

N-Glycosylated *Ganoderma lucidum* immunomodulatory protein
improved anti-inflammatory activity *via* inhibition of p38 MAPK pathway

Qi-zhang Li^{a,b*}, Xin Chen^{c*}, Pei-wen Mao^a, Meng-yuan Jin^a, Qin Wu^a, Xuan-wei Zhou^{a**}

^a*School of Agriculture and Biology, and Engineering Research Center of Therapeutic Antibody,
Ministry of Education, Shanghai Jiao Tong University, Shanghai 200240, PR China*

^b*National “111” Center for Cellular Regulation and Molecular Pharmaceutics, Key Laboratory of
Industrial Fermentation (Ministry of Education), Institute of Biomedical and Pharmaceutical
Sciences, Hubei Key Laboratory of Industrial Microbiology, Hubei University of Technology,
Wuhan 430068, China*

^c*Institute for Immunity, Transplantation, and Infection, Stanford University School of Medicine,
Stanford, CA 94305, USA*

Corresponding author: Xuanwei Zhou, xuanweizhou@sjtu.edu.cn, ORCID: 0000-0002-3993-6346

Table S1. The percentage (%) content of secondary structure elements of WT, N31S, T36N and N31S/T36N was calculated using Yang's model.

Structure elements	WT	N31S	T36N	N31S/T36N
α -helix	65.4	57	37.8	40.4
β -structure	0.6	43	44.7	42.5
Random	34	0	17.5	17.1

Appendix A

Protein sequences

MAPK 1

1 maaaaaagpe mvrqqvfdvg prytlnsyig egaygmvesa ydnlnkvrva ikkispfehq
61 tycqrtlrei killrfrhen iigindiira ptieqmkdvy ivqdlmetdl yklktqhl
121 ndhicyflyq ilrglkyihs anvlhrdlkp snllntted lkicdfglar vadpdhdhtg
181 flteyvatrw yrapeimlns kgytksidiw svgcilaeml snrpifpgkh yldqlnhilg
241 ilgspsqedl nciinkarn yllslphknk vpwnrlfpna dskaldlldk mltfnphkri
301 eveqalahpy leqyydpsde piaepfkfd melddlpkek lkelifeeta rfqpgyrs

MAPK 2

1 mssnqsyvfy rqlnktlwe vpdryqnltp vgsgaygsvc ssfdtrtalr iavkklsrpf
61 qsiihakrty relrlkhmk henvigltdv fspaksfeef ndvylvthlm gadlnnivkc
121 qkltdhdvqf liyqilrglk yihsagiihr dlkpsnlavn edcelkildf glarhtdeem
181 tgyvatrwyr apeimlnwmh ynqtvdwsv gcimaelltg rtfpgtdhi dqlklilrlv
241 gtpPELLQK isseaarnyi qslpymPKMN fedvflganp qavdllekml vldtdkrita
301 aealahsyfa qyhdpddepi aepydqsfes reldieewkr ltyeevtcfv pppldseeme
361 s

MAPK 3

1 maaaaaapgg gggeprgtag vvpvvpgeve vvkqpfddvg prytqlqyig egaygmvsaa
61 ydhvrktrva ikkispfehq tycqrtlrei qillrfrhen vigirdilra ptleamrdvy
121 ivqdlmetdl yklksqqls ndhicyflyq ilrglkyihs anvlhrdlkp snllntted
181 lkicdfglar iadpehdhtg flteyvatrw yrapeimlns kgytksidiw svgcilaeml
241 snrpifpgkh yldqlnhilg ilgspsqedl nciinmkarn yqlslpsktk vawaklfps
301 dskaldlldr mltfnphkri tvealahpy leqyydptde pvaeepftd melddlpker
361 lkelifqeta rfqpgapegp

MAPK 4

1 maekgdcias vygydlggrf idfqlgfgv nglvlsatds racrkvavkk ivlsdarsmk
61 halreikiir rldhdnivkv yevlgpkgsd lqgelfkfsv ayivqeymet dlaclleqgt
121 ltedhaklfm yqlrlgkyi hsanvlhrdl kpanifiste dlvlkigdfg larivdqhys
181 hkgylseglv tkwyrprll lspnnytkai dmwaagcila emltgkmlfa gahleqmq
241 ildtipvre edkeellrvm psfvsstwev krplrklld vnseaidfle kiltfnpmr
301 ltaemglqhp ymispyscped eptsqhpfrl edeiddivlm aasqsqslnw drypvsllsd
361 lewrpdrcqd asevrqdrpa gstplaedvq vdprkdsqss serfleqshs smerafeady
421 grscdykvgs psyldklwr dnkphhysep klildlshwk qaasappraa vaadpvsred
481 epaslfleia qvwkstqsgs erasppdap eprlsasppg htpidggas pqfdldvfis
541 ralklctkpe dlpenklgdl ngacisehpg dlvtqteafsk erw

MAPK 5

1 mgteagegit fsvppfasvg fctipeggsc rrgggaataa egepslqpll vpppppppgs
61 fwnvesaaap gtscpttag ssatrgrgns gsgggrrttv ayvineasqg qlvvaeseal
121 qslreaceav gatlethfg kldfgetavl drfynadiav vemsdafrqp slfyhlgvre
181 sfsmanniil ycdtnsdslq slkeiicqkn tvctgnytfi pymvtphnk v yccdssfmkg
241 ltelmqpnfe lllgpiclpl vdrfvqlkv aqasssqyfr esilsdirka rnlytgkela
301 aelarirqr dnievltadi vinlllsyrd iqdydsivkl vetleklptf dlashhhvkf
361 hyafalnrrn lpgdrakald imipmvqsee qvasdmyclv griykdmfld snftdtesrd
421 hgaswfkaf eseptlqsgi nyavlllaag hqfessfelr kvgvklssll gkkgneklq
481 sywevgfflg asvlandhrl viqaseklfr lktpawylks ivetiliykh fvkltteqps
541 akqelvdvfw dflveatkt vtvvrfpvli leptkiyqps ylsinnevee ktisiwhvlp
601 ddkkgihewn fgassvrgvs iskfeercef lyvlhnsddf qiyfctelhc krffemvnti
661 teekgrgaed gdcegdsl eydydengdr vvlkgktygi vyagrdlsnq vriaikeipe
721 rdsrsqlph eelialhkhk hknivqylgs fsengfikif meqvpqgsls allrskwgp
781 kdneqtigfy tkqileglky lhdnqivhrd ikgdnlvint ysgvlkisdf gtskrlagin
841 pctetftgtl qymapeiidk gprgygkaad iwslgctie matgkppfye lgepqaamfk
901 vgmfvhpei pesmsaeaka filkefedp dkracandll ideflkvssk kkktpklsa
961 lstgsneyr sislpvpvlv edtssseyg svspdtelka dpfsfkarak scekdgkgi
1021 rtlflgipde nfdhsapps peekdsgffm lrkdserrat lhriltedqd kvvrnlmesl
1081 aqgaeplk wehittliss lrefvrstdr kiiattlskl kleldfdshg isqvqvlf
1141 fqdavnkvlr nhnikphwmf aldsiirkav qtaitilvpe lrphfslase sdtadpedld
1201 vedeheelss nqtvrrpai tedavatsgv stlsstvshd sqnahrslnv qlgrmkietn
1261 rleelvrke relqallha iekdqeirh lklksqpidi pgfpvchlns pgtttedsel
1321 pgwlrengad editrflae dytlvdvlyy vtrddlclr lrggmletlw kaiidfrnkc

MAPK 6

1 maekfeslmn ihgfdlgsry mdlkplgcgg nglvfsavdn dedkrvaikk ivltdpqsvk
61 halreikiir rldhdnivkv feilgpsgsq ltddvgsle lnsyivqey metdianle
121 qgpillehar lfmyqlrlg kyihsanvhl rdlkpanlfi ntedlvkig dfglarimdp
181 hyshkghlse glvtkwyrsp rllspnny kaidmwaage ifaemltgk lfagaheleq
241 mqlildsipv vheedrqell svipvyirnd mtephrpltq llpgisreal dfleqiltfs
301 pmdrltaaea lshpymsiys fptdepish pfhiedevdd illmdethsh iynweryhdc
361 qfsehdwpih nnfdidevql dpralsdvt eevqvdpk yldgdrekyl edpafdtys
421 aepcwqypdh henkydlec shtcnktrs spyldnlvwr esevnhyyep kliidlsnw
481 eqskeksdkr gkskcerngl vkaqialea sqqlaererg qgfdfsfia gtiqlsaqh
541 sadvdklnd lnsvsqlel kslisksvr ekqekgranl aqlgalyqss wdsqfvsgge
601 ecflisqfcc evrkdehaek entytsyldk ffsrkedsem letepveegk rgergreagl
661 lsgggeflls kqlesigtpq fhspvgsplk siqatltpsa mksspqiphk tyssilkhln

MAPK 7

1 maekfeslmn ihgfdlgsry mdlkplgcgg nglvfsavdn dedkrvaikk ivltdpqsvk
61 halreikiir rldhdnivkv feilgpsgsq ltddvgslte lnsvyivqey metdianvle
121 qgpillehar lfmyqllrgl kyihsanvlh rdlkpanlfi ntedlvkig dfglarimdp
181 hyshkghlse glvtkwyrsp rlllspnnyt kaidmwaage ifaemltgkt lfagaheleq
241 mqlildsipv vheedrqell svipvyirnd mtephrpltq llpgisreal dfleqiltfs
301 pmdrtaaea lshpymsiys fptdepissh pfhiedevdd illmdethsh iynweryhdc
361 qfsehdwpih nnfdidevql dpralsdvt d eevqvdpk yldgdrekyl edpafdtys
421 aepcwqypdh henkydlec shtcnktrs spyldnlvwr esevnhyyep kliidlsnw
481 eqskeksdkr gkskcerngl vkaqialeea sqqlaererg qgfdfsfia gtiqlsaqh
541 sadvvdklnd lnsvsqlel kslisksvsr ekqekgranl aqlgalyqss wdsqfvsgge
601 ecflisqfcc evrkdehaek entytsyldk ffsrkedsem letepveegk rgergreagl
661 lsgggeflls kqlesigtpq fhspvgsplk siqatltpsa mksspqiphk tyssilkhln

MAPK 8

1 msrskrdnnf ysveigdstf tvlkryqnlk pigsgaagiv caaydailer nvaikklsrp
61 fnqthakra yrelvlmkev nhkniigln vftpqkslee fqdvyivmel mdanlcqv
121 meldhermsy llyqmlcgik hlhsagihr dlkpsnivvk sdtlkildf glartagtsf
181 mmpyvvytry yrapevilgm gykenvdlws vgcimgemvc hkilfpgrdy idqwnkvieq
241 lgtpcpefml klqptvrtv enrpkayags feklfpdvlf padsehnklk asqardllsk
301 mlvidaskri svdealqhy invwydpsea eappkipdk qlderehtie ewkeliykev
361 mdleertkng virgqpsplg aavingsqhp ssssvndvs smstdptlas dtdssleaaa
421 gplgcer

MAPK 9

1 msdskedsqf ysvqvadstf tvlkryqqlk pigsgaagiv caafdtvlg nvaikklsrp
61 fnqthakra yrelvllkev nhkniisln vftpqklee fqdvyivmel mdanlcqv
121 meldhermsy llyqmlcgik hlhsagihr dlkpsnivvk sdtlkildf glartactnf
181 mmpyvvytry yrapevilgm gykenvdiws vgcimgelvk gcvifqgtdh idqwnkvieq
241 lgtpsae fml klqptvrnyv enrpkypgik feelfpdwif pseserdik tsqardllsk
301 mlvidpdkri svdealrhy itvwydpaea eapppqiyda qleerehaie ewkeliykev
361 mdweerskng vvkdpqsd aa vssnatpsqs ssindissms teqtasdt d ssldastgpl
421 eger

MAPK 10

1 mslhflyyces eptldvkiaf cqgfdkqvdy syiakhy nms kskv dnfys vevgdstftv
61 lkryqnlkpi gsgaagivca aydavldrnv aikklsrpfq nqthakrayr elvlmkevn
121 kniisllnvf tpqktleefq dvylvmelmd anlcviqme ldhermsyll yqmlcgikh
181 hsagiihrdl kpsnivvksd ctkildf gl artagtsfmm tpyvvtryr apevilgmgy
241 kenvdiwsvg cimgemvrhk ilfpgrdyid qwnkvieqlg tpepefmlkl qptvrnyven
301 rpkayagltfp klfpdslfpa dsehnklkas qardllskml vidpakrisv ddalqhyin

361 vwydpaevea pppqiydkql derehtieew keliykevmn seektkngvv kgqpspsgaa
421 vnsseslpps ssvndissms tdqtlasdt d ssleasagpl gccr

MAPK 11

1 msgpragfyr qelnktvwev pqrllglrpv gsgaygsvcs aydarlrqkv avkklsrpfq
61 sliharrrtyr elrllkhlkh enviglldvf tpatsiedfs evylvttlmg adlnnivkcq
121 alsdehvqfl vyqllrglky ihsagiihrd lkpsnvavne dcelrildfg larqadeemt
181 gyvatrwyra peimlnwmhy nqtvdiwsvg cimaellqgk alfpngdyid qlkrimevvg
241 tpspevlaki ssehartyiq slppmpqkd l ssvfhganpl aidllgrmlv ldsdqrvsaa
301 ealahayfsq yhdpddepea epydesveak ertleewkel tyqevlsfkip lepsqlpgth
361 eieq

MAPK 12

1 mssppparkg fyrqevtkta wevravyqdl qpvgsayga vcsavdsrtg nkvaikklyr
61 pfqselfakr ayreirllkh mrhenvigll dvftpdeld dftdfylvmp fmgtdlgklm
121 khetlsedri qflvyqmlkg lkyihaagvi hrdlkpgnla vnedcelkil dfglarqads
181 emtgyvtrw yrapevilnw mrytqtdiw svgcimaemi tgkilfkgn d hldqlkeimk
241 itgtpppefv qklqsaeakn ymeglpelek kdfasvlt na spqavnller mlvldaeqrv
301 taaealthpy feslrtdede pkaqkyddsf ddvdrtleew krvttykevls fkpprqlgar
361 vpketal

MAPK 13

1 msltrkrffy kqdinktawe lpktylapah vsgaygavc saidkrtgek vaikklsrpf
61 qseifakray rellllkhmh henviglldv ftpasslr sf hdfylvmpfm qtdlqkimgm
121 efsedkvqyl vyqmlkg lky ihsagivhrd lkpgnlavne dcelkildfg larhtdtemt
181 gyvtrwyra pevilswmhy nqtvdiwsvg cimaemltgk tlfkgkdyld qltqilkvgt
241 vpgaefvqkl kdkaaksyiq slpqspkddf tqlfpraspq aadlldkmle ldvdkrltaa
301 qalahpffep frdpeeetea qqpfdaleh eklsvdewkq hyykeisnfs piarkdsrrr
361 sgmklq

MAPK 14

1 msqerptfyr qelnktiwev peryqnlspv gsgaygsvca afdtkthrv avkklsrpfq
61 siihakrrtyr elrllkhmkh enviglldvf tparsleefn dvylvthlmg adlnnivkcq
121 kltddhvqfl iyqilrglky ihsadiihrd lkpsnlavne dcelkildfg larhtddemt
181 gyvatrwyra peimlnwmhy nqtvdiwsvg cimaelltgr tlfpgtdhid qlklilrvlg
241 tpgaellkki ssesarnyiq slaqmpkmnf anvfiganpl avdllekmlv ldsdkritaa
301 qalahayfaq yhdpddepea dpydqsfesr dlldewksl tydevisfvp ppldqeemes

WT

1 msdtalifrlawdvkklsfdytpnwgrgnpnnfidvtfpkvltkd kaytyrvavsgnlg
61 vkpsyavesdgsqkvnfleyns gygiadtntiqvf vdpdtnndfiiaqwn

N31S

1 msdtalifrlawdvkklsfdytpnwgrgnpsnfidvtfpkvltkd kaytyrvavsgnlg
61 vkpsyavesdgsqkvnfleyns gygiadtntiqvf vdpdtnndfiiaqwn

T36N

1 msdtalifrlawdvkklsfdytpnwgrgnpnnfidnvtfpkvltkd kaytyrvavsgnlg
61 vkpsyavesdgsqkvnfleyns gygiadtntiqvf vdpdtnndfiiaqwn

N31S/ T36N

1 msdtalifrlawdvkklsfdytpnwgrgnpsnfidnvtfpkvltkd kaytyrvavsgnlg
61 vkpsyavesdgsqkvnfleyns gygiadtntiqvf vdpdtnndfiiaqwn