

The adenylate cyclase AcyA regulates development and aflatoxin biosynthesis in *Aspergillus flavus*

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15
16AcyA A.fumigatus_ 1 -----
17AcyA A.clavatus_ 1 -----
18AcyA A.niger_ 1 -----
19AcyA A.flavus_ 1 -----
20AcyA A.oryzae_ 1 -----
21AcyA A.nidulans_ 1 -----
22AcyA N.crassa_ 1 -----MTRNDG
23AcyA C.albicans_ 1 -----
24AcyA S.cerevisiae_ 1 -----
25consensus 1 -----
26
27
28AcyA A.fumigatus_ 1 -----MSLRGSENNSHRRRSSE--
29AcyA A.clavatus_ 1 -----MSMRDSQSLGRRSSE--
30AcyA A.niger_ 1 -----
31AcyA A.flavus_ 1 -----MSFQGGIPEGRRSSE--
32AcyA A.oryzae_ 1 -----MSFQGGIPEGRRSSE--
33AcyA A.nidulans_ 1 -----MAFPGGIPEGRHSSE--
34AcyA N.crassa_ 7 GSRYSIDSAQSSITAKPFPLTPTSSLGSSMTRPLSPSLQAGSSSSNGGHNVSRSASQGA
35AcyA C.albicans_ 1 -----
36AcyA S.cerevisiae_ 1 -----MSSKPDTCSEISGPQRQEE--
37consensus 61 -----
38
39
40AcyA A.fumigatus_ 17 -----SSCAHSLLSQETVREIQNPRLPYNTVLPNGRSNSPFPRSA
41AcyA A.clavatus_ 17 -----SSGKNSWLSQETVREGPSQQPLDRQAMPNGRSNSPFPGPV
42AcyA A.niger_ 1 -----
43AcyA A.flavus_ 17 -----SSGNSWLSQETVKDNQNTNRYQRNHAILNGRLISPFGFA
44AcyA A.oryzae_ 17 -----SSGNSWLSQETVKDNQNTNRYQRNHAILNGRLISPFGFA
45AcyA A.nidulans_ 17 -----SSGNSWLSQETIRDDGRR---YGRIPSGRSISPFSKDD
46AcyA N.crassa_ 67 RRPAPTRLKTDDGTQFASRSRDFESSQSQSQPSHTQTRSHSLSQATLQSCSQPQLSLNS
47AcyA C.albicans_ 1 -----
48AcyA S.cerevisiae_ 20 -----QEQQIECSSPEANDRSIHDEVKPKVKRHEQNSGHKSRNSA
49consensus 121 -----
50
51
52AcyA A.fumigatus_ 57 GLERSASQGH-----NQPRQGSSNNLYSSTFSWNSPDSPPTDQRK--GVG--RKAMA
53AcyA A.clavatus_ 57 NMERSASQGH-----RPPNMGSAANNLYASNFSWGSPDIPPTDQRK--GLGNHRKVMA
54AcyA A.niger_ 1 -----
55AcyA A.flavus_ 57 KADRSTSQGR-----KQPPTLGAHDLSTSNFTWPSPDIPPTDKRNDSGFTGHRKSSA
56AcyA A.oryzae_ 57 KADRSTSQGR-----KQPPTLGAHDLSTSNFTWPSPDIPPTDKRNDSGFTGHRKSSA
57AcyA A.nidulans_ 54 GSDRLELPAP-----RPPSLGAPNDLYTSMFSGSPDIPPTDVRKQNGFGSHRKALA
58AcyA N.crassa_ 127 QQSQSPSQYHSQQTPTQQQPQQQVSPPTGSGRLTQSPTTPSNASIREHMSSELGGYREMA
59AcyA C.albicans_ 1 -----
60AcyA S.cerevisiae_ 62 YSYYSRSLSMTKSRESITPNGMDDVISINVEHPRPTEPKIKRGYPYLLKKTLLSSLSMTSA
61consensus 181 -----
62
63
64AcyA A.fumigatus_ 105 TSGADDPGPPP-TSSSSSKQLQLN-PNQIDYFHQNPNASMSSS-----PKIAPMD
65AcyA A.clavatus_ 107 LLGNDDPGPPP-TSSSNTRSSQPNQPNQIDYFHQDPNASMSSS-----PQIAPMD
66AcyA A.niger_ 3 LLGTDPGTSP-TANSNNRPPQLN-LNPPDNFQHDAPSLASS-----PTVAPND
67AcyA A.flavus_ 109 AIGPDIPGPPP-TSSSPRISCPN-SDEVDFYQQDPNASMSSS-----PKIAPGD
68AcyA A.oryzae_ 109 AIGPDIPGPPP-TSSSPRISCPN-SDEVDFYQQDPNASMSSS-----PKIAPGD
69AcyA A.nidulans_ 106 VLGNDDPGPPP-INNFSPR---VN-TNYGDYFQHDPOGTLSSYS-----PRUGTGD
70AcyA N.crassa_ 187 AMLDTTGGALSRTSSSHSQQQPQQPQQQQQQQQGHAAGSVSGTFSNLSQYAPYLCGN
71AcyA C.albicans_ 3 FLRRDKSK-----
72AcyA S.cerevisiae_ 122 NSTHDDNKDHGYALNSSKTHNYTSTHNNHDDGHHDDHHVQTFPNR-----KESLAETL
73consensus 241 -----
74
75
76AcyA A.fumigatus_ 153 SS---GTFSHDFSE--QEASPASATFRPSTERTFASEP-----VDLDYNRDDRRPSVAS
77AcyA A.clavatus_ 156 AP---GTFHDLSE--HEASPASGSFRPGTERTFASEP-----VDLDYNGDHRPSAS

78	acyA_A.niger_	51	GP----STFFNDYSE--QEASPASNIFRPGTAQTVASES-----LFLDYNGDHRRPSVAS
79	acyA_A.flavus_	157	GN----GAFFQDHSE--HEASPASTSFRPGTSRTVASEP-----LFLDYNGDHRRPSVAS
80	acyA_A.oryzae_	157	GN----GAFFQDHSE--HEASPASTSFRPGTSRTVASEP-----LFLDYNGDHRRPSVAS
81	acyA_A.nidulans_	151	AH----CTFFHHDHSE--HEASPAATFRPGTGRTLASTA-----PDLDYNGDHRRPSVAS
82	acyA_N.crassa_	247	GGGMSMGSLNDSTNLSVISQLSPGTRPMTARPSQASAGSMEFPDSAYYDDERRPSITAS
83	acyA_C.albicans_	11	-----ANFRDGSATGLEEPVSPITHESENVPVP-----LDGNHGDHYHDEDSPR
84	acyA_S.cerevisiae_	174	FKRFS-GSNSHDGNKSGEESKVANLSLSTVNPAPANRKEPKDSTLSNHLADNVPSTLRRK
85	consensus	301	
86			
87			
88	acyA_A.fumigatus_	202	ATTISS-QGSKSSTGGRFRKKLQGGFGDEYLPPEESKQEQEQDTRSLSSRPASIDHFKAR
89	acyA_A.clavatus_	205	ATTISS-QGSKSSTGGRFRKKLQGGFGDEYLPPEESKQEQEQDTRSLSSRPASIDHFKAR
90	acyA_A.niger_	100	AMTVSS-QGSKSSAGLFLFKKKLQGGFGDEYVGNDEPHDSNFTQNSATKPSLSLQFRAR
91	acyA_A.flavus_	206	ATTISS-QGSKSSTGGRFRKKLQGGFGDEYLP-GDSKLES DNQSGHPTTKSSLSLQHIFR
92	acyA_A.oryzae_	206	ATTISS-QGSKSSTGGRFRKKLQGGFGDEYLP-GDSKLES DNQSGHPTTKSSLSLQHIFR
93	acyA_A.nidulans_	200	ATTISS-QGSKSSTGGLFRKKLQGGFGDDPNA-SDSKQDHDG-HHSSGSKPSSIYFESR
94	acyA_N.crassa_	307	ITTTASSQGSRTSKTRGGLOKLOQFFGDRDDWPCRDSEISLPQPSHSGPMSTGKEHRSH
95	acyA_C.albicans_	55	SSVSLPQLIHNSTHLLKENYRGTHN-----KRPKGIANVPPLAQPIKPR
96	acyA_S.cerevisiae_	233	VSSIVRGSSVHDINNLIADKQIRPKAVAQLENTLHSDVPNSKRSHRKSFLLGSTSSSSS
97	consensus	361	
98			
99			
100	acyA_A.fumigatus_	261	ERANSDGARNFPERSQDDTSSLHPS-----RPRTPPLPSSEITPWL
101	acyA_A.clavatus_	264	ERANSDGARNFPERSDASSRHPS-----RPRTPPLPSSEITPWL
102	acyA_A.niger_	159	ERANSDGSRN-----GTSPAPNQA-----RHTPLPSSEITPWL
103	acyA_A.flavus_	264	ERANSDGARSPPQRLIGESSPQRP-----RPRAPLPSSEITPWV
104	acyA_A.oryzae_	264	ERANSDGARSPPQRLIGESSPQRP-----RPRAPLPSSEITPWV
105	acyA_A.nidulans_	257	QRADSFGSRRPSDGVQDAH--QPG-----RPRTPPLPSSEITPWE
106	acyA_N.crassa_	367	SYSLPGSGRSHRDNYNSNATDHPSTFGSVSTVGGRRDASVPVSRPRTPVPAPVVPFL
107	acyA_C.albicans_	102	FRKKNS-----LLNKIYST
108	acyA_S.cerevisiae_	293	RGSNVSSMTNSDSASMATSGSHVLQHN-----VSNVSPTTKSKDSV
109	consensus	421	
110			
111			
112	acyA_A.fumigatus_	301	YQSFNDIPIQGEAPREVPIAPEGSRLAGQTATNAGAPREARRHHGSHRHSRSKEEKPTV
113	acyA_A.clavatus_	304	YQSFNDIPIQGEAPVREAPIASGSHRAAGQSATNAGASRDARRHFGHRHSRSKEEKPTV
114	acyA_A.niger_	194	YQSFNDIPIQGEAPVREAPITTTADGQRSVSQRDQ-----SRRHFGHRHSRSKEEKPTA
115	acyA_A.flavus_	303	FQSFNDIPIQGEAPVREAPIGADGRRAAAQOMARGSGQRNQITGRQFSGHRHSRSKEEKSTT
116	acyA_A.oryzae_	303	FQSFNDIPIQGEAPVREAPIGADGRRAAAQOMARGSGQRNQITGRQFSGHRHSRSKEEKSTT
117	acyA_A.nidulans_	295	YQSFNDIPIQGEAPVREAPTALDRIRISQGASST-SRDPTRRHFGHRHSRSKEEKANA
118	acyA_N.crassa_	427	YQEADDIARYGEAPVRTSLTGPDRLRYIDSSQNPP---KTSSSARSGHISIVHLPGHKKHN
119	acyA_C.albicans_	118	KKEDDEAATS GKESRSSIISDEKRRSSASSASSG-----SRQKFRFSSSF
120	acyA_S.cerevisiae_	335	NSESADHTNNKSEKVTPEYNENIPENSNSDNKREATPTTIETPISCKPSLFRLDNTLEDV
121	consensus	481	
122			
123			
124	acyA_A.fumigatus_	361	AGDLACYPARPATGRDDSYLGLRPFRDHSNLNASTAMSSSTTLGGRSTSPTPSIQSAYSRE
125	acyA_A.clavatus_	364	AGDLACYPARPATGRDDSYLGLRPFRNSLNMPTAMSSSTTLGGRSTSPTPSMQSAYSRE
126	acyA_A.niger_	249	AGDLACYSNRPATGRDDLGLGLRPSREGSLNYPTFMTSTTLVGRSTSPTPSVQSAYSRE
127	acyA_A.flavus_	362	ADDITVYPSRPTTGRDDFGIGLR---ANSLNN-SAMNSTSTLV-RSTSPTPSMQSAHSRE
128	acyA_A.oryzae_	362	ADDITVYPSRPTTGRDDFGIGLR---ANSLNN-SAMNSTSTLV-RSTSPTPSMQSAHSRE
129	acyA_A.nidulans_	354	AGDLAGYDRPSTGRDDFSVGLRPSRDGSLGFRPAANSSINLAGRSTSPTPSIQSFYTKD
130	acyA_N.crassa_	484	KSNEDPRALKPSLSRSDSAASFARDFRNGSSSMGTRSRQSPAPSWTGTSRGLKANSIS
131	acyA_C.albicans_	163	DSNLSTSSSSPPKDK-----KVSVDTVSDSSTVTASMSNMPTISIDNLNDEM
132	acyA_S.cerevisiae_	395	TDITKTVEPTAVNSTLNSTHGTETASPKTVIMPEPRKSVSMADLVAAAAAPNGEFTST
133	consensus	541	
134			
135			
136	acyA_A.fumigatus_	421	QSQNSPGAPS-NKRSILDKIRRTKAHGFLKHFPKSGSAQEASKSSS-KLARREASP-RRG
137	acyA_A.clavatus_	424	QSQNSPGAPP-NKRSILDKIRRTKAHGFLKHFPKSGKIAQEASRSSS-KLSRREASP-RRG
138	acyA_A.niger_	309	QSQNSPGAQ-TSKRSILDKIRRPK-HGHLKNITGSKAVQETTKAAASKLSRREASPARRG
139	acyA_A.flavus_	417	QSQSSPGTQLPNKRSILDKIRRPKAHGFLKHFPKAGKVQEA-KSTS-KLARRDVSPARRG
140	acyA_A.oryzae_	417	QSQSSPGTQLPNKRSILDKIRRPKAHGFLKHFPKAGKVQEA-KSTS-KLARRDVSPARRG

141	AcyA_A.nidulans_	414	SGQGSFGAPS-SKRSFLGKLRPN----LKHFPGSKGPTDAIRGTS-KLARRDASPRRG
142	AcyA_N.crassa_	544	DGTSSP-APS-HKKGILGRFRRHN----KDKEDGSSLRSGSNHLLVHFPSRQDLIRRAES
143	AcyA_C.albicans	212	DIKSPETPT-----
144	AcyA_S.cerevisiae_	455	NDRSQWVAPQ--SWDNETKRKKTKPKGRSKSRSSIDADELDPMSPGPFSKKDSRHHR
145	consensus	601	*
146			
147			
148	AcyA_A.fumigatus_	478	RQGS--LEGGTSLRNLELGDYERRKDGKGIVMGSTKLRNRRGLNFAAPG-----
149	AcyA_A.clavatus_	481	RQGS--LEGGASIRNLEIGDPERRKDGKGLAIGSAKLRNRRRAVVNEAPPG-----
150	AcyA_A.niger_	367	RQGS--LESGTSSRLASGDNERKDGKGLAISSAKLRGRRGHANFVPPG-----
151	AcyA_A.flavus_	475	RQGS--LEGTTPKGTG--ESDRKKDGLAISSAKLRGRRVLGTTPSK-----
152	AcyA_A.oryzae_	475	RQGS--LEGTTPKGTG--ESDRKKDGLAISSAKLRGRRVLGTTPSK-----
153	AcyA_A.nidulans_	468	RQGS--LEG-APSKGAENGHERKKDGKGLGIATGKLRGRRGAGHTPIG-----
154	AcyA_N.crassa_	598	TYPASVYVSDPSEQREVVPVRPGYVQTAPGFTTKLFTSKKSSSAKQPDOD-----
155	AcyA_C.albicans	222	-----PTAGLPTQKAKKASPTAIKNWQAPESWDVKAPIK-----
156	AcyA_S.cerevisiae_	513	KDNESMTAGDSNSSFVDICKENVPNDSKTALDKLVNRLKSNLAMSEPSIRYAPSNLDG
157	consensus	661	*

Adenylate cyclase G-alpha binding

160	AcyA_A.fumigatus_	526	---KDVRLSEEPG---VWRLDSDLHMEGIVSQQPPSPGDKSAQDGVTPKHEEGKK
161	AcyA_A.clavatus_	529	---RDARPSDEQG---VWRLDSDLHMEGIVTQHPPSPPTDMGRPPDGIIVQDEGKR
162	AcyA_A.niger_	415	---KTIROPDRSN---VWELDTDLHMEGIVN---PPSPSAKSKTFDGASIRSEETFR
163	AcyA_A.flavus_	521	---DTKPAAEQEG---MYELDTDLHMEGIVRKRSQPSADRNSVDGDSKLHEEGKS
164	AcyA_A.oryzae_	521	---DTKPAAEQEG---MYELDTDLHMEGIVRKRSQPSADRNSVDGDSKLHEEGKS
165	AcyA_A.nidulans_	515	---KNTNPSEAPG---VWALDSDLHMEGIVQ---PAADDGDKNEGKTVRHDEKRL
166	AcyA_N.crassa_	649	-MDEDIGPTDMHMGGG-TVYHLDNLNNDMEGILTTPQPMPTPLDNSIMRRESEKMIVPIT
167	AcyA_C.albicans	257	-----KEEPHAPKIEEVAENDVAIDNVLEKK
168	AcyA_S.cerevisiae_	573	-DYDTSSTSSSLPSSSISSEHTSCSDSSSYTNAYMEANREQDNKTPILNKTksyTKKFT
169	consensus	721	*

171			
172	AcyA_A.fumigatus_	578	SEGLPPGHWDAPESWQVKKHGEDLAARLPNVASDATGIAREPDGTSYFIRVFRIDSTFAT
173	AcyA_A.clavatus_	581	QEAAAPAGHWDAPESWQVKKHGEDLAARLPSTAGDTCLVPPERDGLSYFIRVFRIDSTFAT
174	AcyA_A.niger_	464	RDAVPACNWDAPESWQVKKHQ-NEPSTLLPQDTSEPPTITEPDGPNWYIRIFRPDATFAT
175	AcyA_A.flavus_	573	RDGLPTGHWDAPDSWQVRRHGEDNAPPFPSGDI EVARTVPQPDGAPYFIRVFRIDSTFAT
176	AcyA_A.oryzae_	573	RDGLPTGHWDAPDSWQVRRHGEDNAPPFPSGDI EVARTVPQPDGAPYFIRVFRIDSTFAT
177	AcyA_A.nidulans_	563	GDQLGAGNWDAPESWQVKRQNEVLAKVFKMTNDAARTIAEPDGVYFIRVFRIDSTFAT
178	AcyA_N.crassa_	707	TD--PEGAMAAPDSWAVRDNKKSLAPQVNEDLCSRQPSSEEKSKSNYVIRVFRSDSTWTT
179	AcyA_C.albicans	283	RLPPLYCTHQVPH-----VTNSKDIKSHIIRVFEDNTFTT
180	AcyA_S.cerevisiae_	632	SSSYNMNSPDGAQSSGLLQDEKDDVEVCQLEHYKDFSDLDPKRHYAIRIFNTDDTFTT
181	consensus	781	**.*.*.*.*

Ras-associating (RA) domain

184	AcyA_A.fumigatus_	638	LSAGLNATVADILMLGRKSFLQDHLNN-YEIVMKFNDLSRQLDHSERPILMQKRLLEQV
185	AcyA_A.clavatus_	641	LSAGLNATVADILMLGRKSFLQDHLNN-YEIVMKKHDLRSRQLDHSERPILMQKRLLEQV
186	AcyA_A.niger_	523	LSGGLYATVADLVHGLSRKSFLTEHLSN-YEIVMQNDLSRQLDQHEMPILMQKRLLEQV
187	AcyA_A.flavus_	633	LSTGLNATVADILVILGRKSFLTDHLNN-YEIVMRNELTRQLDPEKPILMQKRLLEQV
188	AcyA_A.oryzae_	633	LSTGLNATVADILVILGRKSFLTDHLNN-YEIVMRNELTRQLDPEKPILMQKRLLEQV
189	AcyA_A.nidulans_	623	LSNGLHATVADVLISLGRKSFLTDHLNN-YEIVMRNNDLSRQLDPNEQPILMQKRLLEQV
190	AcyA_N.crassa_	765	LTLPLTATAEDVIMGVAKKTYLPPGACDSYSLLIKKHDLFRVLNSAEQPLRIQKRLFOQI
191	AcyA_C.albicans	320	ILCPLETTTSEILLAVQKKFFLESTTNFQLSVCIG--NCVKVLEDFEKPLKIOMGLLLLS
192	AcyA_S.cerevisiae_	692	LSCTPATTVEEIIPALKIKFNITAQGNF--QISLVGKLSKILRPISKPIILIERKLLLLN
193	consensus	841	*.....*.....*

194			
195			
196	AcyA_A.fumigatus_	697	GYTAKDRIEEIGREDHSYICRFIFLPTKLSGYSSL-DGDPGFSIMQKFSHVDLQGRSLVT
197	AcyA_A.clavatus_	700	GYTAKDRIEEIGREDHSYICRFIFLPTKLSGYSSL-DGDPGFNKMOKFSHVDLQGRSLVT
198	AcyA_A.niger_	582	GYTEKDRIEEVGREDHSYILRFTFLPARITGYIID-GNDPLGKAQOKFSHVDLSNRSLVT
199	AcyA_A.flavus_	692	GYTAKDRIEEVGREDHSYIVRFTFLPNKLNGLTSLQGGDSGFNRNOKFSHVDLSNRCCLVT
200	AcyA_A.oryzae_	692	GYTAKDRIEEVGREDHSYIVRFTFLPNKLNGLTSLQGGDSGFNRNOKFSHVDLSNRCCLVT
201	AcyA_A.nidulans_	682	GYTEKDRIEEIGREDHSYILRFTFLPTKLSGYSSL-EGDPGFSKNOKFSHVDLQGRSLVT
202	AcyA_N.crassa_	825	GYQEKDGIIDEIGREDHSYICRWVFLKEKEADMHL-SPDINFR-NOKLNHVDLSGRNLIT
203	AcyA_C.albicans	378	GYTEEDKIRMLGREDLSFVCKFVVENIFLRSLTHD----EEVLLSRNIVDNLISLNLKN

204AcyA_S.cerevisiae_ 750 GYRKS^DPHIMGI^EEDLSFVFKFL^FHEVTPSHFTPE---QEQRIMRSE^FVHV^DLRNMD^LIT^T
205consensus 901 ** . * * . * . * * . . . * . .
206
207
208AcyA_A.fumigatus_ 756 IPITLYK^KASEIIISLNS^RNLSDVPKDFIQGCINLREIK^FIGNEAR^LRLPASFS^LASRLT^T
209AcyA_A.clavatus_ 759 IPITLYK^KASEIIISLNS^RNLSDVPKDFIQGCINLREIK^FIGNEAR^LRLPASFS^LASRLT^T
210AcyA_A.niger_ 641 IPIGLYK^KAEIIISLNS^KNLALDVPKDFIQGCINLREIK^FIGNEAR^LRLPASFGLASRLT^T
211AcyA_A.flavus_ 752 IPISLYSKAAEIIISLNS^KNLSDVPKDFIQGCINLREIK^FIGNEAR^LRLPASFGLASRLT^T
212AcyA_A.oryzae_ 752 IPISLYSKAAEIIISLNS^KNLSDVPKDFIQGCINLREIK^FIGNEAR^LRLPASFGLASRLT^T
213AcyA_A.nidulans_ 741 IPIALYK^KAEIIISLNS^RNLELDVPKDFIQGCINLREIK^FIGSEAR^LRLPPSFS^LASRLT^T
214AcyA_N.crassa_ 883 IPVPLYK^KAAEIVSLNS^RNLSDVPKDFIQACTALR^IKYNNNEA^QALPKSFATAS^KLT^T
215AcyA_C.albicans_ 434 VPPIIFHQHTYEIEKLN^VANNPS^TYFPLDFIQGCTSLAYVDFSHNGCS^KFPNNLL^EAPQLT^T
216AcyA_S.cerevisiae_ 807 PPIIF^FYQHTSEIESL^DVSN^NANIF^FLEF^FIESS^LIKLSLRM^VNIRAS^KFPNSNIT^KAYK^LIV^T
217consensus 961 . * * . . . * * *
218
219

Leucine-rich repeat domain, L domain-like

220AcyA_A.fumigatus_ 816 YLDVSN^NLL^EELGHAN^LDLRLHGLVSIK^MANNK^LSLPSYFGN^FQYLRSLN^ISSNN^FQVFP^T
221AcyA_A.clavatus_ 819 YLDVSN^NLL^EDLHAHL^DSLHGLVSIK^MANNK^LKLPSYFGN^FQYLR^NLN^ISSNS^FQTFP^T
222AcyA_A.niger_ 701 YLDVSN^NLE^DLTHAN^LDLRLHGLVSIK^MANN^RLKLPSYFGN^FQYLRSLN^ISSNN^FKVFP^T
223AcyA_A.flavus_ 812 YLDVSN^NYVEQLDNAG^LDKLQGLVSIK^LSNNK^LSLPSYFGN^FAYLRSLN^ISSNN^FRVFP^T
224AcyA_A.oryzae_ 812 YLDVSN^NYVEQLDNAG^LDKLQGLVSIK^LSNNK^LSLPSYFGN^FAYLRSLN^ISSNN^FRVFP^T
225AcyA_A.nidulans_ 801 YLDVSN^NLE^DQLDHA^NDLRLQGLVSIK^LANN^RLKLEDYFGN^FKSRLSLN^IASNN^FQVFP^T
226AcyA_N.crassa_ 943 YLDVSN^NRLQ^DLDHSEL^SKLTLGLK^VNLANN^CLRSL^EPTLGAK^SLR^LLN^ISSNF^LDLVFP^T
227AcyA_C.albicans_ 494 HLN^LEMN^LFLDEIPQR⁻ISCLSN^LTN^LKLSSN^QLYSLPH^SFTLT^NLQ^DLSSN^FYDSYP^T
228AcyA_S.cerevisiae_ 867 SLEI^QRNFIRKVPNS⁻IMKLSN^LLT^INLQCNE^LESLPAGEV^LKNLQ^LLDI^SSNK^FMHYP^T
229consensus 1021 . * * * * * * *
230
231

232AcyA_A.fumigatus_ 876 SF^LCLN^LKS^LVDLDISFN^NIAELP⁻NIGK^LVT^LLERLWMTN^NMSG^LPLDE^TFKDLVN^LKEID^T
233AcyA_A.clavatus_ 879 SF^LCLN^LKS^LVDLDISFN^NIAELP⁻NIGK^LLT^LTERLW^TTNNVLRG^LPLDE^TFKELVS^LKEID^T
234AcyA_A.niger_ 761 DL^LCLG^LKS^LVDLDISFN^NIAELP⁻CI^GKLAT^LERLWMTN^NIVRGAL^DDTFRDLVN^LKEID^T
235AcyA_A.flavus_ 872 EFLGN^LKNLVDLDISFN^NIAEVP⁻CIGRLST^LERLWMTN^NVLRGAL^DESFKDLVN^LKEID^T
236AcyA_A.oryzae_ 872 EFLGN^LKNLVDLDISFN^NIAEVP⁻CIGRLST^LERLWMTN^NVLRGAL^DESFKDLVN^LKEID^T
237AcyA_A.nidulans_ 861 EFLCN^LKS^LVDLDISFN^NIAELP⁻NIGN^LTS^LERLWMTN^NNGFRGP^FGESIKDLVN^LKEID^T
238AcyA_N.crassa_ 1003 SF^LICE^LET^IVDLDISFN^SINNLP^DNIMK^LRNL^EKFV^TTNNRLSG^LPISES^VRDVLS^LKEID^T
239AcyA_C.albicans_ 553 EAVN^KLTN^LVELN^FSND^LSIIPES^IANLN^LQ^LLN^LCTN^KLSG^LTPGYLS^QLKALK^RID^T
240AcyA_S.cerevisiae_ 926 EVIN^YCTN^LLQ^DLSM^NKIQSLPQSTKYLVK^LAKM^NPSHN^KLN--FIGDLSEMTDL^TLTN^T
241consensus 1081 * * * * * *
242
243

244AcyA_A.fumigatus_ 935 ARFNAITNIDIL^AQLPRL^EQLLIGHN^ASKFK^GSFPKLR^TL^LLDHCPMTQFDIDAP^MPT^T
245AcyA_A.clavatus_ 938 ARFNAITNIDTL^AQLPRL^EQLLIGHN^ASKFRG^SFVKLR^TL^LFDHCPMTQFDIDAP^MPT^T
246AcyA_A.niger_ 820 ARFNEITNIDTLCV^LPRLEQ^VAI^GHNAISKFK^GSFPKLR^TL^LLDHCPMTQFEIDAP^MPT^T
247AcyA_A.flavus_ 931 ARFNEITNIDNLSY^PRL^EQ^LLVGHNAISKFK^GSFPKLR^TL^LLDHCPITQFDIDAP^MPT^T
248AcyA_A.oryzae_ 931 ARFNEITNIDNLSY^PRL^EQ^LLVGHNAISKFK^GSFPKLR^TL^LLDHCPITQFDIDAP^MPT^T
249AcyA_A.nidulans_ 920 ARFNEITNIDSLT^LLPRL^EQLLIGHN^SVSKFRG^SSFPKLR^NL^LVDHCPMTQFDIDAP^MPT^T
250AcyA_N.crassa_ 1063 IRYNQISTIDVLS^DLPRL^EILSADHN^QISKFSG^SFE^LRLSLK^LNSNP^IVKFEV^KAP^MPHI^T
251AcyA_C.albicans_ 613 IRYNYISN^VDLG^IIPN^LEVAYASKNAISTFSDQMKCLRL^LHFDRNPITELK^NTQMOM⁻
252AcyA_S.cerevisiae_ 984 LRYNRISSIKTN--ASN^LQNL^FTDNRISN^FED^LLPKLRALETQENPITSISFKDFY^PKN^T
253consensus 1141 . * . * * * * * *
254
255

256AcyA_A.fumigatus_ 994 LTSLN^IASAKLVQ^FRD^SLFENLPN^LTKL^LLDKNHFVSMSPHIGKLR^LLEHFSMIKNPLAA^T
257AcyA_A.clavatus_ 997 LTSLN^IASAKLVQ^FRD^SLF^EYLPN^LKL^LVDKNHFVSMSPHIGKLR^LLEHFSMIKNPLAA^T
258AcyA_A.niger_ 879 LTSLN^IASAKLVQ^LRD^LFFENLPN^LTK^VILDKNHFVSMSPHIGKLR^LLEHFSMIKNPLAA^T
259AcyA_A.flavus_ 990 LTVLN^IASAKLVQ^LRD^LLFENAPN^LTKL^LVDKNHFVSMSSHIGKLR^LLEHFS^IIKNPLDA^T
260AcyA_A.oryzae_ 990 LTVLN^IASAKLVQ^LRD^LLFENAPN^LTKL^LVDKNHFVSMSSHIGKLR^LLEHFS^IIKNPLDA^T
261AcyA_A.nidulans_ 979 LTSLN^IASAKLVQ^FRD^LDSL^PNLTKL^LLDKNHFVSMSPHIGKLR^LLEHFSMAKNPLSS^T
262AcyA_N.crassa_ 1122 PQILN^LSNAQLAS^DES-IDNLMN^LEL^LLD^SNYFVS^LPNQIGN^LKL^LHL^SMANNH^LIGE^T
263AcyA_C.albicans_ 672 LSVLD^LSRAKITAFPAEFVEK^VPN^EEKLVDKNH^LVSLPNEL^CQLSKLVSL^SVHANN^LQOS^T
264AcyA_S.cerevisiae_ 1042 MTS^LLTNKAQLSS^SPGEL^LTKLS^FEKL^LELNQN^NLTR^PQEI^SKLTKLV^LSVAN^KLEY^T
265consensus 1201 . . . * * * * * *
266

393AcyA_A.niger_ 1518 EMVILASRELWDYVTPDLVVDVTRAERRDLMAAQKIRDLAISFGATNKLMMVMILGVGDL
 394AcyA_A.flavus_ 1625 EMILASRELWDYVTPDLVVDVTRAERRDLMAAQKIRDLAISFGANNKLMVMILGVGDL
 395AcyA_A.oryzae_ 1625 EMILASRELWDYVTPDLVVDVTRAERRDLMAAQKIRDLAISFGANNKLMVMILGVGDL
 396AcyA_A.nidulans_ 1616 EMILASRELWDYVTPDLVVDVTRAERRDLMAAQKIRDLAISFGANNKLMVMILGVGDL
 397AcyA_N.crassa_ 1772 ETVLIASRELWELRPDLIVDVARECRSDLMKASQKIRDLAIAVGSTNKLIMMIGVANL
 398AcyA_C.albicans_ 1225 DMILASRELWDFISYEYSAVDIIRKDNNDPMVAAQKIRDFAIYCATDKICVIVLTFGNR
 399AcyA_S.cerevisiae_ 1568 EMILIASRELWELRPDLIVDVARECRSDLMKASQKIRDLAIAVGSTNKLIMMIGVANL
 400consensus 1861**.....*.....*.....*.....*.....*.....*.....*.....

401

402

403AcyA_A.fumigatus_ 1693 KKREK-FKFRGTSLSMGPPAFPEEQIIPS-TKRTKKPRDMPGDSRLARF-DYVDAPVIGEL
 404AcyA_A.clavatus_ 1693 KKREK-FKFRGTSLSMGPSAFPEGEIIPS-TKRTKKPRDAPGDSRLARF-DYVDAPVIGEL
 405AcyA_A.niger_ 1578 KKREK-IRTRPSLSMVGP---PEEQIIPS-TKRTKKPRDAPGDSRLARF-NYVDAPVIGEL
 406AcyA_A.flavus_ 1685 KKRDRQSKFRNASVSTGML--EQQIIPS-TKRTKKPRDMPGDSRLARF-EFVDAPVIGEL
 407AcyA_A.oryzae_ 1685 KKRDRQSKFRNASVSTGML--EQQIIPS-TKRTKKPRDMPGDSRLARF-EFVDAPVIGEL
 408AcyA_A.nidulans_ 1676 KKREK---RPPRFPSMNSFSQVDSIIPS-PKRTKKPRDMPGDSRLARF-DYVDAPVIGEL
 409AcyA_N.crassa_ 1832 KQRQAQQFKGQLNAFSPQDDPSHPSPSGNKKRKVRAEGPLDSNLMRLNAEVPPTGQL
 410AcyA_C.albicans_ 1285 QKQAANMYSNYGVD-----RFRDRKQQVVGSDSNLRKLEQEIETPTGQL
 411AcyA_S.cerevisiae_ 1628 IQQQN-----RFTLNKNSLMTRFSTFEDTTRRRLQPEISPTCNL
 412consensus 1921*.....*.....*.....*.....*.....*.....*.....

413

414

Nucleotide cyclase

415AcyA_A.fumigatus_ 1750 AIIFTDIKKSTSLWETCPDAMRSAIQIHNDILRRQLGIIGGYEVKTEGDAMFVAFSTTTA
 416AcyA_A.clavatus_ 1750 AIIFTDIKKSTSLWETCPDAMRSAIQIHNDILRRQLGIIGGYEVKTEGDAMFVAFSTTTA
 417AcyA_A.niger_ 1632 AIIFTDIKKSTSLWETCPDAMRSAIQIHNDILRRQLGIIGGYEVKTEGDAMFVAFSTTTA
 418AcyA_A.flavus_ 1741 AIIFTDIKKSTSLWETCPDAMRSAIQIHNDILRRQLGIIGGYEVKTEGDAMFVAFSTTTA
 419AcyA_A.oryzae_ 1741 AIIFTDIKKSTSLWETCPDAMRSAIQIHNDILRRQLGIIGGYEVKTEGDAMFVAFSTTTA
 420AcyA_A.nidulans_ 1731 AIIFTDIKKSTSLWETCPDAMRSAIQIHNDILRRQLGIIGGYEVKTEGDAMFVAFSTTTA
 421AcyA_N.crassa_ 1892 SIIVFTDIKNSTQLWENYPPAMRLAIKHNEVMRRQLRMIGGFEVKTEGDAMFVAFSTTTA
 422AcyA_C.albicans_ 1329 ALVFTDIKNSTLLWDSYPAPMRSIAIKHNTIMRRQLRITGGYEVKTEGDAMFVAFSTTTA
 423AcyA_S.cerevisiae_ 1668 AMVFTDIKSTFLWELFPNAMRLAIKHNDIMRRQLRITGGYEVKTEGDAMFVAFSTTTA
 424consensus 1981 ...*****.....*.....*.....*.....*.....*.....*.....*

425

426

427AcyA_A.fumigatus_ 1810 ALLWCFNCQTQLLEAEWPTEILEQPQCQVQYDMNIIIFRGLSVRMGIHWGEPVCEKDPV
 428AcyA_A.clavatus_ 1810 ALLWCFNCQTQLLEAEWPTEILEQPQCQVQYDMNIIIFRGLSVRMGIHWGEPVCEKDPV
 429AcyA_A.niger_ 1692 ALLWCFNCQTQLLEAEWPTEILEQPQCQVQYDMNIIIFRGLSVRMGIHWGEPVCEKDPV
 430AcyA_A.flavus_ 1801 ALLWCFNCQMQLLEAEWPTEILEQTQCQVEYDMNIIIFRGLSVRMGIHWGEPVCEKDPV
 431AcyA_A.oryzae_ 1801 ALLWCFNCQMQLLEAEWPTEILEQTQCQVEYDMNIIIFRGLSVRMGIHWGEPVCEKDPV
 432AcyA_A.nidulans_ 1791 ALLWCFNCQYQLLEAEWPTEILEQPQCQVQYDMNIIIFRGLSVRMGIHWGEPVCEKDPV
 433AcyA_N.crassa_ 1952 ALLWCFNCFVQMLLTVWPPEVLSNCCQPIYDRNNNIIIFRGLSVRMGIHWGEPVCEKDPV
 434AcyA_C.albicans_ 1389 ALLWCFNCFVQMLLTVWPPEVLSNCCQPIYDRNNNIIIFRGLSVRMGIHWGEPVCEKDPV
 435AcyA_S.cerevisiae_ 1728 GLTWCLSGQLKLLAQWPEEITSVQDGCQVTDNRGNIIIFRGLSVRMGIHWGEPVCEKDPV
 436consensus 2041 ...**.....*.....*.....*.....*.....*.....*.....*

437

438

439AcyA_A.fumigatus_ 1870 TNRMDFGPMVNRRASRISAVADGGQIFVSSDFMSDIQRNLEVFADSERAASTGSEESYAV
 440AcyA_A.clavatus_ 1870 TNRMDFGPMVNRRASRISAVADGGQIFVSSDFMSDIQRNLEVFADSERAASTGSEESYAV
 441AcyA_A.niger_ 1752 TNRMDFGPMVNRRASRISAVADGGQIFVSSDFMSDIQRNLEVFADSERAASTGSEESYAV
 442AcyA_A.flavus_ 1861 TNRMDFGPMVNRRASRISAVADGGQIFVSSDFMSDIQRNLEVFADSERAASTGSEESYAV
 443AcyA_A.oryzae_ 1861 TNRMDFGPMVNRRASRISAVADGGQIFVSSDFMSDIQRNLEVFADSERAASTGSEESYAV
 444AcyA_A.nidulans_ 1851 TNRMDFGPMVNRRASRISAVADGGQIFVSSDFMSDIQRNLEVFADSERAASTGSEESYAV
 445AcyA_N.crassa_ 2012 TRMDYFGPMVNRRASRISAVADGGQITASSDFITETIHRCLETKISVDVD---EISLED
 446AcyA_C.albicans_ 1449 TGRMDYFGPMVNRRASRISAVADGGQITASSDFITETIHRCLETKISVDVD---EISLED
 447AcyA_S.cerevisiae_ 1788 TORMDYFGPMVNRRASRISAVADGGQITASSDFITETIHRCLETKISVDVD---EISLED
 448consensus 2101 ...*****.....*.....*.....*.....*.....*.....*.....*

449

450

Nucleotide cyclase

451AcyA_A.fumigatus_ 1930 DSLGYNIRRELQQLNSQGFVIKQGERKLGLENPEPLYLIYPHSLSGR-----LIT
 452AcyA_A.clavatus_ 1930 DSLGYNIRRELQQLNSQGFVIKQGERKLGLENPEPLYLIYPHSLSGR-----LIT
 453AcyA_A.niger_ 1812 DTLGHNIRRELQQLNSQGFVIKQGERKLGLENPEPLYLIYPHSLSGR-----LIT
 454AcyA_A.flavus_ 1921 DNLGYNIRRELQQLNSLGFVIKQGERKLGLENPEPLYLIYPHSLSGR-----LSI
 455AcyA_A.oryzae_ 1921 DNLGYNIRRELQQLNSLGFVIKQGERKLGLENPEPLYLIYPHSLSGR-----LSI

456	AcyA_A.nidulans_	1911	D-LGDNIRRELQQLNSQGFVIKDQGERKLGLENPEPLYLIYPHALSGR-----LST
457	AcyA_N.crassa_	2068	DATAKAIRAEIRALSSQGFEMKDMGEKKLKGLNPVLVSYYPHALVGRTEQHHHAHTEST
458	AcyA_C.albicans_	1509	ENAGMTIERELNALEDLGCNYFKIGERKLGLETPEPITLVFTNRLKLR-----YDI
459	AcyA_S.cerevisiae_	1847	ETIGEVLIEREAMLESIGWAFDFGEHKLKGLTKELVTAYFKILASR-----
460	consensus	2161	 * * * * *
461			
462			
463	AcyA_A.fumigatus_	1982	TEQAEARE-----NGPTTISKHSELEIQADLIWRLWEITLRLRLCGALENPGEARLKE
464	AcyA_A.clavatus_	1982	TEQAESTE-----NGPTTISKHSQLEIQADLIWRLWEITLRLRLCGALENPGEARLKE
465	AcyA_A.niger_	1864	TDKDASNE-----LAPTTISKHSQLEIQADLIWRLWEITLRLRLCGALENPGEARLKE
466	AcyA_A.flavus_	1973	NQKDAASDK-----NVPTTISKHSQLEIQADLIWRLWEITLRLRLCGALENPGEARLKE
467	AcyA_A.oryzae_	1973	NQKDAASDK-----NVPTTISKHSQLEIQADLIWRLWEITLRLRLCGALENPGEARLKE
468	AcyA_A.nidulans_	1962	QDQMSGEE-----STPTTISKHSQLEIQADLIWRLWEITLRLRLCGALENPGEARLKE
469	AcyA_N.crassa_	2128	QNQAALQPYGALATPKPATDPDSEIQFEPETIWLWRVALRLEMLCSTLEPNARGIQA
470	AcyA_C.albicans_	1561	FQKRLDAN-----HSTRVAGTLPVEITVGLRTVSLRLENLCSSNNNGCNYCSEG
471	AcyA_S.cerevisiae_	1896	-HEFASD-----EQSKLINETMLRLRVINRLESIMSALSGGFIELDSDR
472	consensus	2221	 * * * *
473			
474			
475	AcyA_A.fumigatus_	2036	PNVALFNLVKNHGG---ELADSTVVSVEQQVTRIEMNVTLSVRYMLKPFKPGDKLSD
476	AcyA_A.clavatus_	2036	PNVALFNLVKNHGG---ELADSTVVSVEQQVTRIEMNVTLSVRYMLKPFKPGDKLSD
477	AcyA_A.niger_	1918	PNVALFNLVKNHGG---ELADSTVVSVEQQVTRIEVCIITLFIIRNMRFKPGDQLND
478	AcyA_A.flavus_	2028	PNVSLFNLVKNHGG---ELADSTVVSVEQQVTRIEMTVNTLAIRNMLRPFKPHDRIND
479	AcyA_A.oryzae_	2028	PNVSLFNLVKNHGG---ELADSTVVSVEQQVTRIEMTVNTLAIRNMLRPFKPHDRIND
480	AcyA_A.nidulans_	2016	PNSALFDITKKHGG---ELADSSVVSVEQQVTRIEVAISTLAIRHMLRPFKPGDRIDD
481	AcyA_N.crassa_	2188	ETELLERMKRAG---EVTDFHLLNFMEHQLSRIETCITSLAVRHIAIGSGEITKIND
482	AcyA_C.albicans_	1610	FESSSGVISQKMNS---SFKDSDLSLNHVTTRIESCITLFLRQQLSQIKNGGGLIE
483	AcyA_S.cerevisiae_	1941	TEGSYIKFNPKVENGIMQSISKDALFFHVTTRIESSVALLHIRQQRCS--GLEIFRN
484	consensus	2281	 * * * *
485			
486			
487	AcyA_A.fumigatus_	2092	HAVPIGVVMQQLQTQLAEYRALKEQLAVGAGITGVSSSSPFAEGQDTGSDPSSASSSF
488	AcyA_A.clavatus_	2092	HAAPIDEVMQQLQTQLAEYRALKEQLAVSAGITGTPSTSKGSGAQVTSGSSPSSASSSF
489	AcyA_A.niger_	1974	HAVPITDVMQQLQALAEYRALKEQIDASACTATSYTYTDPQYS---NGSNYDSASSSF
490	AcyA_A.flavus_	2084	HAMPIGDVLQELQTQLAEYRALKEQISVSAAGITGSSPSYASL-----EDSNSSVSSSF
491	AcyA_A.oryzae_	2084	HAMPIGDVLQELQTQLAEYRALKEQISVSAAGITGSSPSYASL-----EDSNSSVSSSF
492	AcyA_A.nidulans_	2072	HAAPIGDVLQELRTQLAEYRALKEQIATNSAGITGASPSSTATDLHYTPFHSSASSSSF
493	AcyA_N.crassa_	2244	LRAPMNDVLSTLKEQMDLARYKAKYGSLDQETDDATDNNSSG-----DVDLDGSDIE
494	AcyA_C.albicans_	1666	TNN--SPSLDVLMDDEVADIMKTVNELK-----
495	AcyA_S.cerevisiae_	1999	DKTSARSNFFNVDELLOMVKNAKDLST-----
496	consensus	2341	 * * * *
497			
498			
499	AcyA_A.fumigatus_	2152	IQATSSSE-----
500	AcyA_A.clavatus_	2152	IQAPPSE-----
501	AcyA_A.niger_	2031	LHMGPPSDEYNPGGPRP
502	AcyA_A.flavus_	2139	LRMSIP-----
503	AcyA_A.oryzae_	2139	LRMSIP-----
504	AcyA_A.nidulans_	2132	T-----
505	AcyA_N.crassa_	2299	QE-----
506	AcyA_C.albicans_		-----
507	AcyA_S.cerevisiae_		-----
508	consensus	2401	
509			

Figure S1. Alignment of amino acid sequences of AcyA and its putative orthologs of different fungi. Identical and similar residues are shaded in black and gray, respectively.

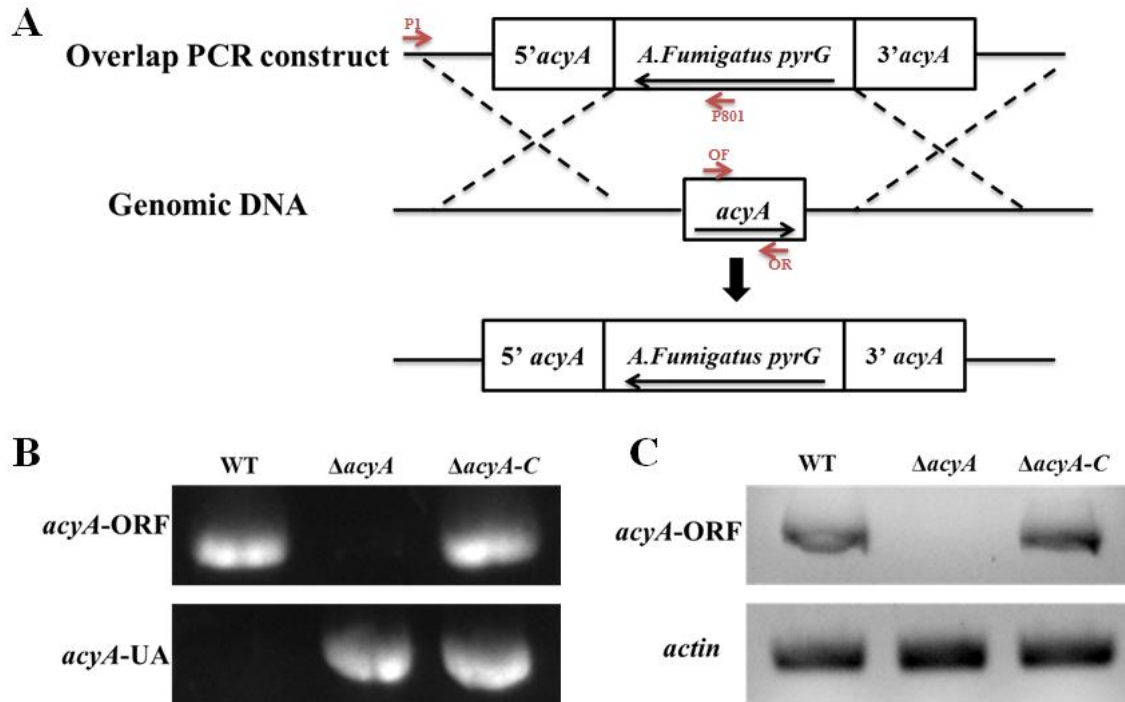


Figure S2. Deletion of *acyA* gene from *A. flavus*. (A) The gene replacement strategy of *acyA*. (B) Diagnostic PCR were performed to confirm the gene deletion and complemented strains, *acyA* ORF was confirmed by primers *acyA*/OF and *acyA*/OR, UA was confirmed by primers *acyA*/p1 and P801.(C) RT-PCR verification of *acyA* gene deletion. Actin gene was used as a reference.

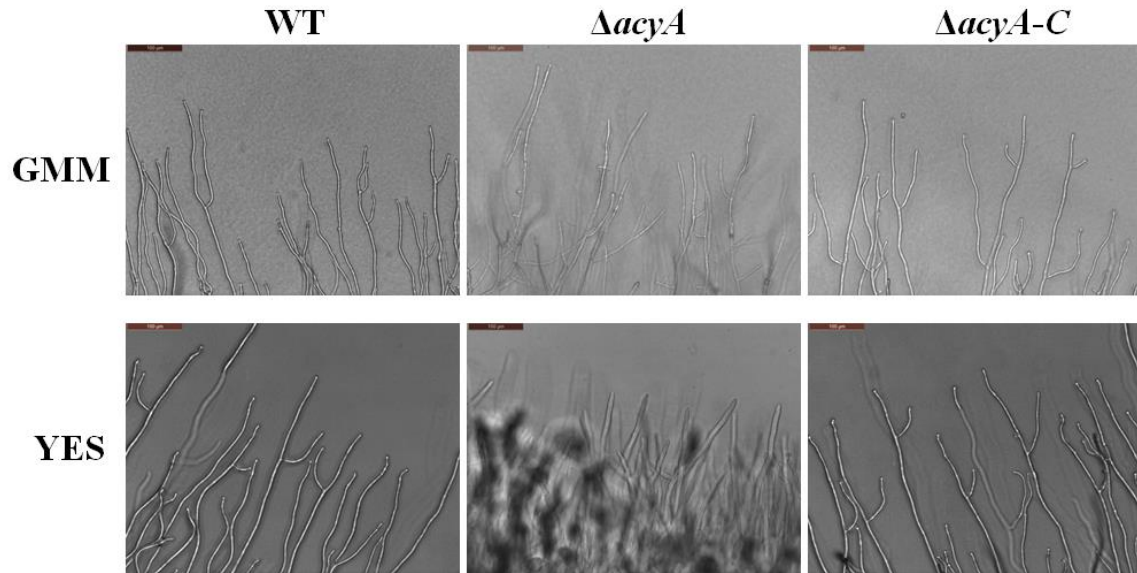


Figure S3. Microscopic examination revealed the difference mycelia tips of WT, Δ acyA and Δ acyA-C complemented strain when growing in GMM and YES medium, bars=100 μm.