overexpression strains. Each diagram indicates genetic constructs introduced to TA3102, TA4045, TA4046, TA4047, and TA4048.

Fig. S2

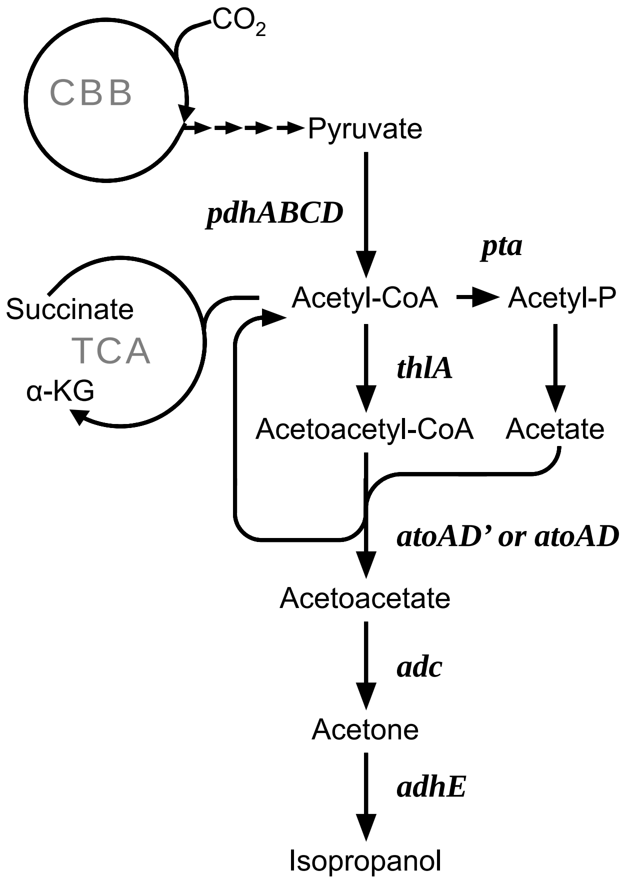

Fig. S2. Diagram of the metabolic pathway for photosynthetic isopropanol production. The isopropanol production pathway branches to acetate synthesis (catalyzed by Pta) and acetoacetyl-CoA synthesis (catalyzed by ThlA) downstream of acetyl-CoA.