Electronic Supplementary Information

Advances in Bio-nylon 5X: Discovery of New Lysine Decarboxylases

for High-Level Production of Cadaverine

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11 9	11	10	10 1	11 16	18	8	9 1	3 15	5 14	14	13 1	6 15	5 20	16	15	6 13	12	15	16 1	16 17	18	15	8	11 9	9 8	7	11	17 12	12	15	3 15	16	12 15	22	22 15	á 18	17	21 1	11 27	28	33	34 32	aaa	46
49 1	1 12	12	11 1	11 13	16	9	8 11	5 14	1 14	15	14 1	2 12	2 15	12	12	7 12	12	14	12 1	15 15	12	14	0	9 0	0 9	11	11	17 12	12	12 1	0 10	12	10 11	20	22 11	16	10	10	12 20	24	20	22 20	46	

Fig S1 Muscle alignment of the highest scoring sequence in each PPR group. The percent identity matrix in each comparison. First row and column are group numbers. The

100 % id in the diagonal of the map was substituted by the letters "aaa"



Fig S2 Phylogenic analyses of the lysine decarboxylases with the highest score from 57 PPR groups, the enzymes are indicated by the name of the organism they are derived from

Edwardstella WP 005282982 1	MNTIAILNHMGVYFKEEPIRELHKALEAONFOIVYPND	38	CHATAMETVOWY APACST MTDRWOM SITH MMMSDVTPTY FRPTRWAYGTLOGTPKS	278 IDEAKCWNLDPKESWHGEKDIDENHMELDPIKVILLTPOMKEDGIMADIGIPASIVAKYL	518	ADGRYTVKVLKTEOK-	714
Hafnia WP 025800207 1	MNTTATINHMGVYFKERPTRELHKALEALDROTVYPND	38	CITCLANKEV CAPACSTVI TERNITAGUI THI MIMISDUTTETVERPTRNAVCTI CCTPKS	278 TDEAKCWPI DSKUSWIGEKUTUNDHWYI DETKVTI I TEGMOKUGSMADIGIPASIVSKYI.	518	ADGRYTVKVTKDOK	713
Serratia WP 020828344 1	MNVTATMNHMGVYFKEEPTRELHKALESLDERVVYPND	38	CTICTANKEV CAPACISTVI TERNENSET THE MAMSENT PETER RATE OF COLORED	278 TDOARCWPLKSDNAWHGEKNTDDEHMYLDPTKVTLLTPGMSKEGEMOREGTPASLVAKYL	518	ADGRYTVKVLKNDK	713
ProteobacteriaWP_001295383_1		38	CITETANKI VCMV CAPACISTI I TRENDARI THI MMMSDVTPTVRPTRNAVCII CCIPOS	278 IDTTECWPIRSDSTWHGENNIDNEHMYIDPTKVTUTTECMEKDGTMSDEGTPASTVAKYI	518	ADGRYTVKVLKEESKK	715
E coli WP 001388778 1	MUTTATI NHMGVYEKEPTREI HRAI ERI NEOTVYEND	38	CITETA METICAL CONTRACT TO DESCRIPTION OF A DESCRIPTION O	278 TETTERWEI RSESTWIGERUTENERWEI DETKUTI I TEGNERGENSDEGTEASTVARVI	518	ADGRYTVKVI KEESKK	715
Klobelolla WP 005123082 1		38	CITETA MARTING AVE AD ACCTUTET DEMONSTRATE TATALANDED TO TATALANDA CITECTION	270 TECARCORD REDSOLUTION RATE AND THE TRANSMITTED THE TRANSMITTED AND THE TRANSMITTED TO THE TO THE TO THE TRANSMITTED TO THE TO THE TRANSMITTED TO THE TRANSMITTED TO THE T	519	ADGRYTVEVI KEENNK	715
Salmonolla WP_001100654_1	WNVTATMINHWGVYFEREPTERI WRAI RGI NERTVYPND	38	THE INDERVIEW ADARSTVICED THE AND STATES THE AND STATES TO A STATES TO A STATES TO A STATES THE ADARSTVICE ADARSTVIC	270 TROADCHT LEODORHOF RATERED INTEDITION ADOTHED FOR	518	ANGRYTVKVI KENTK-	714
Vibrio WP 001220857 1	MAT UT I TUOCTESARERI CHUONNTEATI NHMCUREVERPUROI VAAI EVACUDUUVPUD	60	CHARLEY AND A REAL OF THE DESCRIPTION OF THE REAL PROPERTY AND A COLORED AND A COL	210 IDORECHTERSDORMOTRAIDRENHTEDTIKVIIIITOMRADOTMDEFOITROEVARIE 200 IETTECHVIDENODWACEVAI DENAMVIDETKTIITECHSADOTMDEFOITROEVARIE	540	OKDOSYTVKVI KD	733
Acromonac WP 060526364 1	INTERVENTION OF THE OF	20	THE ISTER VOIL SHE AS A CONTRACT THE INTERPOLATION OF THE INFORMATION OF THE TRACT CONTRACT OF THE INTERPOLATION O	000 TETTEORGEDT NOD INTERADORIALI DE TRETELITORIS CONCELES SOLTAS ASSAULTS	E10	ONDOSTIVINI P	710
Aeromonas nr_008526204.1	MALLALLAND YF FREE IND ASSESSMENT FY II YD	30	MIDIRARLAGHIJAR AGASTALADRAGHIGILIALMIMINDALLILUKALARLAGHIGS		510	WADOSITYKYLK	110
	****.**.**.**.*.*.*.*.*.*.*.		Possible PLP binding sites	*, ,,** * ,, ******,,*,,**,*****,*,***** ,,* , , ******		* .* *****	
Edwardstellawp 005282982 1	REDUCKTEDWINARI OGVERDWITTYNI DI ORDESEMNEHI PVYAFANTHSTUDVSUSDURI.	98	FRARETTERRYKNTPNATWPVHAVATWSTYDCI RYNARYTKKTI DVKSTHRI GAWVPYTN	338 DEMOTIVENT OP VALUE EN EST GED KEKAMSLURGETDE KRAVDENT RVKNMEPSLYREDP	578	1	
HafniaWP 025800207 1	REDITING THROWARD CONTROL TO THE SAME AND THE PARAMETERS IN THE RESEARCE AND THE RESEARCE A	98	FROMDTTAFRYAOTPNATWPVWAVWTVSTVDCI I VNTDVTKRAI DVKSTNTSAWPVTN	338 DENGEDVENTGPYNT I ET ESTGEDETEAT SUT RAT TEERSYDT NI RVENNT PSI VREDP	578	2	
Serratiawp 020828344 1	REDITED ANALOSO FI DEDITALDO DE LOGARENA FIA ANTISTED OLIDERE	08	FRADITARDAR STINATED VALUE AND TARDARD FRADITARDARD FRADITARDARD FRADITARDARD FRADITARD FRADIT	220 DERGEDURET OF TREAT IS STOLDED AND ALL DER THE REST OF THE READ	578	2	
ProtochactoriowP_001205292_1	PDDII VITENNARIOSOVITENENTALESSEETSELAETALEITA PATTISTESVSEADERA	00	PROVATE A VOIVETONA THOUSING AND A VIEW AND A VIEW AND A VOIVET AND A VOIVETONA AND A VIEW AND A VI	200 DEMOTING THE PARTY AND	579	2	
E coliwp 001388778 1	RODLIALI BARRELOVIT DI DRI REBOELI SUBRERLI LI RERATISTEDVSLADERE PDDI I VI TENNA RI CONTERMORVATERI CERTSUNARALI LI RERATISTEDVSLADERE	08	FRATIARY ALTERATORY INSTITUTION DELIGITIES AND	330 DEMOLUTERATOR FREE LESIGIDATION COLLARD DE ALARTARIA SUI ALI SUI A	578	2	
Klobslollawp.0051000000 1	PDDIIVITENNEN CONTENNEN EIGERSUNEVEN VARANTVETIDISI DI	00	PROVATE A DRIVETONA THOMAS IN DOLLAND FIRM DO AND	200 DEMONIVERIOUTINE ENGLOSION PRODUCTION DEMONSTRATINE SUITED	579	2	
Column 10 WP 001100654 1	REDILIZITERRORDOVITERRORDI AL CERTON MENDI VARANCVOTI DICI MI DI	00	EFGUALTARAYSEITRAINTYJAYTINSIIDULLINIDTIKKILDYKSTUUTAANNYTIIN	200 DERCHARTCOLINELE LE STOTDET RALLED ET RALLEDER RAME SUITEDI	E70	5	
Salmonella #1_001100654.1	NEDELECTERNORD-CONTENENT OF CENTERIARE INFLINT OF AND OF THE AND	30	ELGURITERULANEDCYCYDCA YALINGIADUL AMADALADCI PUANTATATATATATATA	350 DERGINARI OF FREEFERSTOIDER RESILERED FERREF DERERVERTER REFERENCES	600		
VID/IO #F_001229051.1	DEDITION TRANSPORTED ADVISED OF CARTADONISM DESCRIPTION OF THE DEDITION OF THE DESCRIPTION OF THE DESCRIPTIO	120	EFSREVIAERVANIFGASAFSIAVIINSIIDGLLINIQFIRESLDCARLARIANVFIIN	200 DEPONDER OF INTELEDICTOCKYNOLIDYL ABBADCADIAL ALMALI BELABAD	600 E70	5	
Aeromonas nr_009520204. 1	VADILALIEAN AVUGALFDADALISUGULEIADANEALFIFAFANDQSILDIALIDLAL	30	ELSUDITARYARILOWARUNAAINSIIDOTTUIOLIVESTDILITUUTANALILU	330 DEROPHERIOFINELELESIGIDESIAMULLIALIEERROIDLELIIRAILESLIREDE	510	6	
	:*:*: * *:::****:*:* **: * **: * **: * **: *:*:		** ; ,* ;* **,* * ;**;*******;**; ,**;;** ********	Possible substrate binding site			
Edwardatella WP 005292092 1	MURRERVAL CAAPRTAL PTROCTRAVIDETI DEI TEAL DIVIDECEVATECTECHICCTAR	150	PORTAVAL CONCERNING CONTRACTOR DATE IN A POOL CHITURY CRITERING ADMINIST	200 PRVPUNDTOPI ACCTVAL TOMAN PDI NVDAPDUJ PTNUNUPUNAPONEL PCOTERIUSI P	6.20	5	
Lafaia WP 02500207 1	NYEFFEIRDIRALELINGSIDRIYDELLFFLIRRENIYREORIIFOIFONNOOIRF NYEFFEIRDIRALELINGSIDRIYDELLFFLIRRENIYREORIIFOIFONNOOIRF	150	PSPTYNCICCNCCCDD72C97717270C704 IAA7C0ACMT777C01782272372470001	330 EF IERMELQELAQUIALIQUUALI DEMI DATEVILI IMVMATINA AROVEL ROOTERIVI P	6.20	5	
Hainia #r_025000201.1	NYEFFEIRUSRAUUIAUNINUSIDAIIDEILFFLIRALFNIYAEGAIIFUIFGMMGGIAF	150	PSFILKGLOGSGGAVEGAVITELGAVITELGATATIAARSGASMIAVAGUINEETFNEMININIS	300 ELIENMUTANTAVATAVATAVATANTA DI NADADALA ATTIMANALAVALAVATASAANA A	600	5	
Serrallanr_020020344.1	QVAFFEIALJAAIDIAALIQUIDEIIDIILFFLIAALFAIVAEGAIIFCIFGAAGGIAF	150	PARTINGALOWSOURVEURVITEIGUITVIIKARSUKARSULAVAUDINEETPREMININII	350 EFIERMELQULAQUITALYYEARLFDLMIAAFEYLFILYMMIFRAAQAELAUEYILE	0.00	5	
Proteobacteriam_001295363.1	QISPPETALGAAEDIANKINQIIDEIINIILPPLINALPKIVREGKIIPUIPGMGGIAP	150	PSPITEGRUGASGGRVEGRVITETGGTTALLARPSGRSMITARGDVNEETPNEATMM/III	330 EFTERMALQELAQUIALLYAANLEDLATAFEYLETMYMTETAAFQAELAGMIEEYTLD	0.00	1	
E.CO//WP_001388118.1	QISFFETALGAAEDIANKINQIIDETINIILPPLIKALFKIVKEGKIIFUIPGHMGGIAF	158	PSPITEGRUGMSGGRVEGRVITETGSTPREITALIAAPSGASMIHVRGDVNEETFNEATMMHII	398 EFTENMELQELAQNIALLYAANLFDLMIKAFEVLFTMVMTFTAAFQEELAGMTEEVTLD	0.00	2	
Kiedsiella wr_095123982.1	QVKFFETALJAAEDIANKINQNIDETIDTILFFLIKALFKIVKEGKIIFUIFGHMGGTAF	158	PSPIIEGRUOMSGGRVEGRVIIEIGSUPPLIAAPSGASMIRVRGDVNEEIPREAIMMRII	336 EFTEMMELQULAQNINELVENNELDIMFRAFEVILFSMYMTFTAAFQEELOQTEEVILE	0.00	1	
Salmonella Wr_001100654.1	QVRFFETALGAAADIAAKIRQNTDETIDNILPPLTKALFKTVREGKTTFUTPGHMGGTAF	158	PSPITQGRUGMSGDRVEGRITTETGSTPPTIAAPSGASMIHVRGDINEETFNEATMMHII	398 EFTENMELQELAQNIALVERANLPDIMTKAFEVILFIMVMTFTTAFQEELEVILE	6.30	1	
Vibrio WP_001229857.1	NVHFFETALGMADDIAIKINQATQETKDAIMPPFTKALFKTVEEGKTTFCTPGHMGGTAF	180	FNRLTEGRUGMSGEAMPGRVFTETGSTPRLIAAFSQASMLHVRGEFDRESFNEAFMMHIB	420 AFTEGMELQELAQGIADLIKETQLPELMIKAFDVLPEMEVIPAVANQQELEGQIEEILLN	660	1	
Aeromonas WP_069526264.1	NVHFFEYRLGMADDIALKMGQATQEYQDAILPPFTKALFKYVEEGKYTFCTPGHMGGTAF	158	FSPITEGRUGMSGEAMPGRVFTETG <mark>EITHE</mark> LLAAFSQASMIHIRGDVEEETFNEAFMIHIS	398 SFTEGMRLQELAQSINDLTUKTRLPELMFKAFDVLPEMNMTPHAAWQQELAGNLEEVPLR	638	έ.	
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Hafniawa oorooooo 1	QRSFYGSLFIDFIGANAMKSDISISYSELGSLIDAIGFAREAEEIIAKIFNAERSIMVIN	210	ISENTATIVA PROTETA A ANNUALIZATIVA TALACTERATOR DEPUTATIVA VERCEAMERDIMODEC	400 EMIGRAMAMILETTTGALLAMIGEMETEESETATETOMICETOMITGETTTGALA	600	5	
Sorratiawn cooccocci i	QKSPVGSIFTDFFGANAMKSDISISWGELGSLILHSGPHREAEETIAKIFNAEKSIMVIN	218	ISTRICTIVATION AND A ANNUAL AND AND A DESTRICTED A TREDUCTION AND A DESCRIPTION OF AN AND A DESCRIPTION AND A DESCRIPTIO	456 EMIGRAMANMILLEIFEGAFLAMEGEMLIEESREALEESREALGETCAMARETTTAGAIR	030	5	
Drotoobootorigup corectoria	QKSPVGSLFIDFFGANAMKSDISISVSELGSLILATGPAREAEEIIAKVFNAEKSIMVIN	218	ISTRICTIVE TALLARMING MACHILINDSILERAL REFRELIQUAY ESECUTED AND DATE	400 DMYGAYNAMMILFIFFGYFLYMFGEMLIEESAFYLEFLQMLLEIGAAIFGFEIDIAGAIA	030		
FIOLEODACIENAWP_001295383.1	QKSPVGSLFTDFFGPNTMKSDLS1SVSELGSLLLHSGPHKEAEQTLAKVFNADKSTMVTN	218	ISPATOLYADI BIAAAMMKONAGKALINGSI EKALKPKKEIKKEKI ESDG#PPDY#QPDA	455 EMVGRINANMILFIFFGVFLVMFGEMITEESRFVLEFLQMILEIGAAIFGFEIDIAGAIR	030	1	
Klobslollawn contractors i	QKSFVGSLFTDFFGFNIMKSDISTSVSELGSLIDHSGPHKEAEQTIARVFNADRSIMVIN	218	ISPATICIAN ADILE HARAMMAGRAGARILINGSI EKAIKPKEIKKLKI ESUGWFFUWUPUH	400 EMVGRINARMILETTEGVELVMEGEMITESSKEVLEFLQMLLEIGARTEGFEIDIRGAIK	698	1	
Nebsiena WP_095123982.1	QKSPVGSTFTDFFGSNIMKSDLSTSWSELGSLTDHSGPHKEAEEYIARVFNAERSYMVIN	218	ISPATOLVADI BIAAAMMKGNAGKELLDGSIEKSIKFKKEIKKLKGESEGWFFDVWQPER	458 EMVGKVNANMILFIFFGVFLVMFGEMITEESKFVLEFLQMLGEIGARTFGFETDIRGATK	698	1	
Saimonella WP_001100654.1	QKSPVGS1FTDFFGPNTMKSD1S1SWSELGSLIDHSGPHKEAEEYIARVFNAERSYMVTN	218	15PATQUVADI BIJAAAMMKGNAGKMLINGSTERAIKFRKEIKRLKSESDGWFFDVWQPER	458 EMVGKVNANMILFIFFGVFLVMFGEMITEESRFVLEFLQMLCEIGAHTFGFETDINGATR	698	1	
VIDTIOWP_001229857.1	QKSPVGS1FTDFTGPNTFKADVSISMPELGSLIDHSGPHKEAEEYIARTFNADASYIVTN	240	15PQTQ1VADIR HAAAMMRGNTGRNLMQDS1DKALKFKKE1KKLKGESEGWFFDVWQPEN	480 EMVGRVSARMILLTIPTGVPLVLPGEMVTDSSRPVLDFLEMLCEIGARTPGFETDIRGLTR	720	1	
Aeromonas WP_069526264.1	QMSPAGSIFIDFIGPNAFKADVSISMPELGSLIDHSGPHKEAEEYIARTFNADRSYIVIN	218	15PQTQTVADIRUSAAMMKGNTGKHLIKUSIDRAISFRKEIKRLRDQSEGWFFDVWQPDN	458 DMVDRISANMILFIFFGVFLVLFGEMVIQDSLFVLEFLEMLCEIGARYPGFETDIRGLYR	698	£	
	* **:**:****:* *::*:*:*:*:***:*********		***:******	<pre>.*:.::********************************</pre>			

Homodimer interface

Fig S3 Sequences alignment of the predicted 10 lysine decarboxylases after the PPR prediction and phylogenetic analysis. The catalytic residue, possible PLP binding sites, possible substrate binding sites and homodimer interface are boxed in red, blue, pink and green color, respectively.



Fig S4 Surface analyses of the homodimer of LdcEt (A) and LdcAer (B).



Fig S5 LdcEt and LdcAer converting 1.5 M L-lysine HCl under difference buffer pH and temperature. A. LdcEt and LdcAer converting 1.5 M L-lysine HCl under difference buffer pH, the high concentration of substrate will affect the reaction pH, so the initial reaction pHs are showed in blue; B LdcEt and LdcAer converting 1.5 M L-lysine HCl under different temperature.