SUPPORTING INFORMATION

De Novo Biosynthesis of Caffeic Acid from Glucose by Engineered *Saccharomyces cerevisiae*

Yuanzi Li [†], Jiwei Mao[‡], Quanli Liu[‡], Xiaofei Song[†], Yuzhen Wu[†], Miao Cai[†], Haijin Xu[†] and Mingqiang Qiao[*†]

[†] The Key Laboratory of Molecular Microbiology and Technology, Ministry of Education, College of Life Sciences, Nankai University, No. 94 Weijin Road, Nankai District, Tianjin, 300071, PR China

[‡] Department of Biology and Biological Engineering, Chalmers University of Technology, 41296 Gothenburg, Sweden

*Corresponding Author

Mingqiang Qiao, the Key Laboratory of Molecular Microbiology and Technology, Ministry of Education, College of Life Sciences, Nankai University, No.94 Weijin Road, Nankai Distract, Tianjin, 300071, China

E-mail: qiaomq@nankai.edu.cn Tel: +862223503692 Fax: +862223503692

ORCID**:** 0000-0002-5435-1514

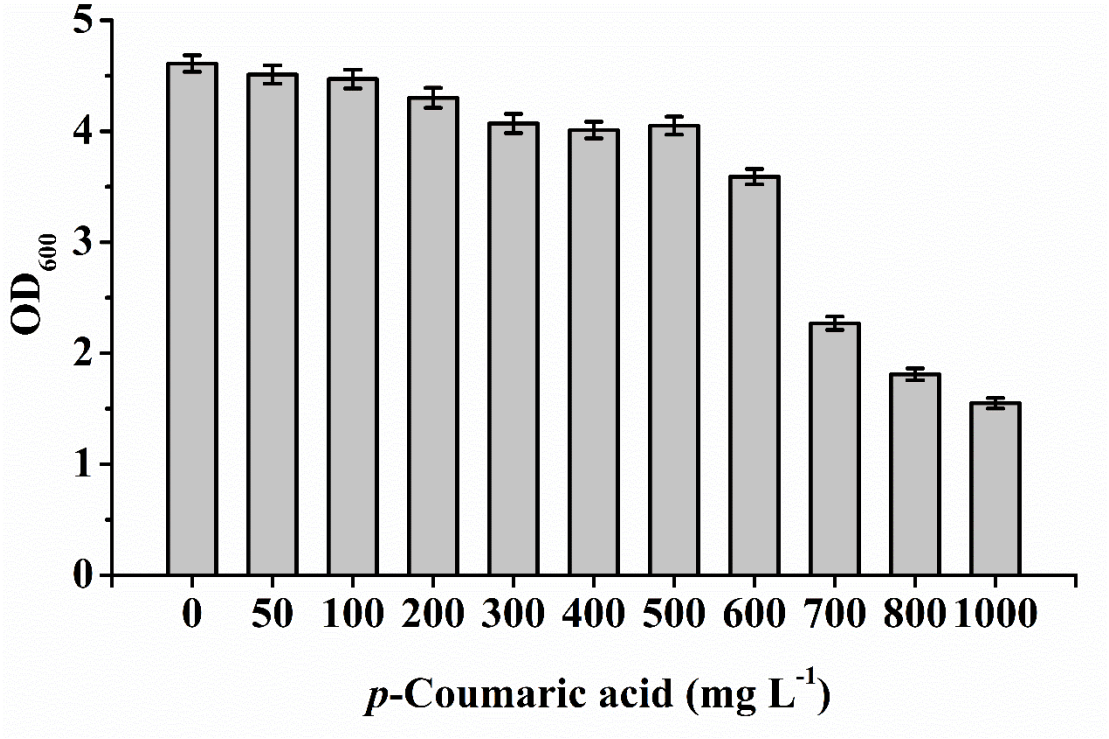

Figure S1. Effects of *p*-coumaric acid supplement concentrations on cells growth. Average ± standard deviations were calculated from three biological replicates.

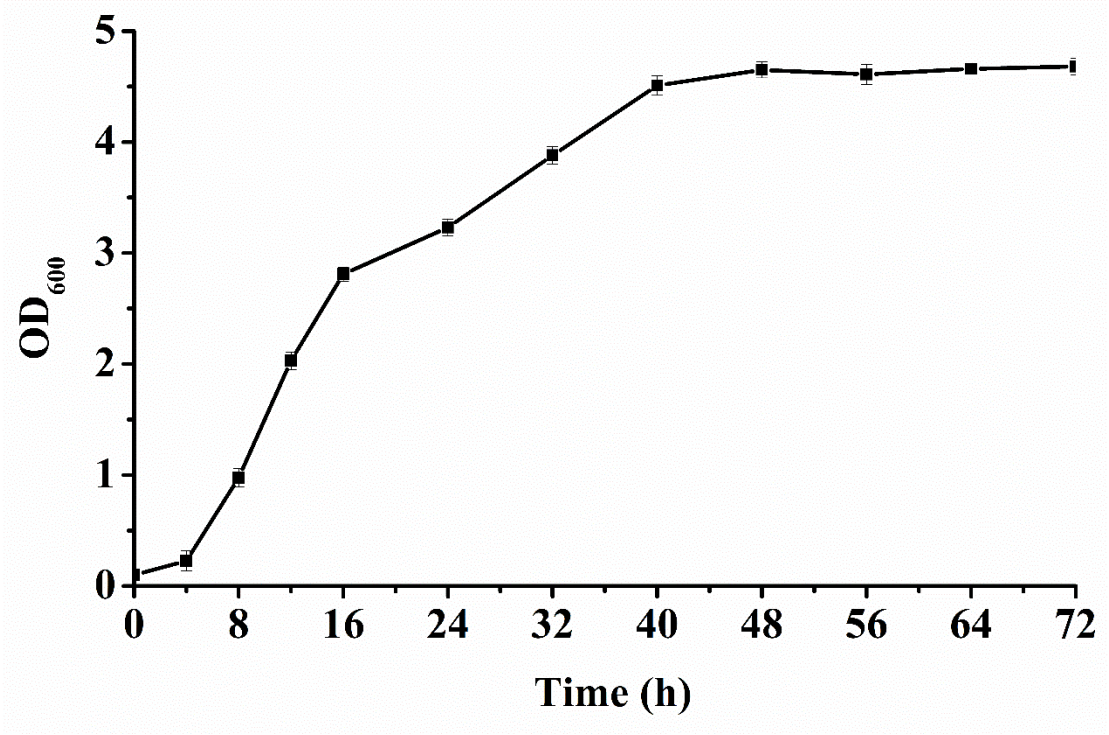

Figure S2. Growth curve of NKC2 strain in SC-His medium. Average ± standard deviations were calculated from three biological replicates.

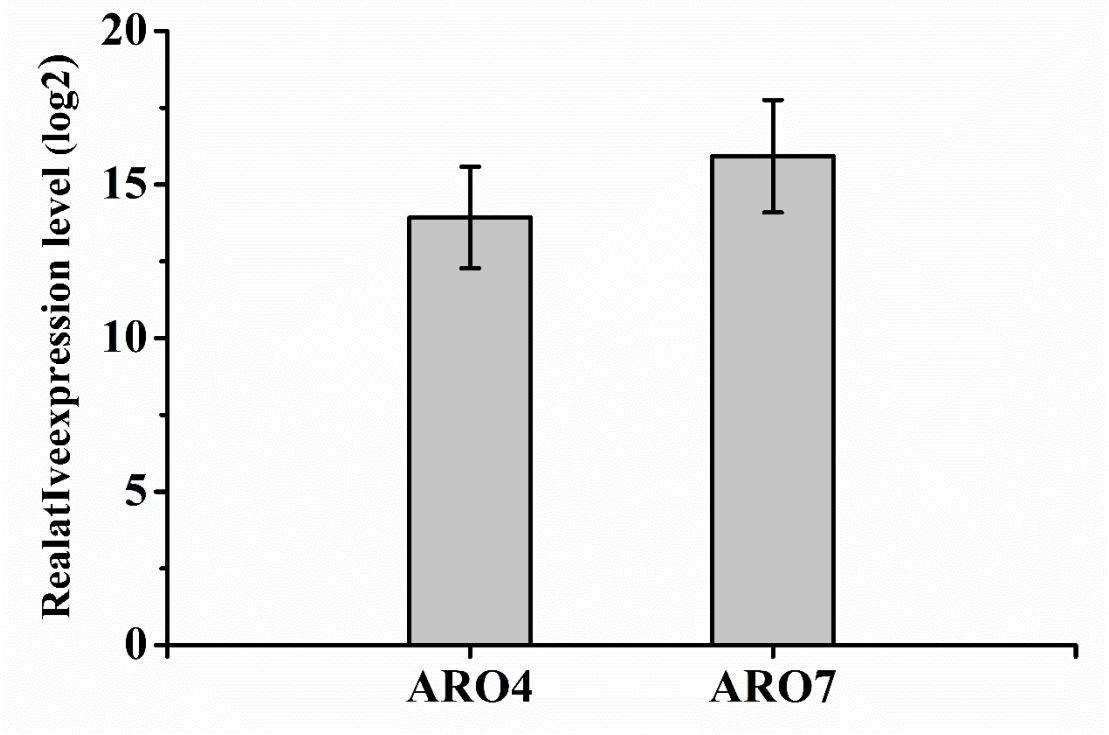

Figure S3. RT-qPCR analysis of gene expression levels of the engineered strain NKC6 compared with BY4742 strain. Average ± standard deviations were calculated from three biological replicates.

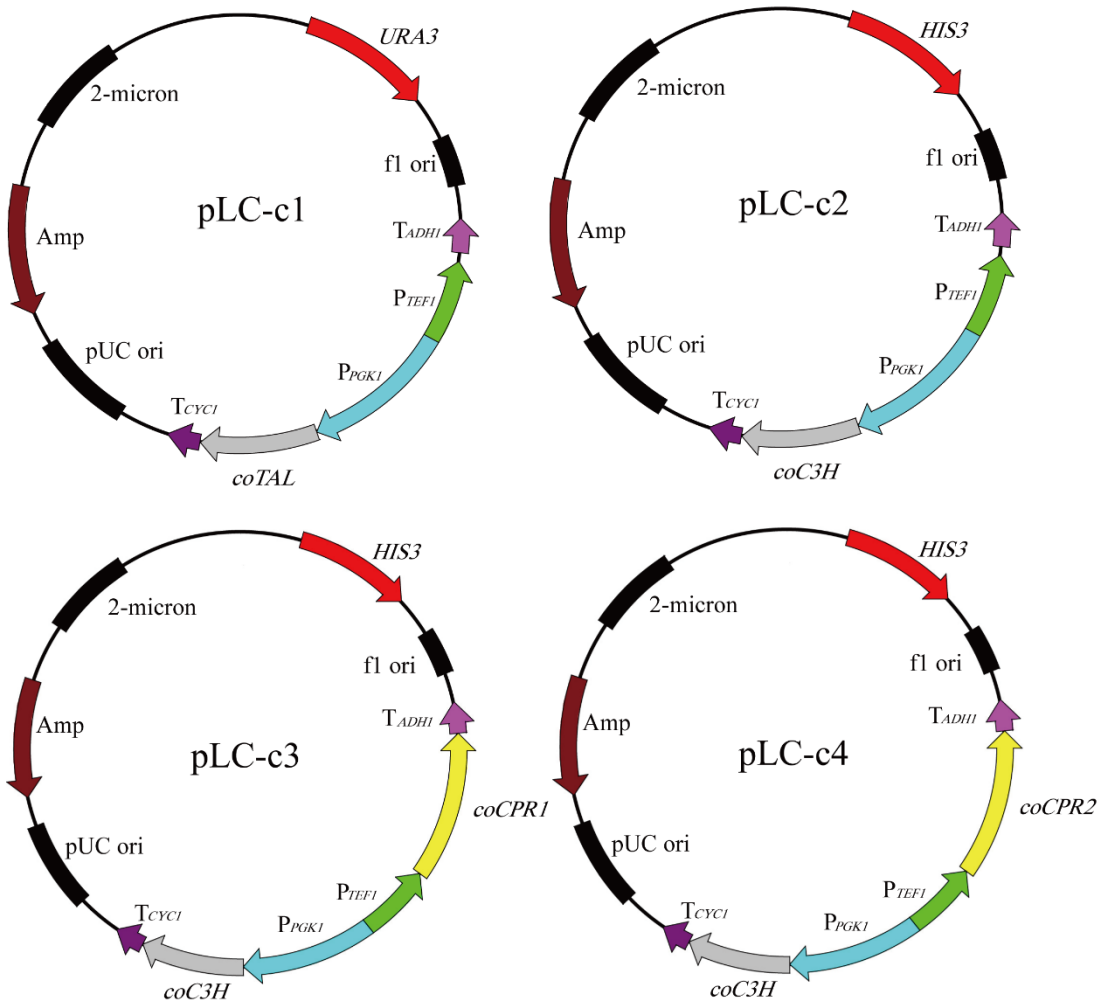

Figure S4. The structure charts of plasmids pLC-c1, pLC-c2, pLC-c3 and pLC-c4.

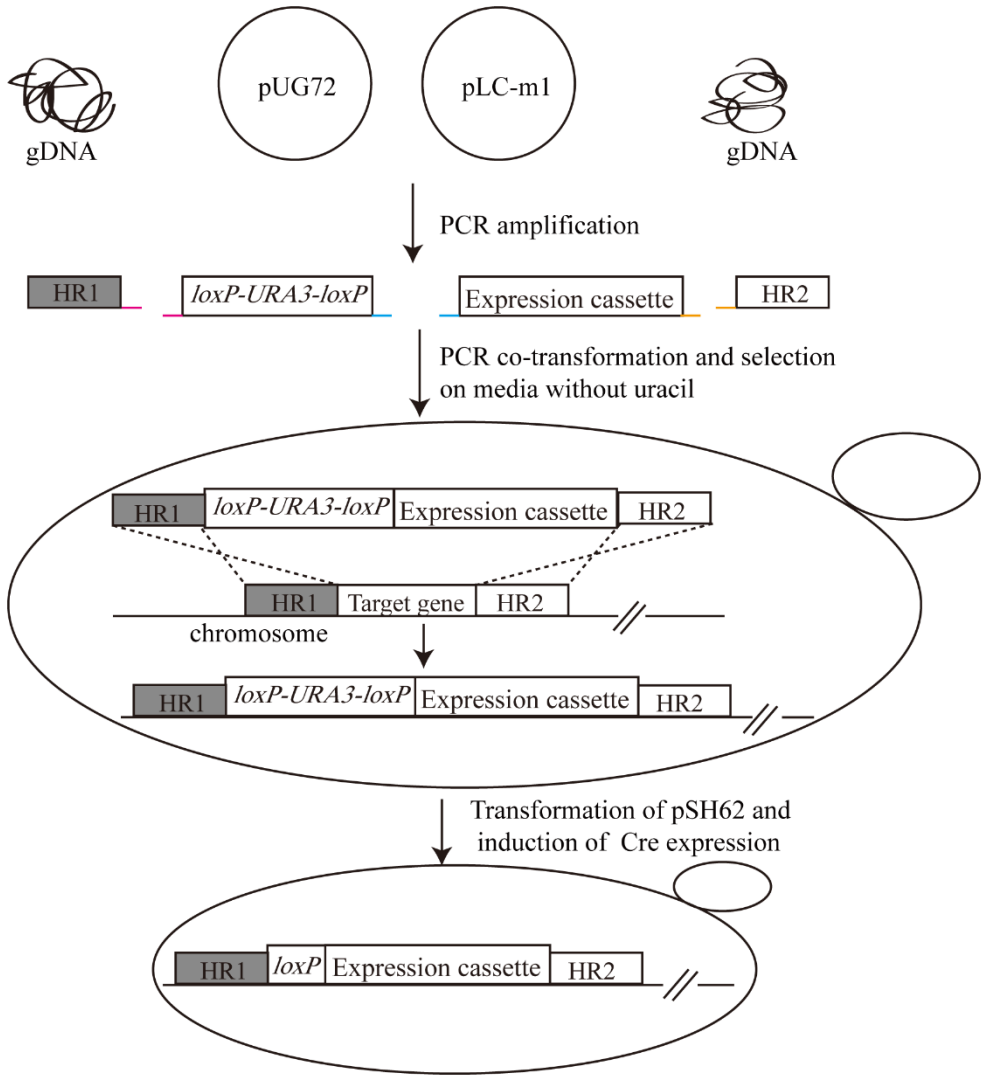

Figure S5. Schematic representation of the replacement of a gene that needed to be knocked out with the overexpression cassette in *S. cerevisiae*. HR1 and HR2 represent upstream homologous region and downstream homologous region of the target gene that would be knocked out, respectively. The overexpression cassette was P_{TEF1}-*ARO4*^{fbr}-T_{ADH1} or P_{PGK1}-*ARO7*^{fbr}-T_{CYC1}. First, HR1, URA3 cassette, overexpression cassette and HR2 were individually amplified via PCR and co-transformed into yeast cell to form the functional cassette via chromosomal integration; second, Cre recombinase was induced with galactose to remove *URA3* selection marker; finally, the target gene was replaced by overexpression cassette.

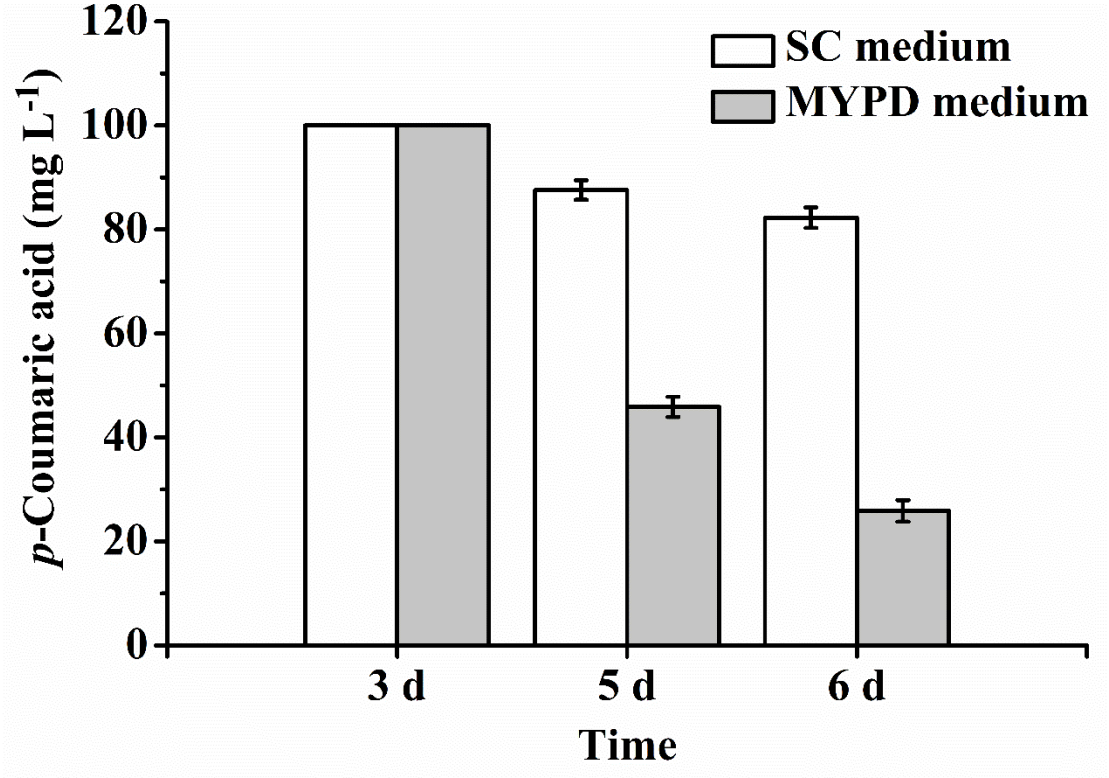

Figure S6. *p*-Coumaric acid consumptions in SC medium and MYPD medium. BY4742 strain was cultured in SC medium and MYPD medium for 6 d, respectively, and 100 mg L^{-1} *p*-coumaric acid was added at 3 d. Average ± standard deviations were calculated from three biological replicates.

Table S1. Gene Sequences of TAL, C3H, CPR1 and CPR2 with Codon Optimization

gene	sequence
coTAL	ATGACTTTGCAATCACAGACTGCAAAGGATTGCTTGGCTTTGGACGGAGC ATTGACTTTGGTCCAATGCGAAGCTATAGCTACTCATAGATCTAGAATTTC TGTCACTCCAGCTTTGAGAGAGAGATGTGCTAGGGCACATGCTAGGTTGG AGCACGCTATAGCAGAACAGAGACACATATACGGAATTACTACTGGTTTC GGTCCTTTGGCAAACAGATTGATTGGTGCTGACCAGGGTGCTGAATTGCAA CAAAATTTAATATACCACTTAGCTACAGGTGTCGGTCCTAAGTTGTCTTGG GCAGAAGCTAGGGCTTTGATGTTAGCTAGATTGAACTCTATTTTGCAAGGT GCTTCTGGTGCTTCTCCAGAGACAATAGACAGAATTGTTGCTGTTTTGAAC GCTGGTTTCGCACCAGAGGTCCCAGCTCAAGGTACTGTCGGTGCTTCTGGT GACTTGACACCATTGGCTCATATGGTTTTGGCATTGCAAGGAAGAGGTAG AATGATTGATCCTTCTGGTAGAGTCCAAGAGGCTGGTGCTGTTATGGACAG ATTATGCGGTGGTCCATTGACATTGGCTGCTAGGGACGGTTTGGCTTTGGT TAACGGAACTTCTGCTATGACTGCTATTGCTGCTTTGACAGGTGTTGAGGC AGCTAGGGCTATTGACGCTGCATTGAGACACTCTGCTGTCTTGATGGAAGT CTTATCTGGTCATGCTGAGGCTTGGCACCCAGCATTTGCAGAATTGAGGCC TCATCCAGGTCAGTTGAGAGCTACTGAGAGGTTAGCTCAGGCTTTGGATGG TGCAGGTAGAGTCTGCAGAACTTTGACTGCTGCTAGGAGGTTAACTGCTGC AGACTTGAGACCAGAGGATCATCCAGCTCAAGACGCTTACTCTTTAAGGG TCGTCCCACAGTTGGTTGGTGCAGTTTGGGACACATTGGACTGGCATGACA GAGTCGTTACTTGTGAATTAAATTCTGTTACTGATAATCCAATTTTCCCAG AGGGTTGCGCTGTTCCTGCTTTGCATGGTGGTAACTTTATGGGTGTCCACG TCGCATTGGCTTCTGACGCTTTGAACGCAGCTTTGGTCACTTTGGCTGGTTT GGTCGAAAGGCAGATTGCAAGATTGACAGATGAGAAGTTGAACAAAGGTT TGCCAGCTTTCTTGCACGGTGGTCAGGCTGGTTTGCAATCTGGTTTCATGG GTGCACAGGTCACAGCTACTGCATTGTTGGCTGAGATGAGGGCTAACGCA ACTCCTGTCTCTGTTCAGTCTTTGTCTACAAATGGTGCAAACCAGGACGTC GTCTCTATGGGTACAATTGCTGCAAGGAGGGCAAGAGCACAGTTGTTGCC ATTGTCACAAATTCAAGCAATTTTAGCTTTGGCTTTGGCACAGGCTATGGA CTTGTTAGACGATCCAGAGGGTCAAGCAGGTTGGTCTTTGACTGCTAGGGA CTTGAGGGACAGAATAAGGGCAGTCTCTCCAGGATTGAGAGCTGACAGAC CTTTGGCTGGTCACATTGAGGCTGTCGCACAAGGTTTGAGACATCCATCTG CTGCAGCTGATCCACCAGCTTAA

coC3H ATGTCTTGGTTTTTAATTGCAGTTGCAACTATAGCTGCAGTTGTTTCTTATA
AATTGATTCAAAGATTGAGGTACAAGTTCCCTCCAGGTCCATCACCAAAAC
CAATTGTTGGTAATTTATACGATATTAAACCAGTCAGATTTAGATGTTACT
ATGAATGGGCACAATCTTATGGTCCTATTATTTCAGTTTGGATTGGTTCTAT
TTTGAATGTCGTTGTTTCATCTGCAGAATTGGCAAAGGAGGTCTTGAAGGA
GCACGACCAAAAGTTGGCTGACAGGCACAGGAACAGATCTACTGAAGCTT
TTTCTAGAAATGGTCAAGATTTGATATGGGCTGACTACGGTCCACATTACG
TTAAAGTTAGAAAAGTTTGTACATTGGAATTATTCACACCAAAGAGATTAG
AATCTTTGAGACCAATTAGAGAGGACGAGGTCACTGCTATGGTTGAGTCT
GTCTTCAGAGATTGTAATTTGCCAGAAAATAGAGCTAAAGGATTACAATT
GAGAAAGTATTTAGGTGCTGTTGCATTCAATAATATTACTAGATTGGCTTT
CGGTAAGAGGTTCATGAATGCTGAGGGTGTTGTCGACGAACAGGGTTTGG
AATTCAAGGCTATTGTTTCTAATGGTTTAAAATTAGGTGCTTCTTTGTCTAT
TGCTGAGCATATTCCATGGTTGAGGTGGATGTTCCCAGCTGATGAGAAGGC
ATTCGCAGAACACGGTGCTAGGAGAGACAGATTGACAAGAGCAATTATGG
AGGAACATACTTTGGCTAGACAAAAATCATCTGGTGCAAAACAACATTTC
GTTGATGCTTTGTTGACTTTGAAAGATCAATATGATTTGTCAGAAGATACT
ATTATTGGTTTATTATGGGATATGATTACTGCTGGTATGGATACTACAGCT
ATTACAGCTGAATGGGCTATGGCTGAAATGATTAAAAATCCAAGAGTCCA
ACAAAAAGTCCAAGAGGAGTTCGATAGAGTCGTCGGTTTGGACAGAATTT
TAACAGAAGCTGACTTTTCTAGATTACCATATTTGCAGTGCGTTGTTAAGG
AATCATTTAGGTTGCACCCTCCAACACCATTGATGTTGCCACATAGATCTA
ATGCTGATGTTAAAATTGGTGGTTACGATATTCCAAAAGGTTCTAACGTCC
ATGTCAATGTCTGGGCTGTTGCTAGGGATCCAGCTGTTTGGAAGAACCCAT
TCGAATTTAGGCCAGAAAGGTTCTTGGAGGAAGACGTTGACATGAAGGGT
CACGACTTCAGATTGTTGCCTTTCGGTGCAGGTAGAAGGGTTTGCCCAGGT
GCACAATTGGGTATTAACTTGGTTACTTCTATGATGTCACACTTATTGCATC
ATTTCGTTTGGACTCCTCCACAGGGTACTAAGCCAGAAGAAATTGATATGT
CTGAAAATCCTGGTTTGGTCACATATATGAGAACACCAGTTCAGGCTGTTG
CTACTCCAAGATTGCCATCTGATTTATATAAAAGGGTTCCATATGATATGT
AA

coCPR1 ATGACTTCAGCTTTGTACGCATCAGATTTGTTTAAGCAATTGAAATCAATT
ATGGGTACTGATTCATTGTCAGATGACGTTGTTTTGGTTATTGCTACTACTT
CTTTAGCTTTGGTTGCAGGTTTTGTTGTTTTGTTGTGGAAAAAGACTACTGC
TGATAGATCTGGTGAGTTGAAGCCATTGATGATACCAAAGTCTTTAATGGC
TAAAGATGAAGACGATGACTTGGATTTGGGTTCTGGTAAAACAAGAGTTT
CTATATTCTTCGGTACTCAAACTGGTACTGCTGAGGGTTTCGCAAAGGCAT
TGTCTGAGGAGATAAAAGCTAGATATGAAAAAGCTGCTGTTAAGGTTATT
GATTTGGATGATTATGCAGCTGATGACGATCAATATGAGGAAAAATTGAA
AAAAGAAACATTGGCTTTTTTCTGTGTTGCTACTTACGGTGACGGTGAGCC
AACTGATAACGCTGCAAGATTCTATAAGTGGTTTACAGAAGAGAATGAAA
GAGATATTAAGTTACAACAATTAGCTTACGGTGTTTTTGCATTGGGTAATA
GACAATACGAACATTTTAATAAAATTGGTATTGTCTTAGATGAGGAGTTGT
GTAAAAAGGGTGCTAAGAGATTGATTGAGGTTGGTTTAGGTGATGATGAT
CAGTCTATAGAAGATGATTTCAATGCTTGGAAAGAATCTTTGTGGTCTGAA
TTGGATAAGTTGTTGAAGGATGAAGATGACAAATCTGTTGCTACACCATAT
ACAGCTGTCATTCCAGAATACAGGGTCGTCACACACGATCCAAGGTTTAC
AACACAAAAGTCTATGGAATCTAATGTCGCTAATGGTAATACAACTATTG
ACATTCATCATCCTTGTAGAGTTGATGTTGCTGTTCAAAAGGAATTGCATA
CTCATGAATCTGATAGATCTTGTATTCATTTGGAGTTCGATATTTCAAGGA
CAGGTATAACATACGAAACTGGTGACCACGTCGGAGTTTACGCAGAAAAT
CATGTTGAAATTGTTGAGGAAGCTGGTAAATTGTTAGGTCATTCATTAGAT
TTAGTCTTTTCAATTCACGCTGACAAGGAGGACGGTTCTCCATTGGAATCA
GCTGTTCCTCCTCCATTCCCAGGTCCATGTACTTTGGGTACTGGTTTGGCAA
GATACGCTGACTTGTTGAATCCACCAAGGAAGTCTGCTTTGGTTGCTTTGG
CAGCTTATGCTACTGAACCATCTGAGGCAGAAAAGTTGAAACATTTAACA
TCTCCAGATGGTAAGGATGAATACTCACAATGGATTGTTGCTTCTCAAAGG
TCTTTGTTGGAAGTCATGGCAGCTTTCCCATCTGCTAAGCCACCATTGGGA
GTCTTCTTTGCTGCTATTGCACCTAGGTTACAACCAAGATATTATTCTATTT
CTTCTTCACCAAGATTGGCTCCTTCTAGGGTCCATGTTACTTCTGCTTTGGT
CTACGGTCCAACTCCAACTGGTAGGATTCACAAGGGTGTCTGTTCAACTTG
GATGAAGAACGCAGTCCCTGCAGAGAAGTCTCATGAGTGCTCTGGTGCTC
CAATATTTATAAGAGCATCAAACTTTAAATTACCATCTAACCCTTCTACTC
CAATTGTTATGGTCGGACCAGGAACAGGTTTAGCTCCATTCAGAGGTTTCT
TGCAAGAGAGAATGGCTTTGAAAGAAGATGGTGAAGAATTGGGATCATCT
TTGTTGTTCTTTGGTTGTAGAAATAGACAAATGGACTTCATTTACGAAGAC
GAATTGAATAATTTCGTTGACCAAGGTGTTATTTCTGAGTTAATTATGGCT
TTCTCTAGGGAAGGTGCTCAGAAGGAATATGTCCAGCACAAGATGATGGA
GAAGGCTGCACAAGTTTGGGACTTAATTAAAGAAGAAGGTTATTTGTATG
TTTGCGGTGATGCTAAGGGAATGGCTAGGGATGTCCACAGAACTTTGCAT
ACTATTGTCCAGGAGCAGGAGGGTGTCTCATCTTCAGAAGCTGAAGCTATT
GTTAAGAAATTACAAACTGAGGGTAGATACTTGAGAGATGTTTGGTAA

coCPR2 ATGTCTTCTTCATCTTCTTCATCAACTTCAATGATTGATTTGATGGCAGCTA
TTATTAAGGGTGAACCAGTTATTGTCTCTGACCCAGCAAACGCTTCAGCTT
ACGAGTCTGTTGCTGCAGAATTATCTTCTATGTTGATAGAGAATAGACAAT
TTGCTATGATTGTTACTACTTCTATTGCTGTTTTAATTGGTTGTATTGTTATG
TTGGTCTGGAGAAGATCAGGTTCTGGTAACTCTAAAAGGGTTGAACCATTG
AAGCCATTGGTCATAAAGCCAAGGGAGGAGGAGATTGACGATGGTAGAA
AAAAGGTCACAATATTCTTCGGTACACAGACAGGAACTGCTGAGGGTTTT
GCTAAGGCTTTGGGAGAGGAAGCTAAGGCTAGGTATGAAAAAACTAGATT
TAAGATTGTCGACTTAGACGATTACGCAGCTGATGACGACGAGTACGAAG
AAAAGTTGAAGAAAGAAGATGTTGCATTTTTCTTTTTGGCTACATATGGTG
ACGGAGAGCCAACTGACAATGCTGCTAGATTCTATAAGTGGTTCACAGAA
GGTAATGATAGAGGTGAATGGTTAAAGAATTTGAAGTACGGTGTCTTCGG
TTTAGGAAATAGGCAATATGAACATTTCAATAAGGTCGCTAAAGTCGTTG
ATGATATTTTGGTTGAGCAAGGAGCTCAGAGGTTGGTTCAAGTCGGTTTGG
GAGACGACGACCAATGTATTGAAGACGACTTTACTGCTTGGAGGGAGGCT
TTGTGGCCAGAATTGGACACTATTTTGAGAGAGGAGGGTGACACTGCTGT
CGCTACTCCTTACACAGCTGCTGTCTTGGAGTACAGGGTCTCAATTCACGA
TTCAGAAGACGCAAAGTTTAACGATATAAATATGGCTAACGGTAACGGTT
ACACAGTCTTCGACGCTCAGCACCCATACAAGGCTAACGTCGCAGTCAAG
AGAGAATTGCATACTCCAGAATCTGATAGATCATGCATACATTTAGAATTC
GATATTGCAGGTTCAGGTTTGACATACGAAACAGGTGACCACGTCGGTGTT
TTGTGCGACAATTTGTCTGAAACTGTTGATGAAGCTTTAAGATTATTGGAT
ATGTCTCCAGATACATACTTCTCTTTGCATGCAGAAAAAGAGGATGGTACT
CCAATTTCTTCTTCATTGCCTCCTCCATTCCCTCCATGCAACTTGAGGACAG
CATTGACTAGATACGCATGTTTGTTGTCTTCTCCTAAAAAATCTGCTTTGGT
TGCATTAGCTGCACACGCTTCTGACCCAACTGAGGCTGAGAGGTTGAAAC
ACTTGGCTTCACCAGCTGGAAAGGTCGATGAATATTCTAAATGGGTCGTTG
AATCTCAAAGATCTTTGTTGGAGGTTATGGCTGAGTTCCCATCAGCTAAGC
CACCATTGGGTGTCTTCTTCGCTGGAGTTGCACCAAGGTTGCAGCCTAGAT
TCTATTCTATTTCTTCTTCACCAAAAATTGCAGAAACAAGAATTCACGTCA
CTTGTGCATTGGTTTATGAGAAGATGCCAACTGGTAGAATTCACAAAGGTG
TTTGTTCTACTTGGATGAAGAATGCTGTTCCATACGAAAAATCAGAAAATT
GTTCATCTGCTCCAATTTTTGTTAGGCAATCAAATTTTAAATTGCCTTCAGA
CTCTAAAGTTCCTATTATAATGATTGGTCCTGGTACTGGTTTGGCACCATTT
AGAGGTTTTTTGCAGGAAAGATTGGCATTGGTCGAGTCTGGTGTCGAGTTG
GGTCCTTCTGTTTTGTTCTTCGGTTGTAGAAATAGAAGAATGGATTTCATTT
ACGAAGAAGAATTACAAAGATTTGTCGAATCTGGTGCATTAGCAGAATTG
TCTGTTGCATTCTCAAGGGAGGGTCCAACAAAGGAATATGTTCAGCATAA
AATGATGGATAAAGCTTCTGATATTTGGAACATGATTTCTCAAGGAGCTTA
TTTGTACGTCTGCGGAGACGCAAAGGGTATGGCAAGAGATGTCCATAGAT
CTTTGCACACAATTGCTCAAGAGCAAGGTTCTATGGACTCTACTAAAGCTG
AAGGATTTGTTAAAAATTTACAAACATCTGGTAGATATTTAAGAGACGTTT
GGTAA

Table S2. Primers Used for the Construction of Plasmids and Strains

primers	sequences (5'-3')	applications
Construction of plasmids		
1	CAAGGAAGTAATTATCTACTTTTTACAACAAATATAAAACAAGGATCCGCCACCATGACTTTGCAATCACAGACTG	Amplify *coTAL* cassette for pLC-c1 construction from *coTAL* fragment synthesized by Gene Art, forward primer
2	GTTCCATGTCGACGCCCGGGCCCTATAGTGAGTCGTATTACGGATCCTTAAGCTGGTGGATCAGCTG	Amplify *coTAL* cassette for pLC-c1 construction from *coTAL* fragment synthesized by Gene Art, reverse primer
3	CAAGGAAGTAATTATCTACTTTTTACAACAAATATAAAACAAGGATCCATGTCTTGGTTTTTAATTGCAGTTG	Amplify *coC3H* cassette for pLC-c2 construction from *coC3H* fragment synthesized by Gene Art, forward primer
4	GTTCCATGTCGACGCCCGGGCCCTATAGTGAGTCGTATTACGGATCCTTACATATCATATGGAACCC	Amplify *coC3H* cassette for pLC-c2 construction from *coC3H* fragment synthesized by Gene Art, reverse primer
5	GCAATCTAATCTAAGTTTTAATTACAAGCGGCCGCATGACTTCAGCTTTGTACGCATC	Amplify *coCPR1* cassette for pLC-c3 construction from *coCPR1* fragment synthesized by Gene Art, forward primer
6	CGTCATCCTTGTAATCCATCGATACTAGTGCGGCCGCTTACCAAACATCTCTCAAGTATC	Amplify *coCPR1* cassette for pLC-c3 construction from *coCPR1* fragment synthesized by Gene Art, reverse primer
7	GCAATCTAATCTAAGTTTTAATTACAAGCGGCCGCATGTCTTCTTCATCTTCTTCATC	Amplify *coCPR2* cassette for pLC-c4 construction from *coCPR2* fragment synthesized by Gene Art, forward primer
8	CGTCATCCTTGTAATCCATCGATACTAGTGCGGCCGCTTACCAAACGTCTCTTAAATATCTAC	Amplify *coCPR2* cassette for pLC-c4 construction from *coCPR2* fragment synthesized by Gene Art, reverse primer
Replacing *ARO10* with P_{PGK1}-*ARO7*^{fbr}-T_{CYC1} cassette		
9	CCTCTTCTTCTTGTGTGTTTAAGC	Amplify *ARO10* upstream homologous region for *ARO7*^{fbr} overexpression and *ARO10* deletion from *S. cerevisiae* genome, forward primer.
10	CGACCTGCAGCGTACGAAGCTTCAGCTGGCTTAAGGGAGTTTCTTTGTTATCTTG	Amplify *ARO10* upstream homologous region for *ARO7*^{fbr} overexpression and *ARO10* deletion from *S. cerevisiae* genome, reverse primer.
11	CAAGATAACAAAGAAACTCCCTTAAGCCAGCTGAAGCTTCGTACGCTGCAGGTCG	Amplify *URA3* selection marker for *ARO7*^{fbr} overexpression and *ARO10* deletion from pUG72, forward primer.

12	GATAAGACCCCATTCTTTGAAGGTACTTCCCGGCCGCATAGGCCACTAGTGGATCTG	Amplify *URA3* selection marker for *ARO7^{fbr}* overexpression and *ARO10* deletion from pUG72, reverse primer.
13	CAGATCCACTAGTGGCCTATGCGGCCGGGAAGTACCTTCAAAGAATGGGGTCTTATC	Amplify P_{PGK1}- *ARO7^{fbr}* -T_{CYC1} cassette for *ARO7^{fbr}* overexpression and *ARO10* deletion from pLC-m1, forward primer.
14	CACACGATAGGAATGACAGAAAAAAGCTTCGAGCGTCCCAAAACCTTCTCAAGC	Amplify P_{PGK1}- *ARO7^{fbr}* -T_{CYC1} cassette for *ARO7^{fbr}* overexpression and *ARO10* deletion from pLC-m1, reverse primer.
15	GCTTGAGAAGGTTTTGGGACGCTCGAAGCTTTTTTCTGTCATTCCTATCGTGTG	Amplify *ARO10* downstream homologous region for *ARO7^{fbr}* overexpression and *ARO10* deletion from *S. cerevisiae* genome, forward primer.
16	CGAAGTATTTCGGACTCTTTCTTC	Amplify *ARO10* downstream homologous region for *ARO7^{fbr}* overexpression and *ARO10* deletion from *S. cerevisiae* genome, reverse primer.

Replacing *PDC5* with P_{TEF1}-*ARO4^{fbr}*-T_{ADH1} cassette

17	GTTGAAAATGACGACGAGCCTG	Amplify *PDC5* upstream homologous region for *ARO4^{fbr}* overexpression and *ARO10* deletion from *S. cerevisiae* genome, forward primer.
18	CGACCTGCAGCGTACGAAGCTTCAGCTGGTGTAATAAGAAAGAGAGGAAAGGAC	Amplify *PDC5* upstream homologous region for *ARO4^{fbr}* overexpression and *ARO10* deletion from *S. cerevisiae* genome, reverse primer.
19	GTCCTTTCCTCTCTTTCTTATTACACCAGCTGAAGCTTCGTACGCTGCAGGTCG	Amplify *URA3* selection marker for *ARO4^{fbr}* overexpression and *PDC5* deletion from pUG72, forward primer.
20	GCTTTCTCAGGTATAGCATGAGGTCGCTCCGGCCGCATAGGCCACTAGTGGATCTG	Amplify *URA3* selection marker for *ARO4^{fbr}* overexpression and *PDC5* deletion from pUG72, reverse primer.
21	CAGATCCACTAGTGGCCTATGCGGCCGGAGCGACCTCATGCTATACCTGAGAAAGC	Amplify P_{TEF1}- *ARO4^{fbr}* -T_{ADH1} cassette for *ARO7^{fbr}* overexpression and *ARO10* deletion from pLC-m1, forward primer.
22	CCTAAACATCTATAACCTTCAAAAGGCACACACCATAGCTTCAAAATGTTTCTAC	Amplify P_{TEF1}- *ARO4^{fbr}* -T_{ADH1} cassette for *ARO7^{fbr}* overexpression and *ARO10* deletion from pLC-m1, reverse primer.
23	GTAGAAACATTTTGAAGCTATGGTGTGTGCCTTTTGAAGGTTATAGATGTTTAGG	Amplify *PDC5* downstream homologous region for *ARO4^{fbr}* overexpression and *PDC5* deletion from *S. cerevisiae* genome, forward primer.

24	CTCTTGCTTGTTCGGAGTTC	Amplify *PDC5* downstream homologous region for *ARO4*^{fbr} overexpression and *PDC5* deletion from *S. cerevisiae* genome, reverse primer.

Table S3. Primers Used for Real-time Quantitative PCR

primers	sequences (5'-3')	applications
1	GTGAACAATTACACAGCTCCTATAG	Amplify partial cDNA of *S. cerevisiae ALG9* gene for real-time PCR, forward primer.
2	CCTATGATTATCTGGCAGCAGGAAAG	Amplify partial cDNA of *S. cerevisiae ALG9* gene for real-time PCR, reverse primer.
3	CGCTAACGGTGAAAACGCCATTACC	Amplify partial cDNA of *S. cerevisiae ARO4* gene for real-time PCR, forward primer.
4	CGTCTTCAGTAGTTTCCCAACCTATAC	Amplify partial cDNA of *S. cerevisiae ARO4* gene for real-time PCR, reverse primer.
5	GAGAGGTCGCATTTCGCCACATG	Amplify partial cDNA of *S. cerevisiae ARO7* gene for real-time PCR, forward primer.
6	CAGGTGATTCGAATCTTCTGATGCG	Amplify partial cDNA of *S. cerevisiae ARO7* gene for real-time PCR, reverse primer.