Figure. 1

Kudzu IspS DNA for *E. coli* (SEQ ID NO:1)

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a

Figure 2

Kudzu IspS protein (SEQ ID NO:2)

MCATSSQFTQITEHNSRRSANYQPNLWNFEFLQSLENDLKVEKLEEKATKLEEEVRCMINRVDTQPLSLLELIDDVQ
RLGLTYKFEKDIIKALENIVLLDENKKNKSDLHATALSFRLLRQHGFEVSQDVFERFKDKEGGFSGELKGDVQGLLS
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KWSNNKIIPAFSKYLENASVSSSGVALLAPSYFSVCQQQEDISDHALRSLTDFHGLVRSSCVIFRLCNDLATSAAEL
ERGETTNSIISYMHENDGTSEEQAREELRKLIDAEWKKMNRERVSDSTLLPKAFMEIAVNMARVSHCTYQYGDGLGR
PDYATENRIKLLLIDPFPINQLMYV

Figure 3

Poplar IspS DNA for *E. coli* (SEQ ID NO:6)

atgtgctctgtttctaccgagaacgtttccttcactgagacggaaaccgaggcacgtcgtagcgcgaactacgagcc
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Figure 4

Poplar IspS protein (SEQ ID NO:7)

MCSVSTENVSFTETETEARRSANYEPNSWDYDFLLSSDTDESIEVYKDKAKKLEAEVRREINNEKAEFLTLLELIDN
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ILSLYEASFLALEGENILDEARVFAISHLKELSEEKIGKELAEQVNHALELPLHRRTQRLEAVWSIEAYRKKEDANQ
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QEAKWLYNKSTPTFDDYFGNAWKSSSGPLQLIFAYFAVVQNIKKEEIENLQKYHDIISRPSHIFRLCNDLASASAEI
ARGETANSVSCYMRTKGISEELATESVMNLIDETCKKMNKEKLGGSLFAKPFVETAINLARQSHCTYHNGDAHTSPD
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Figure 5



Figure 6

Poplar Isoprene Synthase

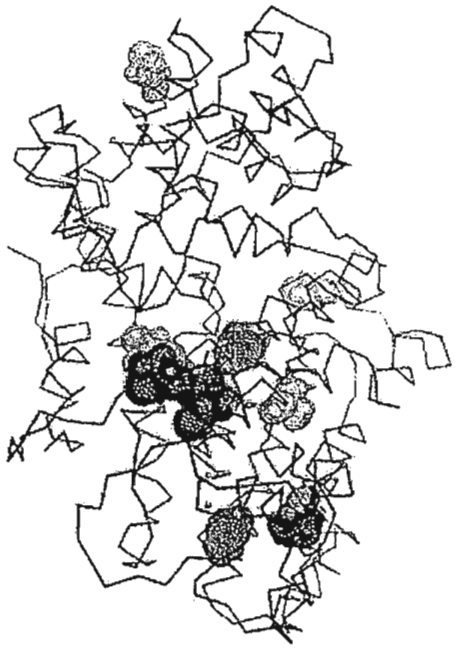


Figure 7

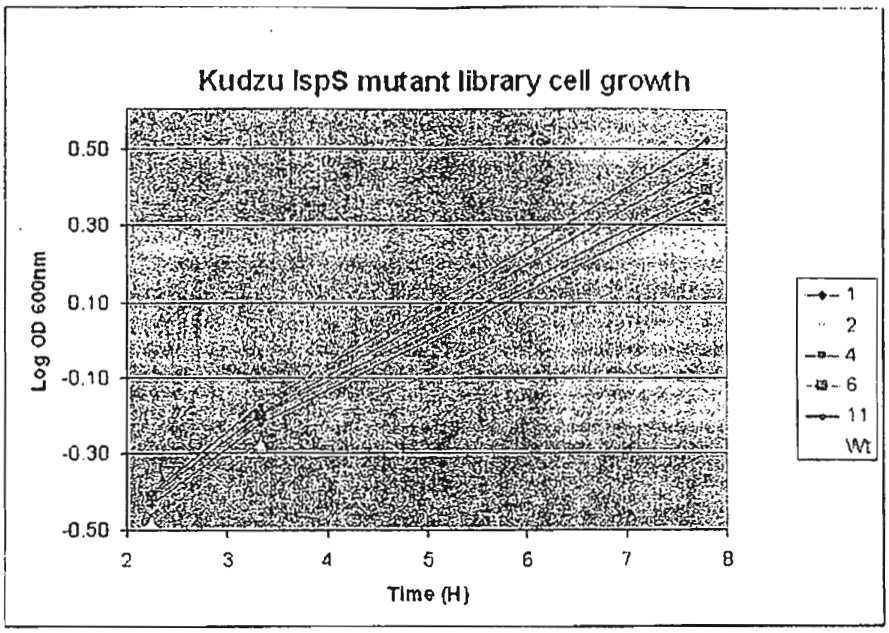

Kudzu IspS mutant library cell growth
Log OD 600nm
0.50
0.30
0.10
-0.10
-0.30
-0.50
2
3
4
5
6
7
8
Time (H)
1
2
4
6
11
Wt

Figure 8

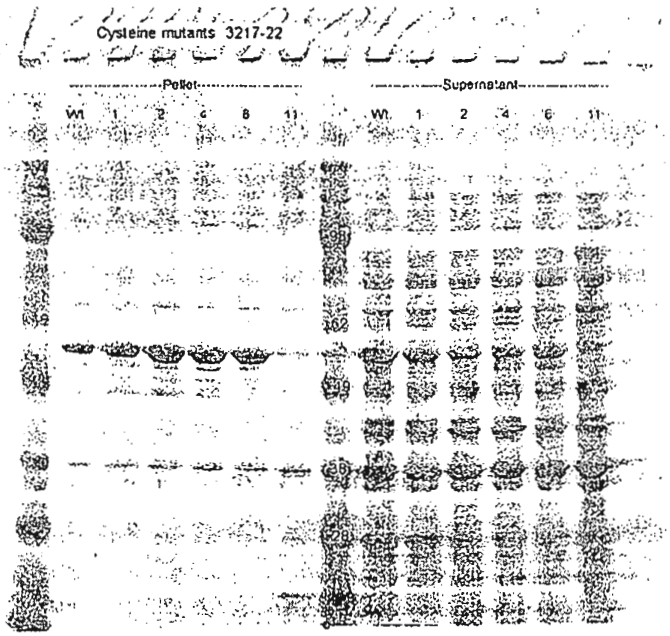

Cysteine mutants 3217-22
Pellet
Supernatant
Wt
1
2
4
8
11
Wt
1
2
4
6
11

Figure 9

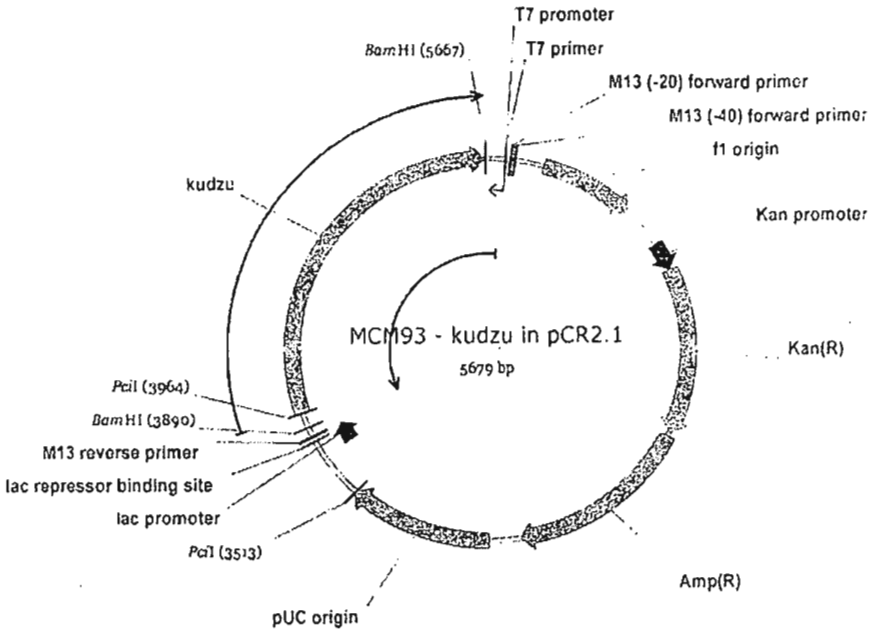

T7 promoter
T7 primer
BamHI (5667)
M13 (-20) forward primer
M13 (-40) forward primer
f1 origin
kudzu
Kan promoter
MCM93 - kudzu in pCR2.1
5679 bp
Kan(R)
PciI (3964)
BamHI (3890)
M13 reverse primer
lac repressor binding site
lac promoter
PciI (3513)
Amp(R)
pUC origin

Figure 10A

plasmid MCM93 = pCR2.1-Kudzu (SEQ ID NO:22)

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Figure 10B

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Figure 11

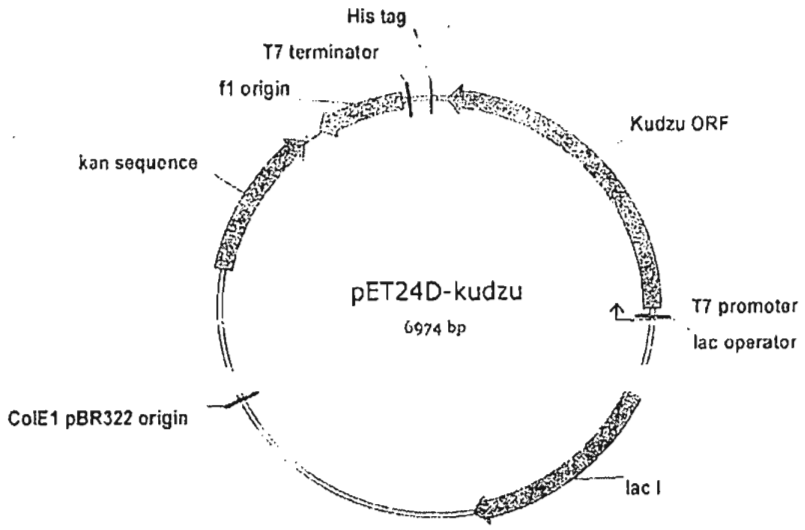

His tag
T7 terminator
f1 origin
Kudzu ORF
kan sequence
pET24D-kudzu
6974 bp
T7 promoter
lac operator
ColE1 pBR322 origin
lac I

Figure 12A

pET24D-Kudzu (SEQ ID NO:23) Kudzu IspS ORF 48-1742 (complementary)

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Figure 12B

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Figure 13

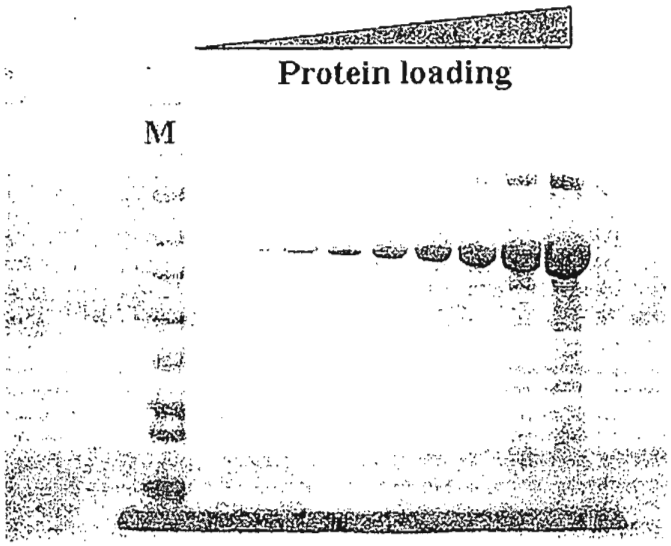


Figure 14

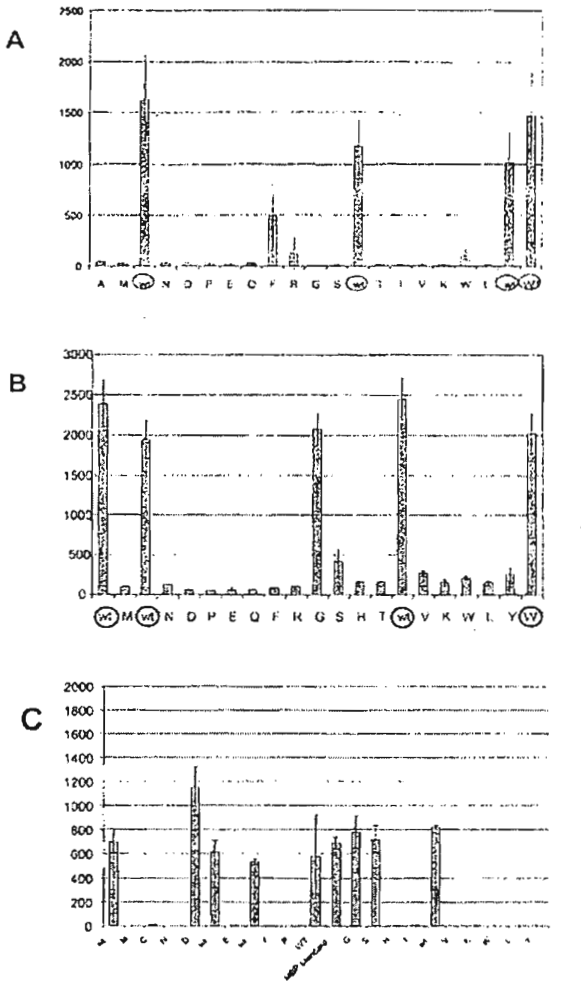

A
2500
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1000
500
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B
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C
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800
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Figure 15

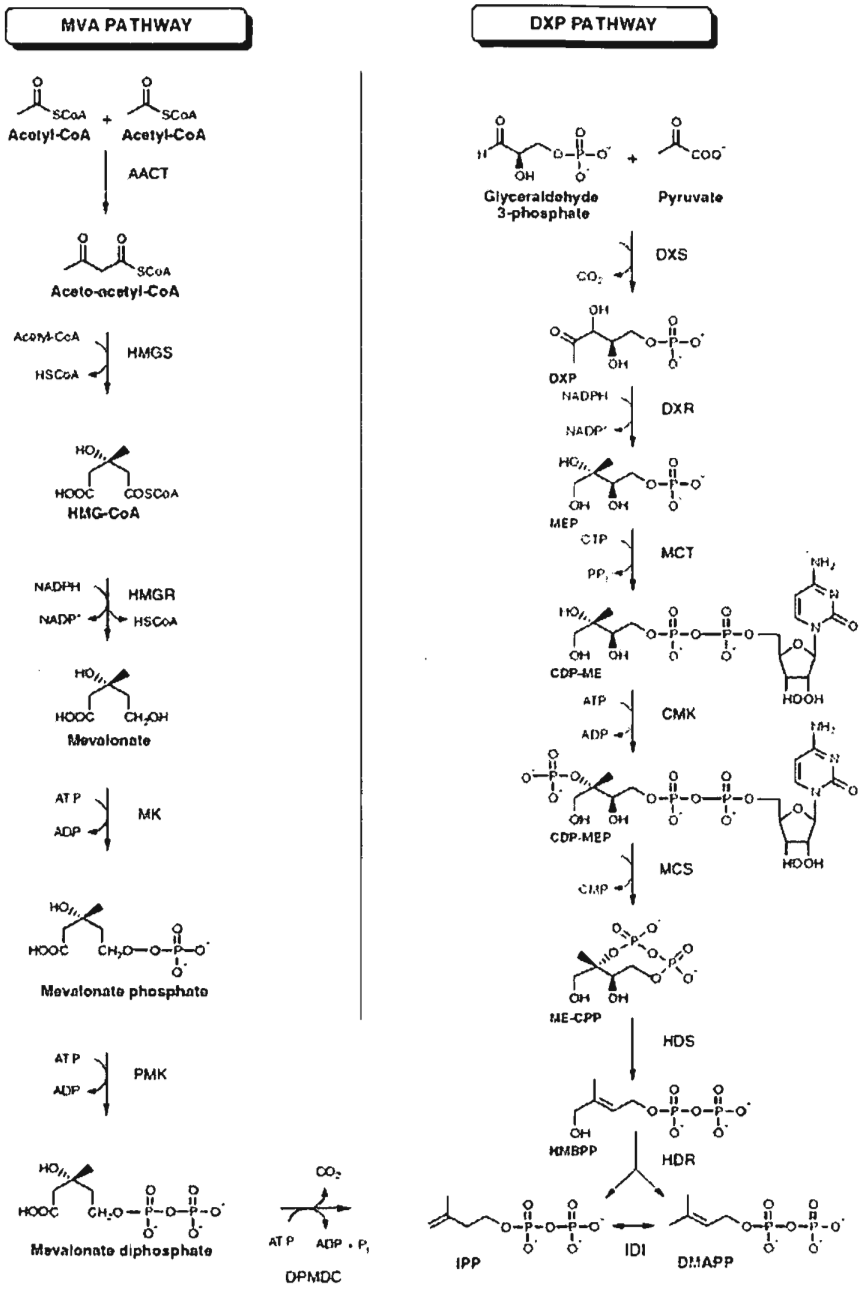

MVA PATHWAY
DXP PATHWAY
Acetyl-CoA
Acetyl-CoA
AACT
Aceto-acetyl-CoA
HMGS
HMG-CoA
NADPH
NADP+
HMGR
HSCoA
Mevalonate
ATP
ADP
MK
Mevalonate phosphate
PMK
Mevalonate diphosphate
CO2
ATP
ADP + Pi
DPMDC
Glyceraldehyde 3-phosphate
Pyruvate
DXS
DXP
NADPH
NADP+
DXR
MEP
CTP
PPi
MCT
CDP-ME
ATP
ADP
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CMP
ME-CPP
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HMBPP
HDR
IPP
IDI
DMAPP

Figure 16

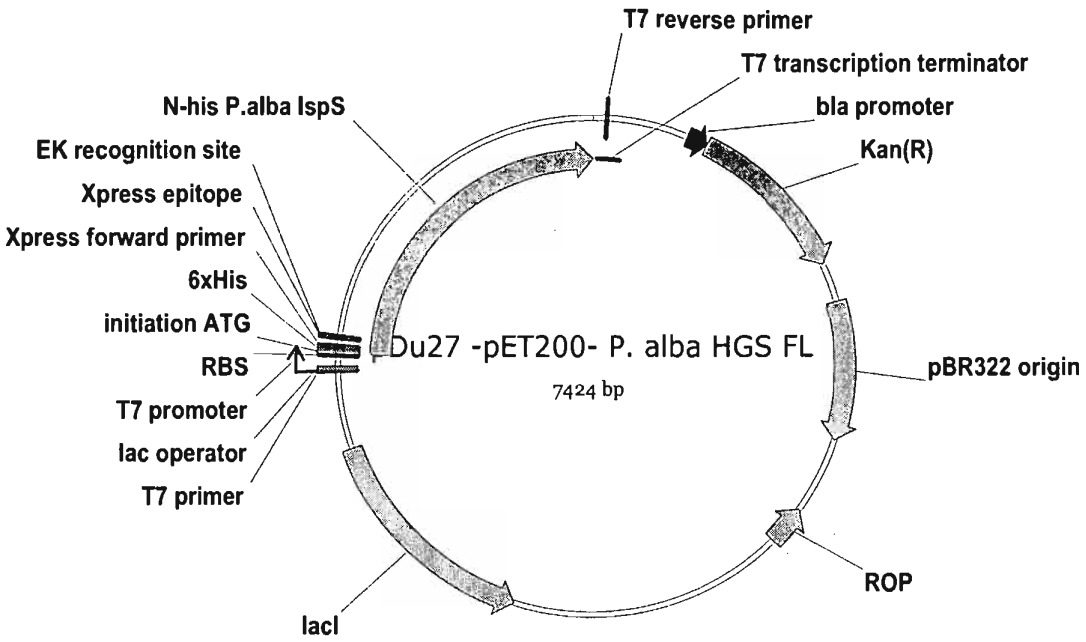

T7 reverse primer
T7 transcription terminator
N-his P.alba IspS
bla promoter
EK recognition site
Kan(R)
Xpress epitope
Xpress forward primer
6xHis
initiation ATG
Du27 -pET200- P. alba HGS FL
7424 bp
RBS
pBR322 origin
T7 promoter
lac operator
T7 primer
ROP
lacI

Figure 17

Amino acid sequence of 6XHis N-terminally tagged *P. alba* IspS (SEQ ID NO:118)

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LSLYEASFLALEGENILDEAKVFAISHLKELSEEKIGKELAEQVNHALELPLHRRTQRLEAVWS
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GVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLDELELFTDAVERWDVNAINDLPDYMKLCF
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GPLQLVFAYFAVVQNIKKEEIENLQKYHDTISRPSHIFRLCNDLASASAEIARGETANSVSCYM
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ELTRKRVLSVITEPILPFER

Figure 18A

Nucleotide sequence of pDu27 (SEQ ID NO:119)

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Figure 18B

Nucleotide sequence of pDu27

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Figure 18C

Nucleotide sequence of pDu27

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Figure 19

Amino acid sequence of full length *P. alba* IspS in P. alba (SEQ ID NO:120)

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GKELAEQVNHALELPLHRRTQRLEAVWSIEAYRKKEDANQVLLELAILDYNMIQSVYQRDLRET
SRWWRRVGLATKLHFARDRLIESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLD
ELELFTDAVERWDVNAINDLPDYMKLCFLALYNTINEIAYDNLKDKGENILPYLTKAWADLCNA
FLQEAKWLYNKSTPTFDDYFGNAWKSSSGPLQLVFAYFAVVQNIKKEEIENLQKYHDTISRPSH
IFRLCNDLASASAEIARGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFA
KPFVETAINLARQSHCTYHNGDAHTSPDELTRKRVLSVITEPILPFER

Figure 20A

Nucleotide sequence of P. alba pET24a (SEQ ID NO:121)

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Figure 20B

Nucleotide sequence of P. alba pET24a

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Figure 20C

Nucleotide sequence of P. alba pET24a

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gggtcttgaggggttttttgctgaaaggaggaactatatccggat

Figure 21

10% NUPAGE Bis-Tris Gel, Reduced

Lane	Gel No. 1 Volume	Description
1	10	MW Marker
2	1.5	Purif IsoS 0.5 ug
3	3.1	Purif IsoS 1 ug
4	6.3	Purif IsoS 2 ug
5	15	P alba Uninduced
6	15	P alba Induced
7	15	P alba Lysate
8	15	P alba Supernatant
9	10	P alba Pellet
10	0	Blank
Function	Coomassie Stain	

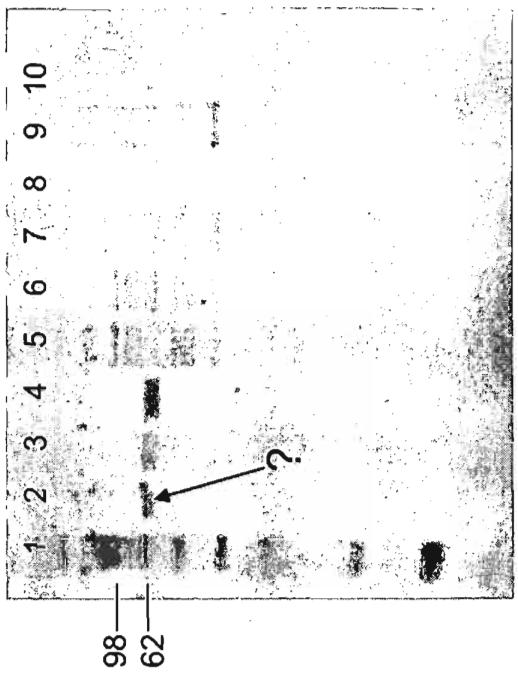


Figure 22

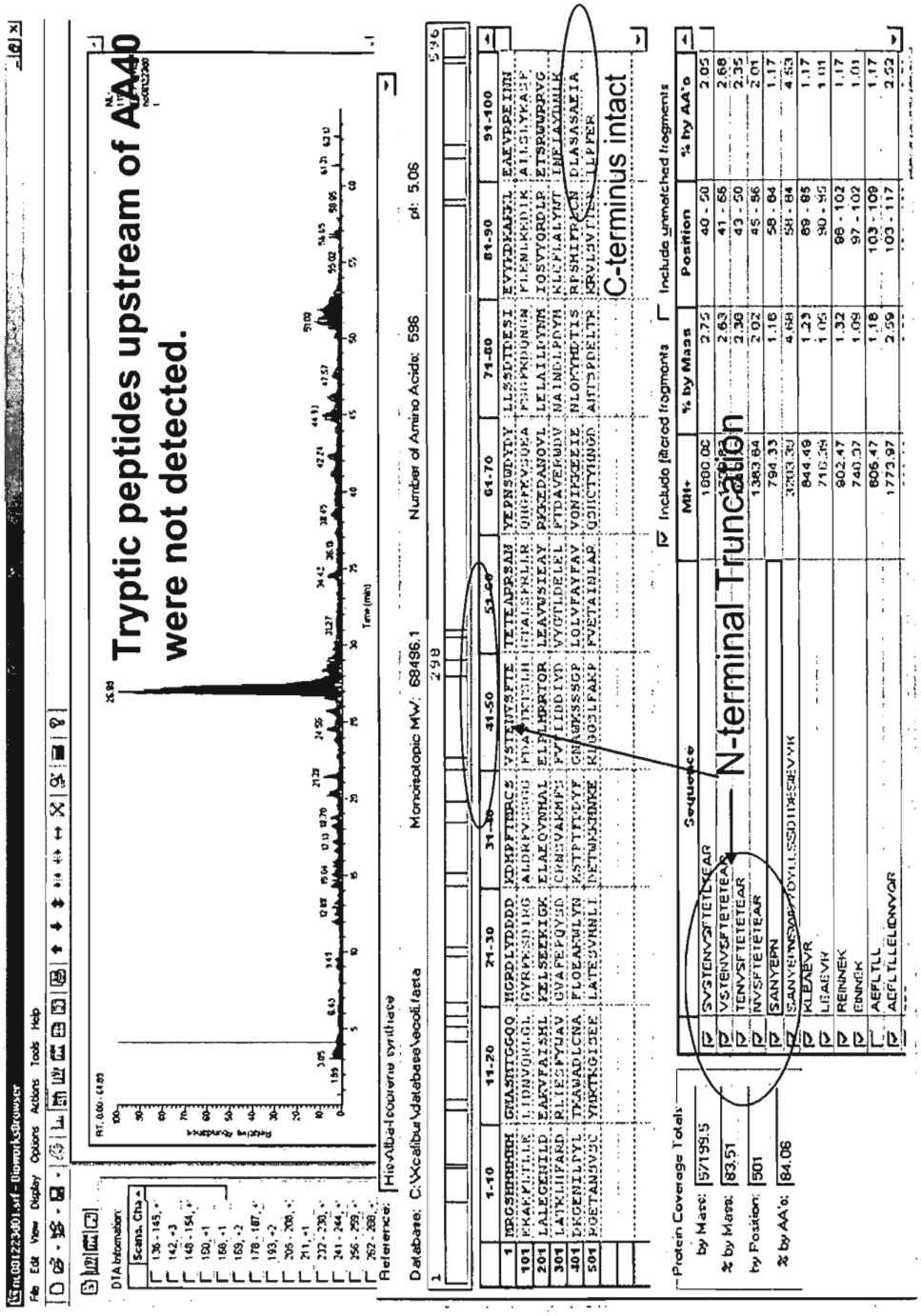

Tryptic peptides upstream of AA40 were not detected.
N-terminal Truncation
C-terminus intact

Figure 23

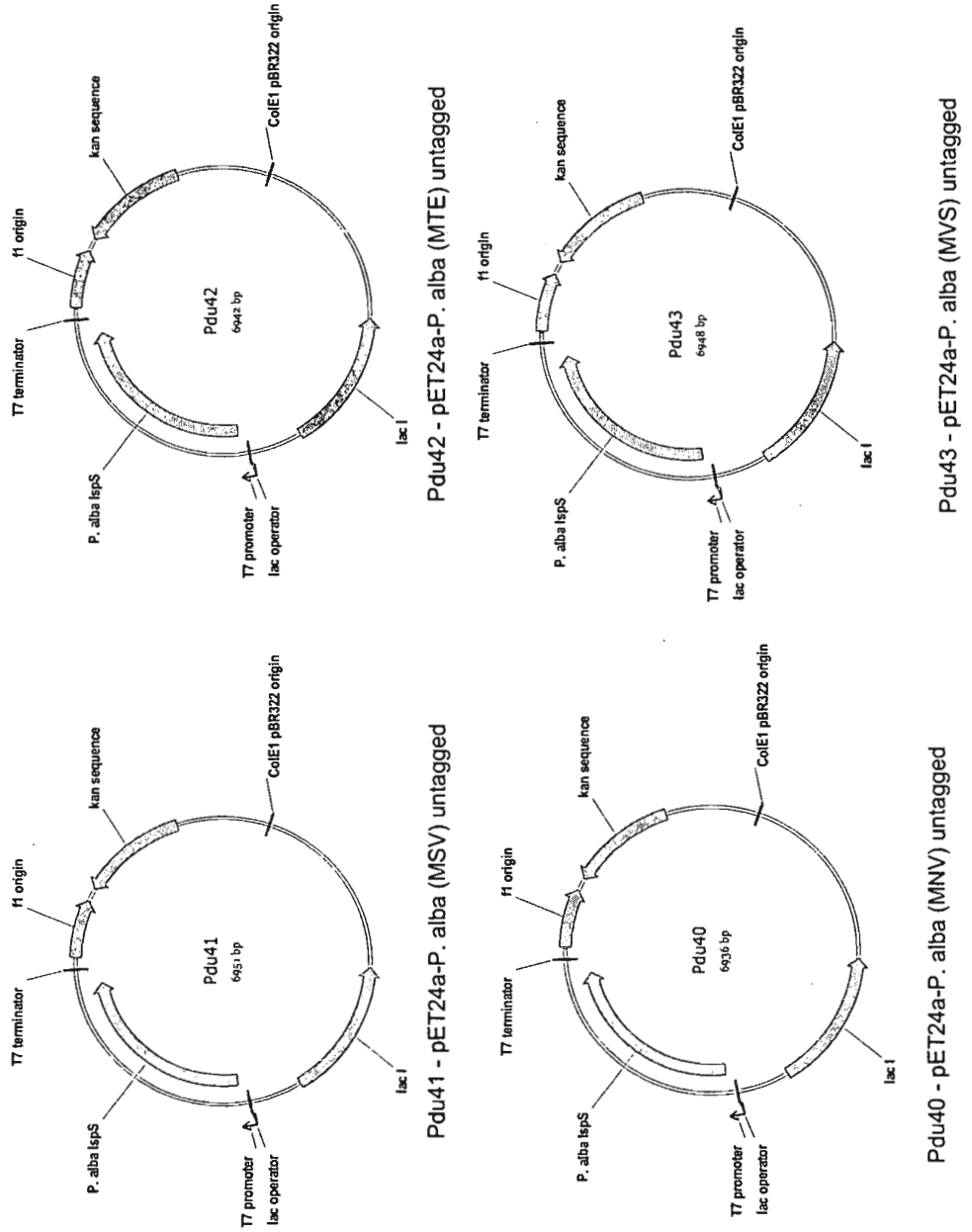

Pdu42
6942 bp
f1 origin
kan sequence
ColE1 pBR322 origin
T7 terminator
P. alba IspS
T7 promoter
lac operator
lac I
Pdu42 - pET24a-P. alba (MTE) untagged
Pdu43
6948 bp
Pdu43 - pET24a-P. alba (MVS) untagged
Pdu41
6931 bp
Pdu41 - pET24a-P. alba (MSV) untagged
Pdu40
6936 bp
Pdu40 - pET24a-P. alba (MNV) untagged

Figure 24

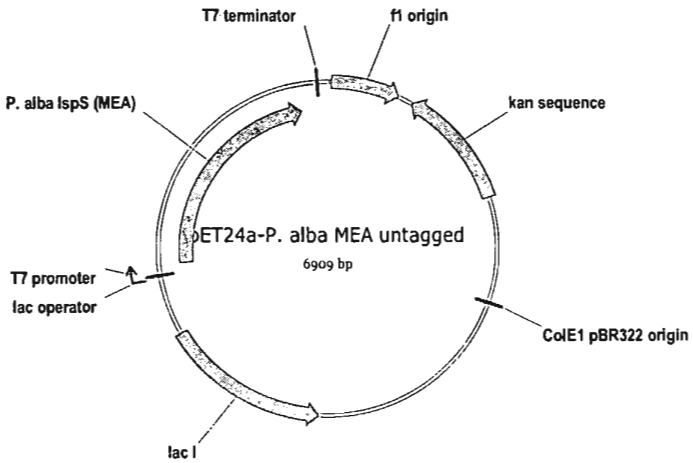

T7 terminator
f1 origin
P. alba IspS (MEA)
kan sequence
pET24a-P. alba MEA untagged
6909 bp
T7 promoter
lac operator
ColE1 pBR322 origin
lac I

Figure 25

Amino acid sequence of "MEA" variant of *P. alba* IspS (SEQ ID NO:122)

MEARRSANYEPNSWDYDYLLSSDTDESIEVYKDKAKKLEAEVRREINNEKAEFLTLLELIDNVQ
RLGLGYRFESDIRGALDRFVSSGGFDAVTKTSLHGTALSFRLLRQHGFEVSQEAFSGFKDQNGN
FLENLKEDIKAILSLYEASFLALEGENILDEAKVFAISHLKELSEEKIGKELAEQVNHALELPL
HRRTQRLEAVWSIEAYRKKEDANQVLLELAILDYNMIQSVYQRDLRETSRWWRRVGLATKLHFA
RDRLIESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLDELELFTDAVERWDVNA
INDLPDYMKLCFLALYNTINEIAYDNLKDKGENILPYLTKAWADLCNAFLQEAKWLYNKSTPTF
DDYFGNAWKSSSGPLQLVFAYFAVVQNIKKEEIENLQKYHDTISRPSHIFRLCNDLASASAEIA
RGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAKPFVETAINLARQSHC
TYHNGDAHTSPDELTRKRVLSVITEPILPFER

Figure 26A

Nucleotide sequence of pDu39 (SEQ ID NO:123)

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tgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcacgtagtgggccatcg
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Figure 26B

Nucleotide sequence of pDu39

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atcgcttcgtttcctccggcggcttcgatgcggtaaccaagacttccctgcacggtacggcact
gtctttccgtctgctgcgtcaacacggttttgaggtttctcaggaagcgttcagcggcttcaaa
gaccaaaacggcaacttcctggagaacctgaaggaagatatcaaagctatcctgagcctgtacg

Figure 26C

Nucleotide sequence of pDu39

aggccagcttcctggctctggaaggcgaaaacatcctggacgaggcgaaggttttcgcaatctc
tcatctgaaagaactgtctgaagaaaagatcggtaaagagctggcagaacaggtgaaccatgca
ctggaactgccactgcatcgccgtactcagcgtctggaagcagtatggtctatcgaggcctacc
gtaaaaaggaggacgcgaatcaggttctgctggagctggcaattctggattacaacatgatcca
gtctgtataccagcgtgatctgcgtgaaacgtcccgttggtggcgtcgtgtgggtctggcgacc
aaactgcactttgctcgtgaccgcctgattgagagcttctactgggccgtgggtgtagcattcg
aaccgcaatactccgactgccgtaactccgtcgcaaaaatgttttctttcgtaaccattatcga
cgatatctacgatgtatacggcaccctggacgaactggagctgtttactgatgcagttgagcgt
tgggacgtaaacgccatcaacgacctgccggattacatgaaactgtgctttctggctctgtata
acactattaacgaaatcgcctacgacaacctgaaagataaaggtgagaacatcctgccgtatct
gaccaaagcctgggctgacctgtgcaacgctttcctgcaagaagccaagtggctgtacaacaaa
tctactccgacctttgacgactacttcggcaacgcatggaaatcctcttctggcccgctgcaac
tggtgttcgcttacttcgctgtcgtgcagaacattaaaaaggaagagatcgaaaacctgcaaaa
ataccatgacaccatctctcgtccttcccatatcttccgtctgtgcaatgacctggctagcgcg
tctgcggaaattgcgcgtggtgaaaccgcaaatagcgtttcttgttacatgcgcactaaaggta
tctccgaagaactggctaccgaaagcgtgatgaatctgatcgatgaaacctggaaaaagatgaa
caaggaaaaactgggtggtagcctgttcgcgaaaccgttcgtggaaaccgcgatcaacctggca
cgtcaatctcactgcacttatcataacggcgacgcgcatacctctccggatgagctgacccgca
aacgcgttctgtctgtaatcactgaaccgattctgccgtttgaacgctaaggatccgaattcga
gctccgtcgacaagcttgcggccgcactcgagcaccaccaccaccaccactgagatccggctgc
taacaaagcccgaaaggaagctgagttggctgctgccaccgctgagcaataactagcataaccc
cttggggcctctaaacgggtcttgaggggttttttgctgaaaggaggaactatatccggat

Figure 27

Amino acid sequence of truncated "MSV" variant of *P. alba* IspS (SEQ ID NO:124)

MSVSTENVSFTETETEARRSANYEPNSWDYDYLLSSDTDESIEVYKDKAKKLEAEVRREINNEK
AEFLTLLELIDNVQRLGLGYRFESDIRGALDRFVSSGGFDAVTKTSLHGTALSFRLLRQHGFEV
SQEAFSGFKDQNGNFLENLKEDIKAILSLYEASFLALEGENILDEAKVFAISHLKELSEEKIGK
ELAEQVNHALELPLHRRTQRLEAVWSIEAYRKKEDANQVLLELAILDYNMIQSVYQRDLRETSR
WWRRVGLATKLHFARDRLIESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLDEL
ELFTDAVERWDVNAINDLPDYMKLCFLALYNTINEIAYDNLKDKGENILPYLTKAWADLCNAFL
QEAKWLYNKSTPTFDDYFGNAWKSSSGPLQLVFAYFAVVQNIKKEEIENLQKYHDTISRPSHIF
RLCNDLASASAEIARGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAKP
FVETAINLARQSHCTYHNGDAHTSPDELTRKRVLSVITEPILPFER

Figure 28A

Nucleotide sequence of pDu41 (pET24a-P.alba (MSV) Untagged) (SEQ ID NO:125)

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagc
gtgaccgctacacttgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcg
ccacgttcgccggctttccccgtcaagctctaaatcgggggctcccttagggttccgatttag
tgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcacgtagtgggccatcg
ccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgt
tccaaactggaacaacactcaaccctatctcggtctattcttttgatttataagggattttgcc
gatttcggcctattggttaaaaaatgagctgatttaacaaaaatttaacgcgaattttaacaaa
atattaacgtttacaatttcaggtggcacttttcggggaaatgtgcgcggaacccctatttgtt
tatttttctaaatacattcaaatatgtatccgctcatgaattaattcttagaaaaactcatcga
gcatcaaatgaaactgcaatttattcatatcaggattatcaataccatatttttgaaaaagccg
tttctgtaatgaaggagaaaactcaccgaggcagttccataggatggcaagatcctggtatcgg
tctgcgattccgactcgtccaacatcaatacaacctattaatttcccctcgtcaaaaataaggt
tatcaagtgagaaatcaccatgagtgacgactgaatccggtgagaatggcaaaagtttatgcat
ttctttccagacttgttcaacaggccagccattacgctcgtcatcaaaatcactcgcatcaacc
aaaccgttattcattcgtgattgcgcctgagcgagacgaaatacgcgatcgctgttaaaaggac
aattacaaacaggaatcgaatgcaaccggcgcaggaacactgccagcgcatcaacaatattttc
acctgaatcaggatattcttctaatacctggaatgctgttttcccggggatcgcagtggtgagt
aaccatgcatcatcaggagtacggataaaatgcttgatggtcggaagaggcataaattccgtca
gccagtttagtctgaccatctcatctgtaacatcattggcaacgctacctttgccatgtttcag
aaacaactctggcgcatcgggcttcccatacaatcgatagattgtcgcacctgattgcccgaca
ttatcgcgagcccatttatacccatataaatcagcatccatgttggaatttaatcgcggcctag
agcaagacgtttcccgttgaatatggctcataacacccttgtattactgtttatgtaagcaga
cagttttattgttcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcagaccc
cgtagaaaagatcaaaggatcttcttgagatccttttttttctgcgcgtaatctgctgcttgcaa
acaaaaaaaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttc
cgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgtagccgtagtt
aggccaccacttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttacca
gtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccgg
ataaggcgcagcggtcgggctgaacgggggggttcgtgcacacagcccagcttggagcgaacgac
ctacaccgaactgagatacctacagcgtgagctatgagaaagcgccacgcttcccgaagggaga
aaggcggacaggtatccggtaagcggcagggtcggaacaggagagcgcacgagggagcttccag
ggggaaacgcctggtatctttatagtcctgtcgggtttcgccacctctgacttgagcgtcgatt
tttgtgatgctcgtcaggggggcggagcctatggaaaaacgccagcaacgcggccttttacgg
ttcctggccttttgctggccttttgctcacatgttctttcctgcgttatcccctgattctgtgg
ataaccgtattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccgagcgcag
cgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacgcatctgtgc
ggtatttcacaccgcatatatggtgcactctcagtacaatctgctctgatgccgcatagttaag
ccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacac
ccgctgacgcgccctgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgt
ctccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggcagctgcgg
taaagctcatcagcgtggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagct
cgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatgttaagggcggt

Figure 28B

Nucleotide sequence of pDu41 (pET24a-P.alba (MSV) Untagged)

ttttcctgtttggtcactgatgcctccgtgtaaggggatttctgttcatgggggtaatgata
ccgatgaaacgagagaggatgctcacgatacgggttactgatgatgaacatgcccggttactgg
aacgttgtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcaggg
tcaatgccagcgcttcgttaatacagatgtaggtgttccacagggtagccagcagcatcctgcg
atgcagatccggaacataatggtgcagggcgctgacttccgcgtttccagactttacgaaacac
ggaaaccgaagaccattcatgttgttgctcaggtcgcagacgttttgcagcagcagtcgcttca
cgttcgctcgcgtatcggtgattcattctgctaaccagtaaggcaaccccgccagcctagccgg
gtcctcaacgacaggagcacgatcatgcgcacccgtggggccgccatgccggcgataatggcct
gcttctcgccgaaacgtttggtggcgggaccagtgacgaaggcttgagcgagggcgtgcaagat
tccgaataccgcaagcgacaggccgatcatcgtcgcgctccagcgaaagcggtcctcgccgaaa
atgacccagagcgctgccggcacctgtcctacgagttgcatgataaagaagacagtcataagtg
cggcgacgatagtcatgccccgcgcccaccggaaggagctgactgggttgaaggctctcaaggg
catcggtcgagatcccggtgcctaatgagtgagctaacttacattaattgcgttgcgctcactg
cccgctttccagtcgggaaacctgtcgtgccagctgcattaatgaatcggccaacgcgcgggga
gaggcggtttgcgtattgggcgccagggtggtttttctttcaccagtgagacgggcaacagct
gattgcccttcaccgcctggccctgagagagttgcagcaagcggtccacgctggtttgccccag
caggcgaaaatcctgtttgatggtggttaacggcgggatataacatgagctgtcttcggtatcg
tcgtatcccactaccgagatatccgcaccaacgcgcagcccggactcggtaatggcgcgcattg
cgcccagcgccatctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcat
ttgcatggtttgttgaaaaccggacatggcactccagtcgccttcccgttccgctatcggctga
atttgattgcgagtgagatatttatgccagccagccagacgcagacgcgccgagacagaactta
atgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagatgctccacgcccagtcg
cgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcagagacatcaagaaat
aacgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagt
taatgatcagcccactgacgcgttgcgcgagaagattgtgcaccgccgctttacaggcttcgac
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actgtttgcccgccagttgttgtgccacgcggttgggaatgtaattcagctccgccatcgccgc
ttccactttttcccgcgttttcgcagaaacgtggctggcctggttcaccacgcgggaaacggtc
tgataagagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccc
tgaattgactctcttccgggcgctatcatgccataccgcgaaaggttttgcgccattcgatggt
gtccgggatctcgacgctctcccttatgcgactcctgcattaggaagcagcccagtagtaggtt
gaggccgttgagcaccgccgccgcaaggaatggtgcatgcaaggagatggcgcccaacagtccc
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cccgatcttccccatcggtgatgtcggcgatataggcgccagcaaccgcacctgtggcgccggt
gatgccggccacgatgcgtccggcgtagaggatcgagatctcgatcccgcgaaattaatacgac
tcactatagggaattgtgagcggataacaattcccctctagaaataattttgtttaactttaa
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ggacgagtccatcgaagtatacaaagacaaagcgaaaaagctggaagccgaagttcgtcgcgag
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gcctgggttaccgtttcgagtctgatatccgtggtgcgctggatcgcttcgtttcctccggcgg
cttcgatgcggtaaccaagacttccctgcacggtacggcactgtctttccgtctgctgcgtcaa

Figure 28C

Nucleotide sequence of pDu41 (pET24a-P.alba (MSV) Untagged)

cacggttttgaggtttctcaggaagcgttcagcggcttcaaagaccaaaacggcaacttcctgg
agaacctgaaggaagatatcaaagctatcctgagcctgtacgaggccagcttcctggctctgga
aggcgaaaacatcctggacgaggcgaaggttttcgcaatctctcatctgaaagaactgtctgaa
gaaaagatcggtaaagagctggcagaacaggtgaaccatgcactggaactgccactgcatcgcc
gtactcagcgtctggaagcagtatggtctatcgaggcctaccgtaaaaaggaggacgcgaatca
ggttctgctggagctggcaattctggattacaacatgatccagtctgtataccagcgtgatctg
cgtgaaacgtcccgttggtggcgtcgtgtgggtctggcgaccaaactgcactttgctcgtgacc
gcctgattgagagcttctactgggccgtgggtgtagcattcgaaccgcaatactccgactgccg
taactccgtcgcaaaaatgttttctttcgtaaccattatcgacgatatctacgatgtatacggc
accctggacgaactggagctgtttactgatgcagttgagcgttgggacgtaaacgccatcaacg
acctgccggattacatgaaactgtgctttctggctctgtataacactattaacgaaatcgccta
cgacaacctgaaagataaaggtgagaacatcctgccgtatctgaccaaagcctgggctgacctg
tgcaacgctttcctgcaagaagccaagtggctgtacaacaaatctactccgacctttgacgact
acttcggcaacgcatggaaatcctcttctggcccgctgcaactggtgttcgcttacttcgctgt
cgtgcagaacattaaaaaggaagagatcgaaaacctgcaaaaataccatgacaccatctctcgt
ccttcccatatcttccgtctgtgcaatgacctggctagcgcgtctgcggaaattgcgcgtggtg
aaaccgcaaatagcgtttcttgttacatgcgcactaaaggtatctccgaagaactggctaccga
aagcgtgatgaatctgatcgatgaaacctggaaaaagatgaacaaggaaaaactgggtggtagc
ctgttcgcgaaaccgttcgtggaaaccgcgatcaacctggcacgtcaatctcactgcacttatc
ataacggcgacgcgcatacctctccggatgagctgacccgcaaacgcgttctgtctgtaatcac
tgaaccgattctgccgtttgaacgctaaggatccgaattcgagctccgtcgacaagcttgcggc
cgcactcgagcaccaccaccaccaccactgagatccggctgctaacaaagcccgaaaggaagct
gagttggctgctgccaccgctgagcaataactagcataaccccttggggcctctaaacgggtct
tgaggggttttttgctgaaaggaggaactatatccggat

Figure 29

Amino acid sequence of truncated "MVS" Variant of *P. alba* IspS (SEQ ID NO:126)

MVSTENVSFTETETEARRSANYEPNSWDYDYLLSSDTDESIEVYKDKAKKLEAEVRREINNEKA
EFLTLLELIDNVQRLGLGYRFESDIRGALDRFVSSGGFDAVTKTSLHGTALSFRLLRQHGFEVS
QEAFSGFKDQNGNFLENLKEDIKAILSLYEASFLALEGENILDEAKVFAISHLKELSEEKIGKE
LAEQVNHALELPLHRRTQRLEAVWSIEAYRKKEDANQVLLELAILDYNMIQSVYQRDLRETSRW
WRRVGLATKLHFARDRLIESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLDELE
LFTDAVERWDVNAINDLPDYMKLCFLALYNTINEIAYDNLKDKGENILPYLTKAWADLCNAFLQ
EAKWLYNKSTPTFDDYFGNAWKSSSGPLQLVFAYFAVVQNIKKEEIENLQKYHDTISRPSHIFR
LCNDLASASAEIARGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAKPF
VETAINLARQSHCTYHNGDAHTSPDELTRKRVLSVITEPILPFER

Figure 30A

Nucleotide sequence of pDu43 (pET24a-P.alba (MVS) Untagged) (SEQ ID NO:127)

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagc
gtgaccgctacacttgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcg
ccacgttcgccggctttccccgtcaagctctaaatcgggggctccctttagggttccgatttag
tgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcacgtagtgggccatcg
ccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgt
tccaaactggaacaacactcaaccctatctcggtctattcttttgatttataagggattttgcc
gatttcggcctattggttaaaaaatgagctgatttaacaaaaatttaacgcgaattttaacaaa
atattaacgtttacaatttcaggtggcacttttcggggaaatgtgcgcggaacccctatttgtt
tatttttctaaatacattcaaatatgtatccgctcatgaattaattcttagaaaaactcatcga
gcatcaaatgaaactgcaatttattcatatcaggattatcaataccatatttttgaaaaagccg
tttctgtaatgaaggagaaaactcaccgaggcagttccataggatggcaagatcctggtatcgg
tctgcgattccgactcgtccaacatcaatacaacctattaatttcccctcgtcaaaaataaggt
tatcaagtgagaaatcaccatgagtgacgactgaatccggtgagaatggcaaaagtttatgcat
ttctttccagacttgttcaacaggccagccattacgctcgtcatcaaaatcactcgcatcaacc
aaaccgttattcattcgtgattgcgcctgagcgagacgaaatacgcgatcgctgttaaaaggac
aattacaaacaggaatcgaatgcaaccggcgcaggaacactgccagcgcatcaacaatattttc
acctgaatcaggatattcttctaatacctggaatgctgttttcccggggatcgcagtggtgagt
aaccatgcatcatcaggagtacggataaaatgcttgatggtcggaagaggcataaattccgtca
gccagtttagtctgaccatctcatctgtaacatcattggcaacgctacctttgccatgtttcag
aaacaactctggcgcatcgggcttcccatacaatcgatagattgtcgcacctgattgcccgaca
ttatcgcgagcccatttatacccatataaatcagcatccatgttggaatttaatcgcggcctag
agcaagacgtttcccgttgaatatggctcataacacccttgtattactgtttatgtaagcaga
cagttttattgttcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcagaccc
cgtagaaaagatcaaaggatcttcttgagatcctttttttctgcgcgtaatctgctgcttgcaa
acaaaaaaaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttc
cgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgtagccgtagtt
aggccaccacttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttacca
gtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccgg
ataaggcgcagcggtcgggctgaacgggggttcgtgcacacagcccagcttggagcgaacgac
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ggggaaacgcctggtatctttatagtcctgtcgggtttcgccacctctgacttgagcgtcgatt
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ttcctggccttttgctggccttttgctcacatgttctttcctgcgttatcccctgattctgtgg
ataaccgtattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccgagcgcag
cgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacgcatctgtgc
ggtatttcacaccgcatatatggtgcactctcagtacaatctgctctgatgccgcatagttaag
ccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacac
ccgctgacgcgccctgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgt
ctccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggcagctgcgg
taaagctcatcagcgtggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagct
cgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatgttaagggcggt
tttttcctgtttggtcactgatgcctccgtgtaagggggatttctgttcatgggggtaatgata

Figure 30B

Nucleotide sequence of pDu43 (pET24a-P.alba (MVS) Untagged)

ccgatgaaacgagagaggatgctcacgatacgggttactgatgatgaacatgcccggttactgg
aacgttgtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcaggg
tcaatgccagcgcttcgttaatacagatgtaggtgttccacagggtagccagcagcatcctgcg
atgcagatccggaacataatggtgcagggcgctgacttccgcgtttccagactttacgaaacac
ggaaaccgaagaccattcatgttgttgctcaggtcgcagacgttttgcagcagcagtcgcttca
cgttcgctcgcgtatcggtgattcattctgctaaccagtaaggcaaccccgccagcctagccgg
gtcctcaacgacaggagcacgatcatgcgcacccgtggggccgccatgccggcgataatggcct
gcttctcgccgaaacgtttggtggcgggaccagtgacgaaggcttgagcgagggcgtgcaagat
tccgaataccgcaagcgacaggccgatcatcgtcgcgctccagcgaaagcggtcctcgccgaaa
atgacccagagcgctgccggcacctgtcctacgagttgcatgataaagaagacagtcataagtg
cggcgacgatagtcatgccccgcgcccaccggaaggagctgactgggttgaaggctctcaaggg
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gaggcggtttgcgtattgggcgccagggtggtttttctttcaccagtgagacgggcaacagct
gattgcccttcaccgcctggccctgagagagttgcagcaagcggtccacgctggtttgccccag
caggcgaaaatcctgtttgatggtggttaacggcgggatataacatgagctgtcttcggtatcg
tcgtatcccactaccgagatatccgcaccaacgcgcagcccggactcggtaatggcgcgcattg
cgcccagcgccatctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcat
ttgcatggtttgttgaaaaccggacatggcactccagtcgccttcccgttccgctatcggctga
atttgattgcgagtgagatatttatgccagccagccagacgcagacgcgccgagacagaacttа
atgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagatgctccacgcccagtcg
cgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcagagacatcaagaaat
aacgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagt
taatgatcagcccactgacgcgttgcgcgagaagattgtgcaccgccgctttacaggcttcgac
gccgcttcgttctaccatcgacaccaccacgctggcacccagttgatcggcgcgagatttaatc
gccgcgacaatttgcgacggcgcgtgcagggccagactggaggtggcaacgccaatcagcaacg
actgtttgcccgccagttgttgtgccacgcggttgggaatgtaattcagctccgccatcgccgc
ttccactttttcccgcgttttcgcagaaacgtggctggcctggttcaccacgcgggaaacggtc
tgataagagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccc
tgaattgactctcttccgggcgctatcatgccataccgcgaaaggttttgcgccattcgatggt
gtccgggatctcgacgctctcccttatgcgactcctgcattaggaagcagcccagtagtaggtt
gaggccgttgagcaccgccgccgcaaggaatggtgcatgcaaggagatggcgcccaacagtccc
ccggccacggggcctgccaccatacccacgccgaaacaagcgctcatgagcccgaagtggcgag
cccgatcttccccatcggtgatgtcggcgatataggcgccagcaaccgcacctgtggcgccggt
gatgccggccacgatgcgtccggcgtagaggatcgagatctcgatcccgcgaaattaatacgac
tcactataggggaattgtgagcggataacaattcccctctagaaataattttgtttaactttaa
gaaggagatatacatatggtgtccaccgaaaatgtgtctttcaccgaaactgaaaccgaagctc
gtcgttctgcgaactacgaacctaacagctgggactatgattacctgctgtcctccgacacgga
cgagtccatcgaagtatacaaagacaaagcgaaaaagctggaagccgaagttcgtcgcgagatt
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tgggttaccgtttcgagtctgatatccgtggtgcgctggatcgcttcgtttcctccggcggctt
cgatgcggtaaccaagacttccctgcacggtacggcactgtctttccgtctgctgcgtcaacac
ggttttgaggtttctcaggaagcgttcagcggcttcaaagaccaaaacggcaacttcctggaga

Figure 30C

Nucleotide sequence of pDu43 (pET24a-P.alba (MVS) Untagged)

acctgaaggaagatatcaaagctatcctgagcctgtacgaggccagcttcctggctctggaagg
cgaaaacatcctggacgaggcgaaggttttcgcaatctctcatctgaaagaactgtctgaagaa
aagatcggtaaagagctggcagaacaggtgaaccatgcactggaactgccactgcatcgccgta
ctcagcgtctggaagcagtatggtctatcgaggcctaccgtaaaaaggaggacgcgaatcaggt
tctgctggagctggcaattctggattacaacatgatccagtctgtataccagcgtgatctgcgt
gaaacgtcccgttggtggcgtcgtgtgggtctggcgaccaaactgcactttgctcgtgaccgcc
tgattgagagcttctactgggccgtgggtgtagcattcgaaccgcaatactccgactgccgtaa
ctccgtcgcaaaaatgttttctttcgtaaccattatcgacgatatctacgatgtatacggcacc
ctggacgaactggagctgtttactgatgcagttgagcgttgggacgtaaacgccatcaacgacc
tgccggattacatgaaactgtgctttctggctctgtataacactattaacgaaatcgcctacga
caacctgaaagataaaggtgagaacatcctgccgtatctgaccaaagcctgggctgacctgtgc
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tcggcaacgcatggaaatcctcttctggcccgctgcaactggtgttcgcttacttcgctgtcgt
gcagaacattaaaaaggaagagatcgaaaacctgcaaaaataccatgacaccatctctcgtcct
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ttcgcgaaaccgttcgtggaaaccgcgatcaacctggcacgtcaatctcactgcacttatcata
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accgattctgccgtttgaacgctaaggatccgaattcgagctccgtcgacaagcttgcggccgc
actcgagcaccaccaccaccaccactgagatccggctgctaacaaagcccgaaaggaagctgag
ttggctgctgccaccgctgagcaataactagcataaccccttggggcctctaaacgggtcttga
ggggttttttgctgaaaggaggaactatatccggat

Figure 31

Amino acid sequence of truncated "MTE" variant of *P. alba* IspS (SEQ ID NO:128)

MTENVSFTETETEARRSANYEPNSWDYDYLLSSDTDESIEVYKDKAKKLEAEVRREINNEKAEF
LTLLELIDNVQRLGLGYRFESDIRGALDRFVSSGGFDAVTKTSLHGTALSFRLLRQHGFEVSQE
AFSGFKDQNGNFLENLKEDIKAILSLYEASFLALEGENILDEAKVFAISHLKELSEEKIGKELA
EQVNHALELPLHRRTQRLEAVWSIEAYRKKEDANQVLLELAILDYNMIQSVYQRDLRETSRWWR
RVGLATKLHFARDRLIESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLDELELF
TDAVERWDVNAINDLPDYMKLCFLALYNTINEIAYDNLKDKGENILPYLTKAWADLCNAFLQEA
KWLYNKSTPTFDDYFGNAWKSSSGPLQLVFAYFAVVQNIKKEEIENLQKYHDTISRPSHIFRLC
NDLASASAEIARGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAKPFVE
TAINLARQSHCTYHNGDAHTSPDELTRKRVLSVITEPILPFER

Figure 32A

Nucleotide sequence of pDu42 (pET24a-P.alba (MTE) Untagged) (SEQ ID NO:129)

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagc
gtgaccgctacacttgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcg
ccacgttcgccggctttccccgtcaagctctaaatcgggggctcccttagggttccgatttag
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ccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgt
tccaaactggaacaacactcaaccctatctcggtctattcttttgatttataagggattttgcc
gatttcggcctattggttaaaaaatgagctgatttaacaaaaatttaacgcgaattttaacaaa
atattaacgtttacaatttcaggtggcacttttcggggaaatgtgcgcggaacccctatttgtt
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gcatcaaatgaaactgcaatttattcatatcaggattatcaataccatatttttgaaaaagccg
tttctgtaatgaaggagaaaactcaccgaggcagttccataggatggcaagatcctggtatcgg
tctgcgattccgactcgtccaacatcaatacaacctattaatttcccctcgtcaaaaataaggt
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aattacaaacaggaatcgaatgcaaccggcgcaggaacactgccagcgcatcaacaatattttc
acctgaatcaggatattcttctaatacctggaatgctgttttcccggggatcgcagtggtgagt
aaccatgcatcatcaggagtacggataaaatgcttgatggtcggaagaggcataaattccgtca
gccagtttagtctgaccatctcatctgtaacatcattggcaacgctacctttgccatgtttcag
aaacaactctggcgcatcgggcttcccatacaatcgatagattgtcgcacctgattgcccgaca
ttatcgcgagcccatttatacccatataaatcagcatccatgttggaatttaatcgcggcctag
agcaagacgtttcccgttgaatatggctcataacacccttgtattactgtttatgtaagcaga
cagttttattgttcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcagaccc
cgtagaaaagatcaaaggatcttcttgagatccttttttttctgcgcgtaatctgctgcttgcaa
acaaaaaaaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttc
cgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgtagccgtagtt
aggccaccacttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttacca
gtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccgg
ataaggcgcagcggtcgggctgaacgggggggttcgtgcacacagcccagcttggagcgaacgac
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ttcctggccttttgctggccttttgctcacatgttctttcctgcgttatcccctgattctgtgg
ataaccgtattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccgagcgcag
cgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacgcatctgtgc
ggtatttcacaccgcatatatggtgcactctcagtacaatctgctctgatgccgcatagttaag
ccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacac
ccgctgacgcgccctgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgt
ctccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggcagctgcgg
taaagctcatcagcgtggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagct
cgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatgttaagggcggt
tttttcctgtttggtcactgatgcctccgtgtaaggggatttctgttcatgggggtaatgata

Figure 32B

Nucleotide sequence of pDu42 (pET24a-P.alba (MTE) Untagged)

ccgatgaaacgagagaggatgctcacgatacgggttactgatgatgaacatgcccggttactgg
aacgttgtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcaggg
tcaatgccagcgcttcgttaatacagatgtaggtgttccacagggtagccagcagcatcctgcg
atgcagatccggaacataatggtgcagggcgctgacttccgcgtttccagactttacgaaacac
ggaaaccgaagaccattcatgttgttgctcaggtcgcagacgttttgcagcagcagtcgcttca
cgttcgctcgcgtatcggtgattcattctgctaaccagtaaggcaaccccgccagcctagccgg
gtcctcaacgacaggagcacgatcatgcgcacccgtggggccgccatgccggcgataatggcct
gcttctcgccgaaacgtttggtggcgggaccagtgacgaaggcttgagcgagggcgtgcaagat
tccgaataccgcaagcgacaggccgatcatcgtcgcgctccagcgaaagcggtcctcgccgaaa
atgacccagagcgctgccggcacctgtcctacgagttgcatgataaagaagacagtcataagtg
cggcgacgatagtcatgccccgcgcccaccggaaggagctgactgggttgaaggctctcaaggg
catcggtcgagatcccggtgcctaatgagtgagctaacttacattaattgcgttgcgctcactg
cccgctttccagtcgggaaacctgtcgtgccagctgcattaatgaatcggccaacgcgcgggga
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gattgcccttcaccgcctggccctgagagagttgcagcaagcggtccacgctggtttgccccag
caggcgaaaatcctgtttgatggtggttaacggcgggatataacatgagctgtcttcggtatcg
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cgcccagcgccatctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcat
ttgcatggtttgttgaaaaccggacatggcactccagtcgccttcccgttccgctatcggctga
atttgattgcgagtgagatatttatgccagccagccagacgcagacgcgccgagacagaactta
atgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagatgctccacgcccagtcg
cgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcagagacatcaagaaat
aacgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagt
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ttccactttttcccgcgttttcgcagaaacgtggctggcctggttcaccacgcgggaaacggtc
tgataagagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccc
tgaattgactctcttccgggcgctatcatgccataccgcgaaaggttttgcgccattcgatggt
gtccgggatctcgacgctctcccttatgcgactcctgcattaggaagcagcccagtagtaggtt
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accgtttcgagtctgatatccgtggtgcgctggatcgcttcgtttcctccggcggcttcgatgc
ggtaaccaagacttccctgcacggtacggcactgtctttccgtctgctgcgtcaacacggtttt
gaggtttctcaggaagcgttcagcggcttcaaagaccaaaacggcaacttcctggagaacctga

Figure 32C

Nucleotide sequence of pDu42 (pET24a-P.alba (MTE) Untagged)

aggaagatatcaaagctatcctgagcctgtacgaggccagcttcctggctctggaaggcgaaaa
catcctggacgaggcgaaggttttcgcaatctctcatctgaaagaactgtctgaagaaaagatc
ggtaaagagctggcagaacaggtgaaccatgcactggaactgccactgcatcgccgtactcagc
gtctggaagcagtatggtctatcgaggcctaccgtaaaaaggaggacgcgaatcaggttctgct
ggagctggcaattctggattacaacatgatccagtctgtataccagcgtgatctgcgtgaaacg
tcccgttggtggcgtcgtgtgggtctggcgaccaaactgcactttgctcgtgaccgcctgattg
agagcttctactgggccgtgggtgtagcattcgaaccgcaatactccgactgccgtaactccgt
cgcaaaaatgttttctttcgtaaccattatcgacgatatctacgatgtatacggcaccctggac
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attacatgaaactgtgctttctggctctgtataacactattaacgaaatcgcctacgacaacct
gaaagataaaggtgagaacatcctgccgtatctgaccaaagcctgggctgacctgtgcaacgct
ttcctgcaagaagccaagtggctgtacaacaaatctactccgacctttgacgactacttcggca
acgcatggaaatcctcttctggcccgctgcaactggtgttcgcttacttcgctgtcgtgcagaa
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atcttccgtctgtgcaatgacctggctagcgcgtctgcggaaattgcgcgtggtgaaaccgcaa
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gcaccaccaccaccaccactgagatccggctgctaacaaagcccgaaaggaagctgagttggct
gctgccaccgctgagcaataactagcataaccccttggggcctctaaacgggtcttgaggggtt
ttttgctgaaaggaggaactatatccggat

Figure 33

Amino acid Sequence of truncated "MNV" variant of *P. alba* IspS (SEQ ID NO:130)

MNVSFTETETEARRSANYEPNSWDYDYLLSSDTDESIEVYKDKAKKLEAEVRREINNEKAEFLT
LLELIDNVQRLGLGYRFESDIRGALDRFVSSGGFDAVTKTSLHGTALSFRLLRQHGFEVSQEAF
SGFKDQNGNFLENLKEDIKAILSLYEASFLALEGENILDEAKVFAISHLKELSEEKIGKELAEQ
VNHALELPLHRRTQRLEAVWSIEAYRKKEDANQVLLELAILDYNMIQSVYQRDLRETSRWWRRV
GLATKLHFARDRLIESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLDELELFTD
AVERWDVNAINDLPDYMKLCFLALYNTINEIAYDNLKDKGENILPYLTKAWADLCNAFLQEAKW
LYNKSTPTFDDYFGNAWKSSSGPLQLVFAYFAVVQNIKKEEIENLQKYHDTISRPSHIFRLCND
LASASAEIARGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAKPFVETA
INLARQSHCTYHNGDAHTSPDELTRKRVLSVITEPILPFER

Figure 34A

Nucleotide sequence of pDu40 (pET24a-P.alba (MNV) Untagged) (SEQ ID NO:131)

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagc
gtgaccgctacacttgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcg
ccacgttcgccggctttccccgtcaagctctaaatcgggggctcccttagggttccgatttag
tgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcacgtagtgggccatcg
ccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgt
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gcatcaaatgaaactgcaatttattcatatcaggattatcaataccatatttttgaaaaagccg
tttctgtaatgaaggagaaaactcaccgaggcagttccataggatggcaagatcctggtatcgg
tctgcgattccgactcgtccaacatcaatacaacctattaatttcccctcgtcaaaaataaggt
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ttctttccagacttgttcaacaggccagccattacgctcgtcatcaaaatcactcgcatcaacc
aaaccgttattcattcgtgattgcgcctgagcgagacgaaatacgcgatcgctgttaaaaggac
aattacaaacaggaatcgaatgcaaccggcgcaggaacactgccagcgcatcaacaatatttttc
acctgaatcaggatattcttctaatacctggaatgctgttttcccggggatcgcagtggtgagt
aaccatgcatcatcaggagtacggataaaatgcttgatggtcggaagaggcataaattccgtca
gccagtttagtctgaccatctcatctgtaacatcattggcaacgctacctttgccatgtttcag
aaacaactctggcgcatcgggcttcccatacaatcgatagattgtcgcacctgattgcccgaca
ttatcgcgagcccatttatacccatataaatcagcatccatgttggaatttaatcgcggcctag
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cagttttattgttcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcagaccc
cgtagaaaagatcaaaggatcttcttgagatccttttttttctgcgcgtaatctgctgcttgcaa
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cgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgtagccgtagtt
aggccaccacttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttacca
gtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccgg
ataaggcgcagcggtcgggctgaacgggggggttcgtgcacacagcccagcttggagcgaacgac
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cgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacgcatctgtgc
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taaagctcatcagcgtggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagct
cgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatgttaagggcggt
tttttcctgtttggtcactgatgcctccgtgtaagggggatttctgttcatgggggtaatgata

Figure 34B

Nucleotide sequence of pDu40 (pET24a-P.alba (MNV) Untagged)

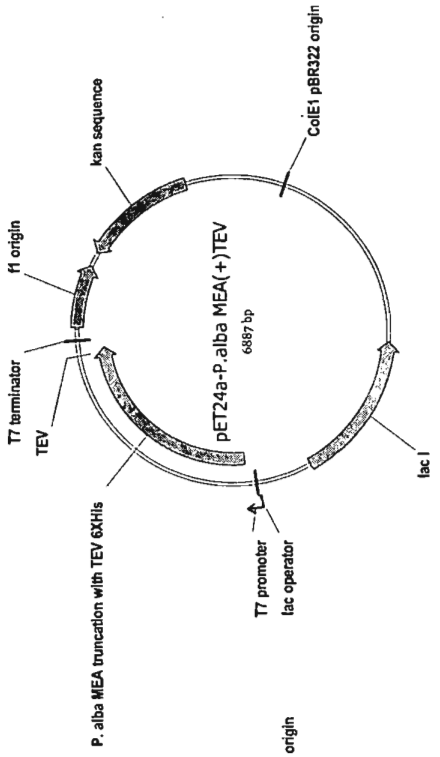
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aacgttgtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcaggg
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ggaaaccgaagaccattcatgttgttgctcaggtcgcagacgttttgcagcagcagtcgcttca
cgttcgctcgcgtatcggtgattcattctgctaaccagtaaggcaaccccgccagcctagccgg
gtcctcaacgacaggagcacgatcatgcgcacccgtggggccgccatgccggcgataatggcct
gcttctcgccgaaacgtttggtggcgggaccagtgacgaaggcttgagcgagggcgtgcaagat
tccgaataccgcaagcgacaggccgatcatcgtcgcgctccagcgaaagcggtcctcgccgaaa
atgacccagagcgctgccggcacctgtcctacgagttgcatgataaagaagacagtcataagtg
cggcgacgatagtcatgccccgcgcccaccggaaggagctgactgggttgaaggctctcaaggg
catcggtcgagatcccggtgcctaatgagtgagctaacttacattaattgcgttgcgctcactg
cccgctttccagtcgggaaacctgtcgtgccagctgcattaatgaatcggccaacgcgcgggga
gaggcggtttgcgtattgggcgccagggtggtttttctttcaccagtgagacgggcaacagct
gattgcccttcaccgcctggccctgagagagttgcagcaagcggtccacgctggtttgccccag
caggcgaaaatcctgtttgatggtggttaacggcgggatataacatgagctgtcttcggtatcg
tcgtatcccactaccgagatatccgcaccaacgcgcagcccggactcggtaatggcgcgcattg
cgcccagcgccatctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcat
ttgcatggtttgttgaaaaccggacatggcactccagtcgccttcccgttccgctatcggctga
atttgattgcgagtgagatatttatgccagccagccagacgcagacgcgccgagacagaactta
atgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagatgctccacgcccagtcg
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aacgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagt
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actgtttgcccgccagttgttgtgccacgcggttgggaatgtaattcagctccgccatcgccgc
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tgataagagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccc
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gaggccgttgagcaccgccgccgcaaggaatggtgcatgcaaggagatggcgcccaacagtccc
ccggccacggggcctgccaccatacccacgccgaaacaagcgctcatgagcccgaagtggcgag
cccgatcttccccatcggtgatgtcggcgatataggcgccagcaaccgcacctgtggcgccggt
gatgccggccacgatgcgtccggcgtagaggatcgagatctcgatcccgcgaaattaatacgac
tcactatagggaattgtgagcggataacaattcccctctagaaataattttgtttaactttaa
gaaggagatatacatatgaatgtgtctttcaccgaaactgaaaccgaagctcgtcgttctgcga
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agtatacaaagacaaagcgaaaaagctggaagccgaagttcgtcgcgagattaataacgaaaaa
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caagacttccctgcacggtacggcactgtctttccgtctgctgcgtcaacacggttttgaggtt
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Figure 34C

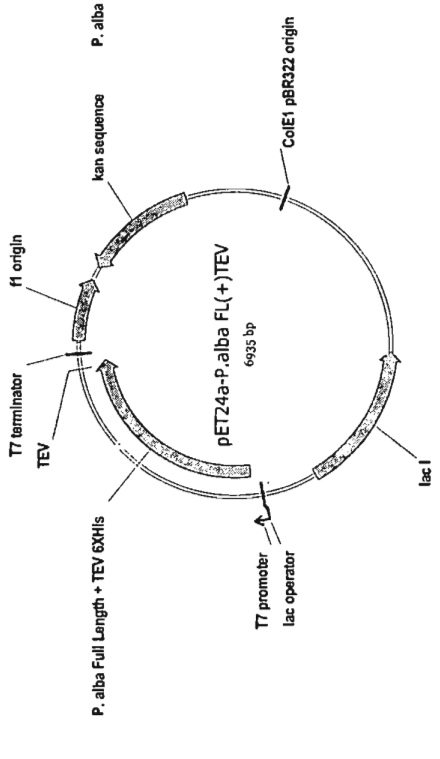
Nucleotide sequence of pDu40 (pET24a-P.alba (MNV) Untagged)

atatcaaagctatcctgagcctgtacgaggccagcttcctggctctggaaggcgaaaacatcct
ggacgaggcgaaggttttcgcaatctctcatctgaaagaactgtctgaagaaaagatcggtaaa
gagctggcagaacaggtgaaccatgcactggaactgccactgcatcgccgtactcagcgtctgg
aagcagtatggtctatcgaggcctaccgtaaaaaggaggacgcgaatcaggttctgctggagct
ggcaattctggattacaacatgatccagtctgtataccagcgtgatctgcgtgaaacgtcccgt
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aatgttttctttcgtaaccattatcgacgatatctacgatgtatacggcaccctggacgaactg
gagctgtttactgatgcagttgagcgttgggacgtaaacgccatcaacgacctgccggattaca
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tttcttgttacatgcgcactaaaggtatctccgaagaactggctaccgaaagcgtgatgaatct
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gtttgaacgctaaggatccgaattcgagctccgtcgacaagcttgcggccgcactcgagcacca
ccaccaccaccactgagatccggctgctaacaaagcccgaaaggaagctgagttggctgctgcc
accgctgagcaataactagcataaccccttggggcctctaaacgggtcttgaggggttttttgc
tgaaaggaggaactatatccggat

Figure 35



MD09-163



MD09-161

Figure 36

Amino acid sequence of *P. alba* MEA(+)TEV (SEQ ID NO:132)

MEARRSANYEPNSWDYDYLLSSDTDESIEVYKDKAKKLEAEVRREINNEKAEFLTLLELIDNVQ
RLGLGYRFESDIRGALDRFVSSGGFDAVTKTSLHGTALSFRLLRQHGFEVSQEAFSGFKDQNGN
FLENLKEDIKAILSLYEASFLALEGENILDEAKVFAISHLKELSEEKIGKELAEQVNHALELPL
HRRTQRLEAVWSIEAYRKKEDANQVLLELAILDYNMIQSVYQRDLRETSRWWRRVGLATKLHFA
RDRLIESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLDELELFTDAVERWDVNA
INDLPDYMKLCFLALYNTINEIAYDNLKDKGENILPYLTKAWADLCNAFLQEAKWLYNKSTPTF
DDYFGNAWKSSSGPLQLVFAYFAVVQNIKKEEIENLQKYHDTISRPSHIFRLCNDLASASAEIA
RGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAKPFVETAINLARQSHC
TYHNGDAHTSPDELTRKRVLSVITEPILPFERENLYFQGLEHHHHHH

Figure 37A

Nucleotide sequence of MD09-163 (pET24a-P. alba MEA(+)TEV) (SEQ ID NO:133)

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagc
gtgaccgctacacttgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcg
ccacgttcgccggctttccccgtcaagctctaaatcgggggctcccttagggttccgatttag
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ccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgt
tccaaactggaacaacactcaaccctatctcggtctattcttttgatttataagggattttgcc
gatttcggcctattggttaaaaaatgagctgatttaacaaaaatttaacgcgaatttaacaaa
atattaacgtttacaatttcaggtggcacttttcggggaaatgtgcgcggaacccctatttgtt
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aattacaaacaggaatcgaatgcaaccggcgcaggaacactgccagcgcatcaacaatattttc
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aaccatgcatcatcaggagtacggataaaatgcttgatggtcggaagaggcataaattccgtca
gccagtttagtctgaccatctcatctgtaacatcattggcaacgctacctttgccatgtttcag
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cagttttattgttcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcagaccc
cgtagaaaagatcaaaggatcttcttgagatccttttttttctgcgcgtaatctgctgcttgcaa
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ataaggcgcagcggtcgggctgaacgggggggttcgtgcacacagcccagcttggagcgaacgac
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ccgctgacgcgccctgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgt
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taaagctcatcagcgtggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagct
cgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatgttaagggcggt

Figure 37B

Nucleotide sequence of MD09-163 (pET24a-P. alba MEA(+)TEV)

ttttcctgtttggtcactgatgcctccgtgtaaggggatttctgttcatgggggtaatgata
ccgatgaaacgagagaggatgctcacgatacgggttactgatgatgaacatgcccggttactgg
aacgttgtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcaggg
tcaatgccagcgcttcgttaatacagatgtaggtgttccacagggtagccagcagcatcctgcg
atgcagatccggaacataatggtgcagggcgctgacttccgcgtttccagactttacgaaacac
ggaaaccgaagaccattcatgttgttgctcaggtcgcagacgttttgcagcagcagtcgcttca
cgttcgctcgcgtatcggtgattcattctgctaaccagtaaggcaaccccgccagcctagccgg
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atgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagatgctccacgcccagtcg
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aacgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagt
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atcgcttcgtttcctccggcggcttcgatgcggtaaccaagacttccctgcacggtacggcact
gtcttttccgtctgctgcgtcaacacggttttgaggtttctcaggaagcgttcagcggcttcaaa

Figure 37C

Nucleotide sequence of MD09-163 (pET24a-P. alba MEA(+)TEV)

gaccaaaacggcaacttcctggagaacctgaaggaagatatcaaagctatcctgagcctgtacg
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tcatctgaaagaactgtctgaagaaaagatcggtaaagagctggcagaacaggtgaaccatgca
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gtaaaaaggaggacgcgaatcaggttctgctggagctggcaattctggattacaacatgatcca
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gggcctcgagcaccaccaccaccaccactgagatccggctgctaacaaagcccgaaaggaagct
gagttggctgctgccaccgctgagcaataactagcataaccccttggggcctctaaacgggtct
tgaggggttttttgctgaaaggaggaactatatccggat

Figure 38

Amino acid sequence of *P. alba* FL (+) TEV (SEQ ID NO:134)

MRCSVSTENVSFTETETEARRSANYEPNSWDYDYLLSSDTDESIEVYKDKAKKLEAEVRREINN
EKAEFLTLLELIDNVQRLGLGYRFESDIRGALDRFVSSGGFDAVTKTSLHGTALSFRLLRQHGF
EVSQEAFSGFKDQNGNFLENLKEDIKAILSLYEASFLALEGENILDEAKVFAISHLKELSEEKI
GKELAEQVNHALELPLHRRTQRLEAVWSIEAYRKKEDANQVLLELAILDYNMIQSVYQRDLRET
SRWWRRVGLATKLHFARDRLIESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLD
ELELFTDAVERWDVNAINDLPDYMKLCFLALYNTINEIAYDNLKDKGENILPYLTKAWADLCNA
FLQEAKWLYNKSTPTFDDYFGNAWKSSSGPLQLVFAYFAVVQNIKKEEIENLQKYHDTISRPSH
IFRLCNDLASASAEIARGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFA
KPFVETAINLARQSHCTYHNGDAHTSPDELTRKRVLSVITEPILPFERENLYFQGLEHHHHHH

Figure 39A

Nucleotide sequence of MD09-161 (pET24a-P. alba FL(+)TEV) (SEQ ID NO:135)

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gtgaccgctacacttgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcg
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gatttcggcctattggttaaaaaatgagctgatttaacaaaaatttaacgcgaattttaacaaa
atattaacgtttacaatttcaggtggcacttttcggggaaatgtgcgcggaacccctatttgtt
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gcatcaaatgaaactgcaatttattcatatcaggattatcaataccatatttttgaaaaagccg
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acctgaatcaggatattcttctaatacctggaatgctgttttcccggggatcgcagtggtgagt
aaccatgcatcatcaggagtacggataaaatgcttgatggtcggaagaggcataaattccgtca
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ttatcgcgagcccatttatacccatataaatcagcatccatgttggaatttaatcgcggcctag
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taaagctcatcagcgtggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagct
cgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatgttaagggcggt

Figure 39B

Nucleotide sequence of MD09-161 (pET24a-P. alba FL(+)TEV)

ttttcctgtttggtcactgatgcctccgtgtaaggggatttctgttcatgggggtaatgata
ccgatgaaacgagagaggatgctcacgatacgggttactgatgatgaacatgcccggttactgg
aacgttgtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcaggg
tcaatgccagcgcttcgttaatacagatgtaggtgttccacagggtagccagcagcatcctgcg
atgcagatccggaacataatggtgcagggcgctgacttccgcgtttccagactttacgaaacac
ggaaaccgaagaccattcatgttgttgctcaggtcgcagacgttttgcagcagcagtcgcttca
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Figure 39C

Nucleotide sequence of MD09-161 (pET24a-P. alba FL(+)TEV)

cgtcaacacggttttgaggtttctcaggaagcgttcagcggcttcaaagaccaaaacggcaact
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Figure 40

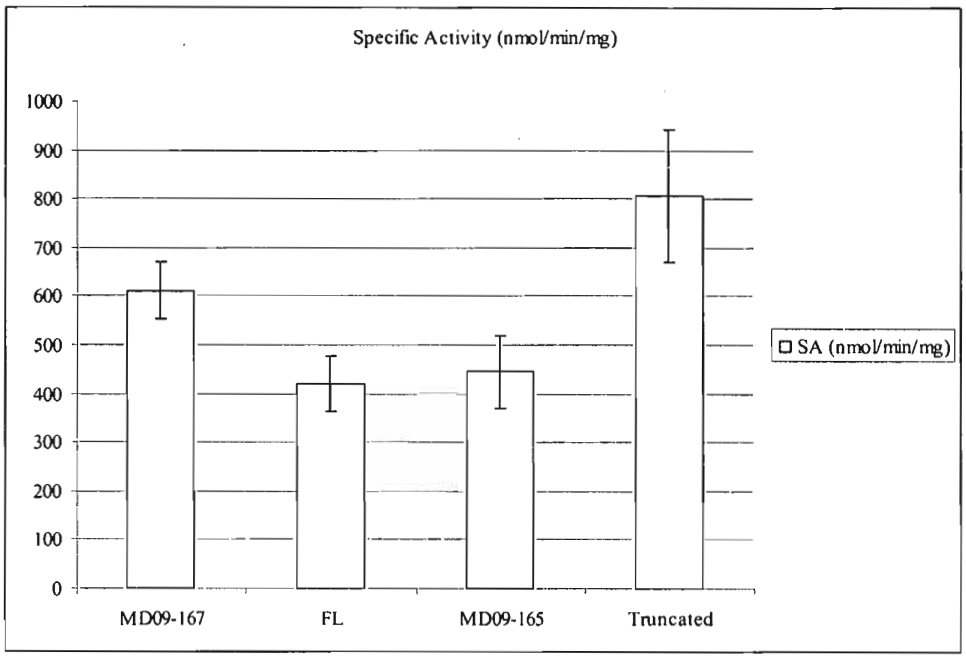

Specific Activity (nmol/min/mg)
1000
900
800
700
600
500
400
300
200
100
0
MD09-167
FL
MD09-165
Truncated
SA (nmol/min/mg)

Figure 41

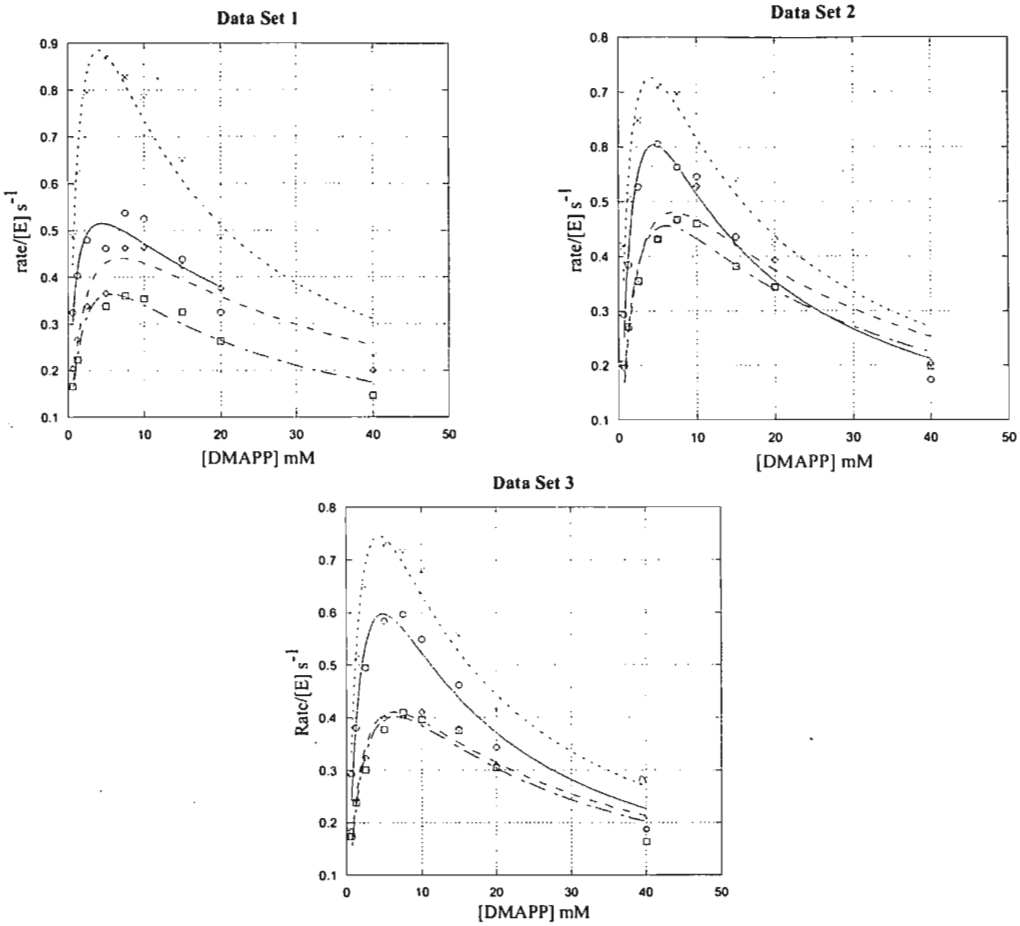

Data Set 1
rate/[E] s-1
[DMAPP] mM
Data Set 2
rate/[E] s-1
[DMAPP] mM
Data Set 3
Ratc/[E] s-1
[DMAPP] mM

Figure 42

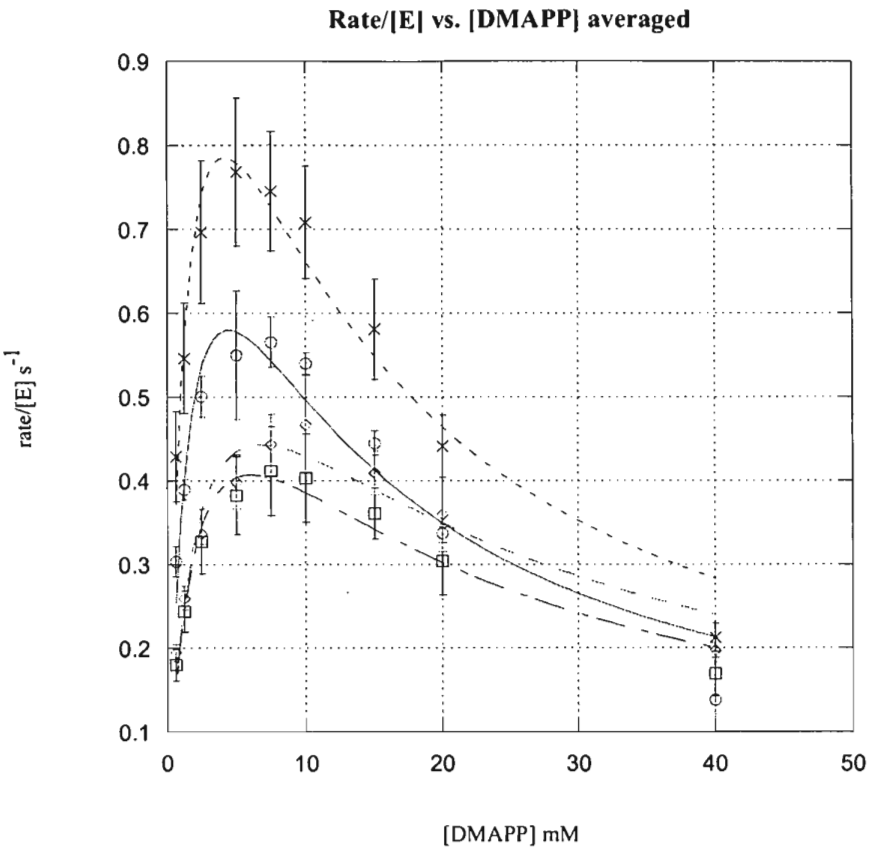
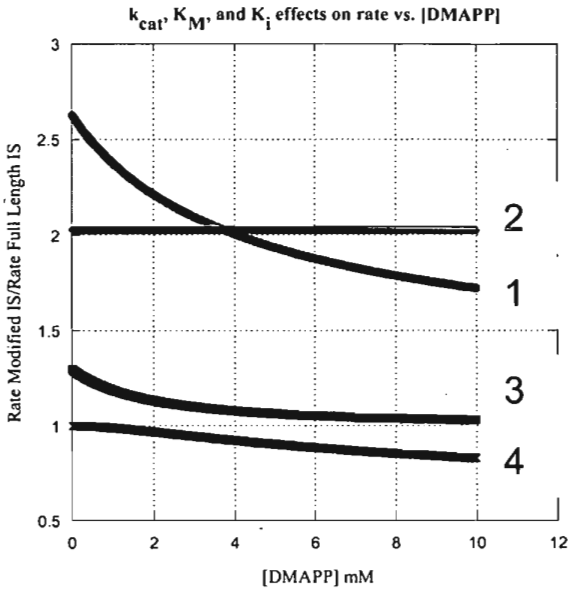

Rate/[E] vs. [DMAPP] averaged
rate/[E] s-1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
10
20
30
40
50
[DMAPP] mM

Figure 43

A.


k_{cat}, K_M, and K_i effects on rate vs. [DMAPP]
Rate Modified IS/Rate Full Length IS
[DMAPP] mM
1
2
3
4

B.

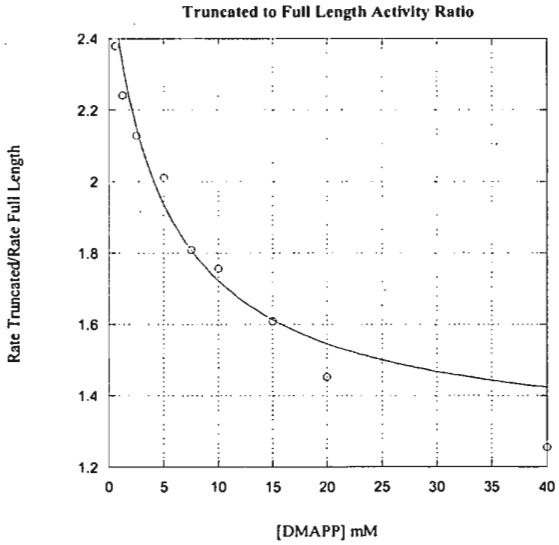
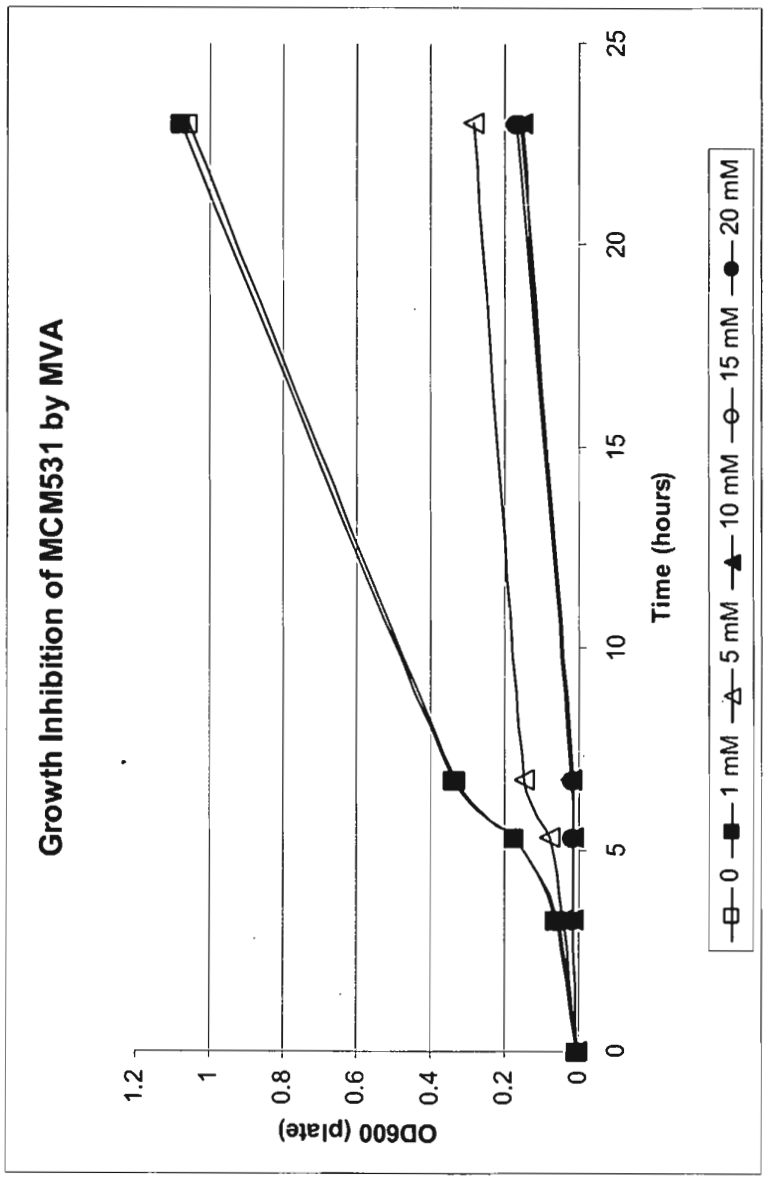
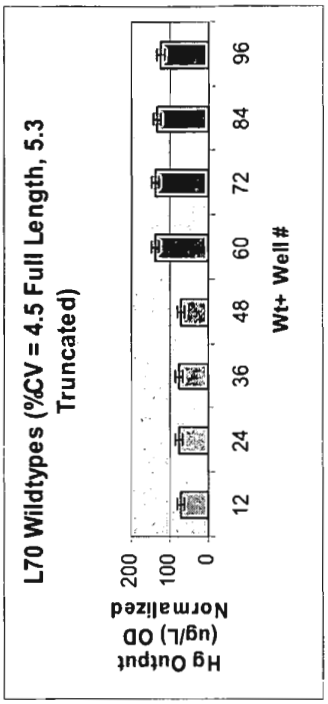

Truncated to Full Length Activity Ratio
Rate Truncated/Rate Full Length
[DMAPP] mM

Figure 44


Growth Inhibition of MCM531 by MVA
OD600 (plate)
1.2
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
Time (hours)
0
1 mM
5 mM
10 mM
15 mM
20 mM


L70 Wildtypes (%CV = 4.5 Full Length, 5.3 Truncated)
Hg Output (ug/L) OD Normalized
200
100
0
12
24
36
48
60
72
84
96
Wt+ Well #

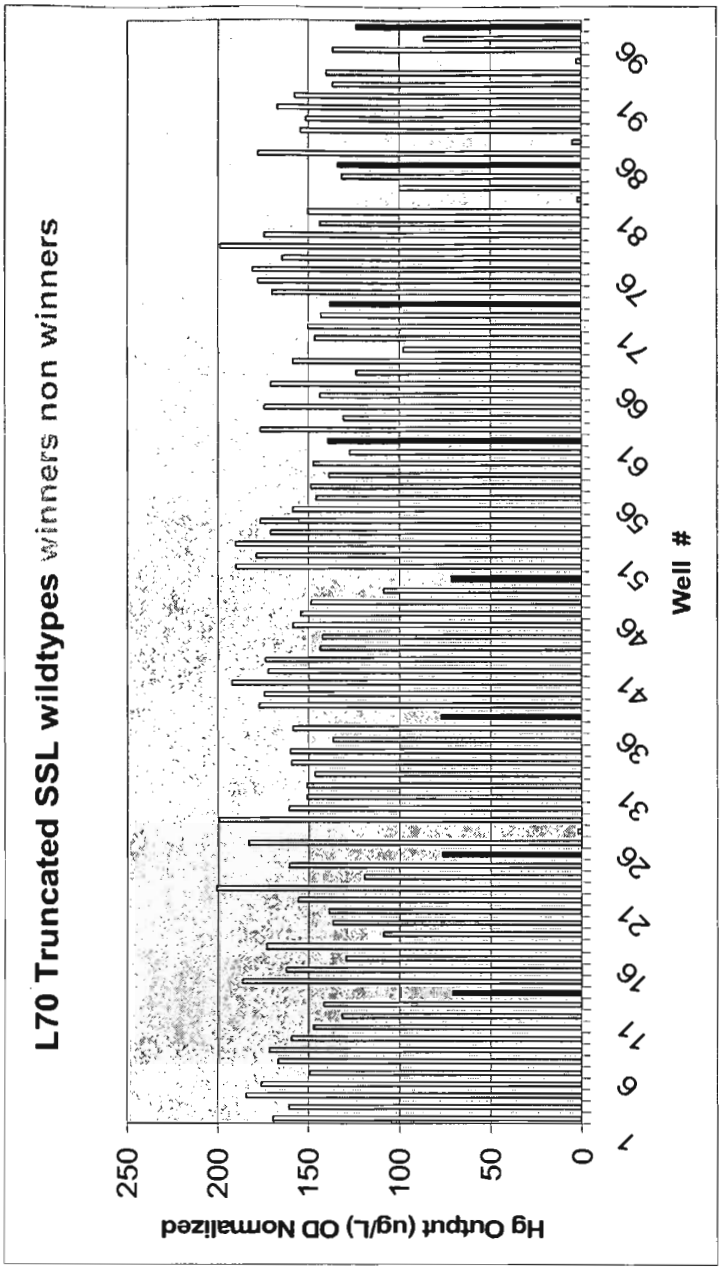

L70 Truncated SSL wildtypes winners non winners
Hg Output (ug/L) OD Normalized
250
200
150
100
50
0
1
6
11
16
21
26
31
36
41
46
51
56
61
66
71
76
81
86
91
96
Well #

Figure 45

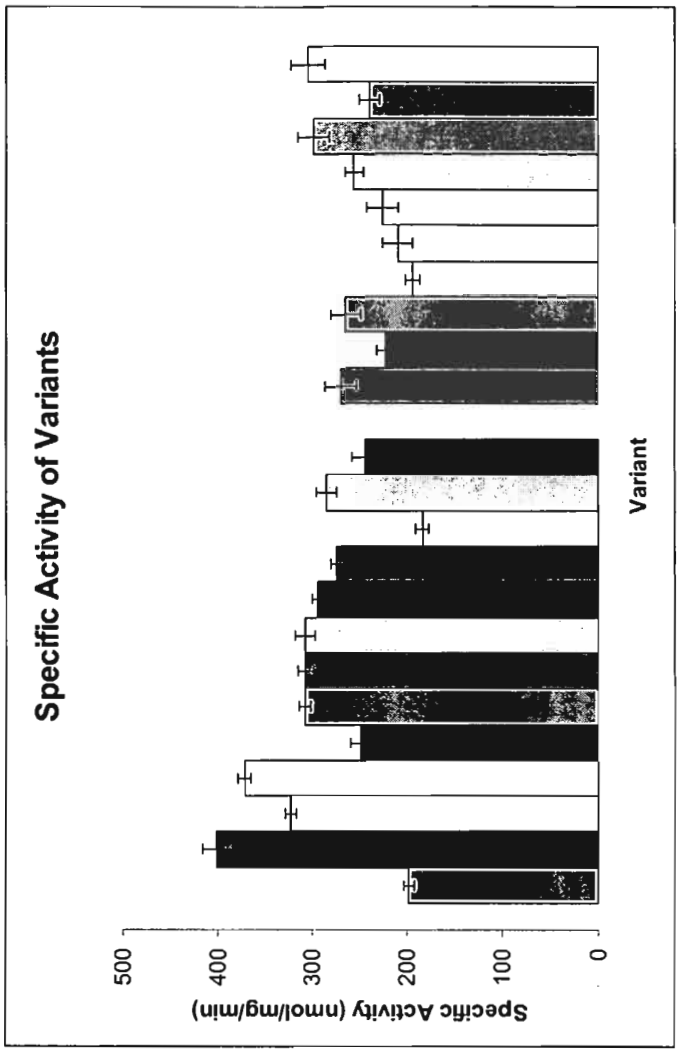

Specific Activity of Variants
Specific Activity (nmol/mg/min)
500
400
300
200
100
0
Variant

Figure 46

Figure 47

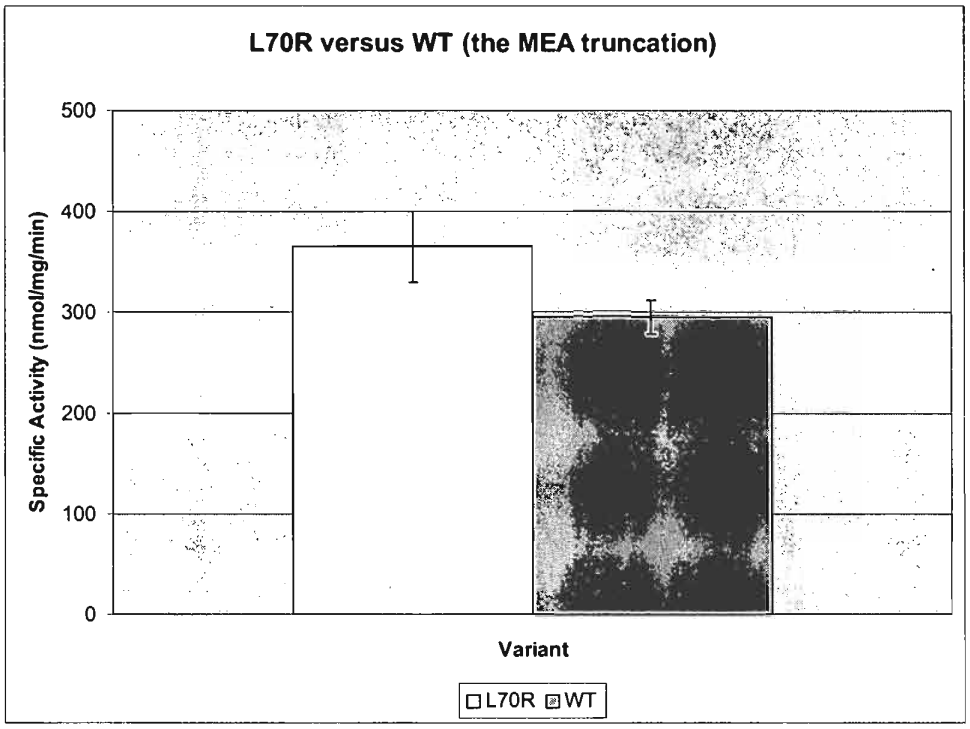
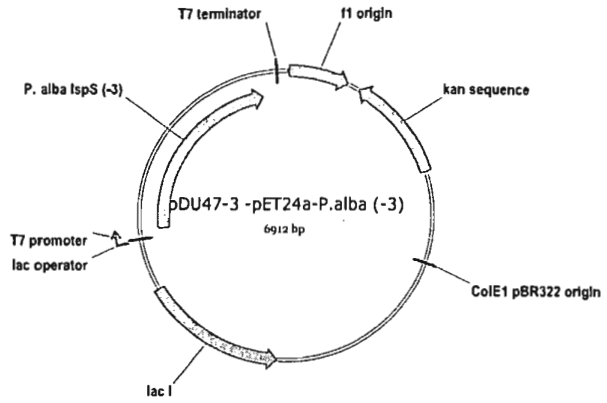
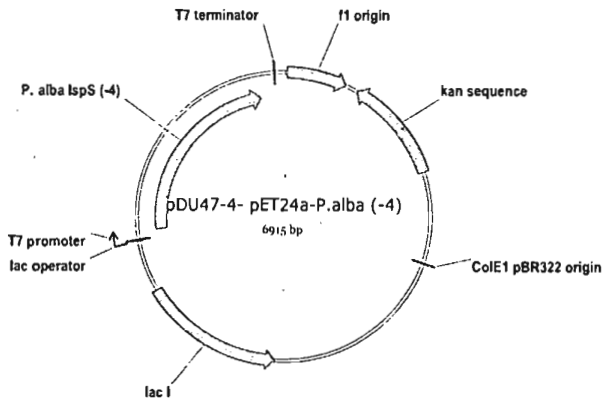

L70R versus WT (the MEA truncation)
Specific Activity (nmol/mg/min)
500
400
300
200
100
0
Variant
L70R
WT

Figure 48

A.



B.



C.

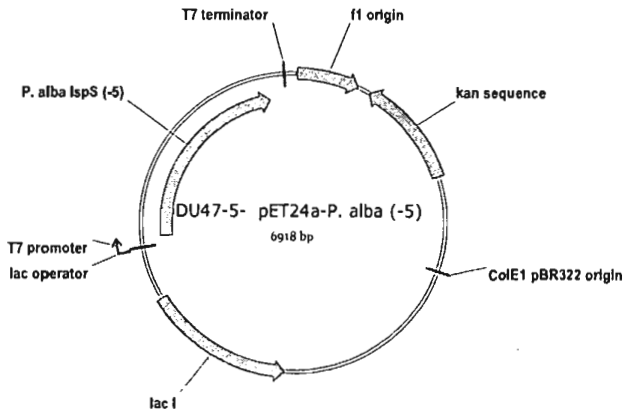
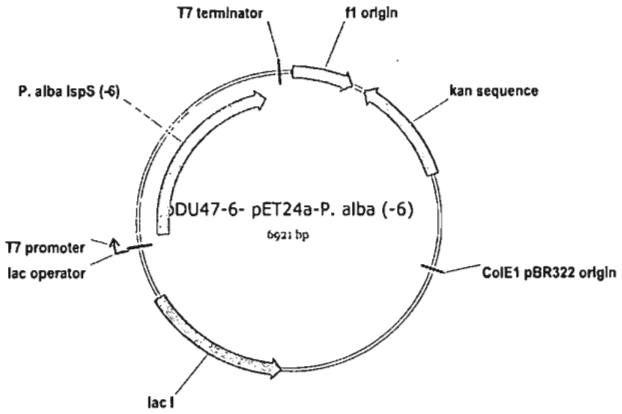
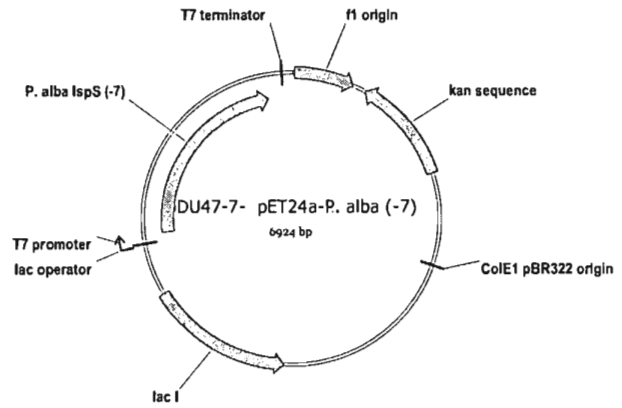


Figure 49

A.



B.



C.

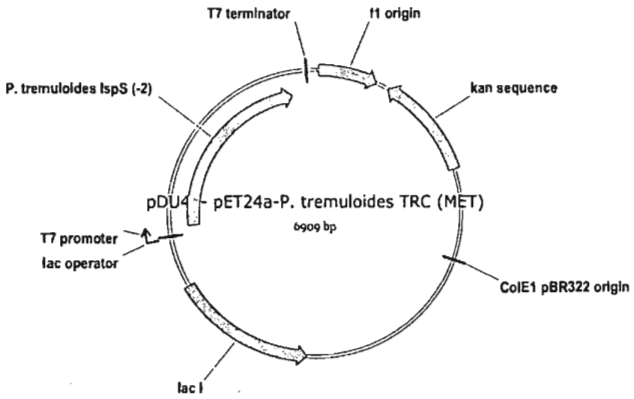
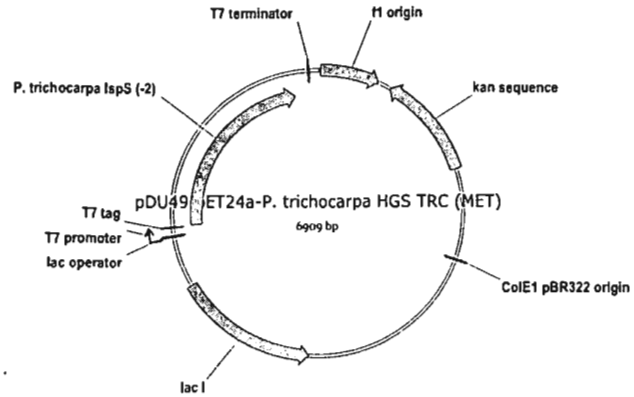
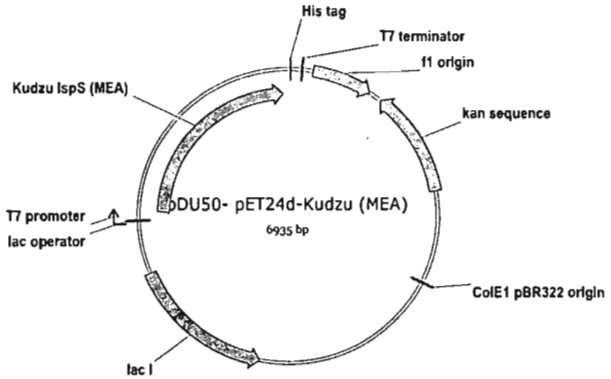


Figure 50

A.



B.



C.

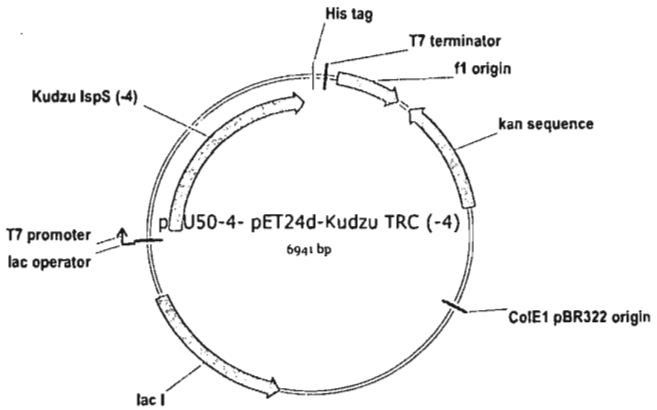


Figure 51

Amino acid sequence of *P.alba* TRC (-3) (SEQ ID NO:136)

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QRLGLGYRFESDIRGALDRFVSSGGFDAVTKTSLHGTALSFRLLRQHGFEVSQEAFSGFKDQNG
NFLENLKEDIKAILSLYEASFLALEGENILDEAKVFAISHLKELSEEKIGKELAEQVNHALELP
LHRRTQRLEAVWSIEAYRKKEDANQVLLELAILDYNMIQSVYQRDLRETSRWWRRVGLATKLHF
ARDRLIESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLDELELFTDAVERWDVN
AINDLPDYMKLCFLALYNTINEIAYDNLKDKGENILPYLTKAWADLCNAFLQEAKWLYNKSTPT
FDDYFGNAWKSSSGPLQLVFAYFAVVQNIKKEEIENLQKYHDTISRPSHIFRLCNDLASASAEI
ARGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAKPFVETAINLARQSH
CTYHNGDAHTSPDELTRKRVLSVITEPILPFER

Figure 52A

Nucleotide sequence of pDu47-3 (SEQ ID NO:137)

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagc
gtgaccgctacacttgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcg
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Figure 52B

Nucleotide sequence of pDu47-3

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gccgcgacaatttgcgacggcgcgtgcagggccagactggaggtggcaacgccaatcagcaacg
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ttccactttttcccgcgttttcgcagaaacgtggctggcctggttcaccacgcgggaaacggtc
tgataagagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccc
tgaattgactctcttccgggcgctatcatgccataccgcgaaaggttttgcgccattcgatggt
gtccgggatctcgacgctctcccttatgcgactcctgcattaggaagcagcccagtagtaggtt
gaggccgttgagcaccgccgccgcaaggaatggtgcatgcaaggagatggcgcccaacagtccc
ccggccacggggcctgccaccatacccacgccgaaacaagcgctcatgagcccgaagtggcgag
cccgatcttccccatcggtgatgtcggcgatataggcgccagcaaccgcacctgtggcgccggt
gatgccggccacgatgcgtccggcgtagaggatcgagatctcgatcccgcgaaattaatacgac
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gaaggagatatacatatgaccgaagctcgtcgttctgcgaactacgaacctaacagctgggact
atgattacctgctgtcctccgacacggacgagtccatcgaagtatacaaagacaaagcgaaaaa
gctggaagccgaagttcgtcgcgagattaataacgaaaaagcagaatttctgaccctgctggaa
ctgattgacaacgtccagcgcctgggcctgggttaccgtttcgagtctgatatccgtggtgcgc
tggatcgcttcgtttcctccggcggcttcgatgcggtaaccaagacttccctgcacggtacggc
actgtctttccgtctgctgcgtcaacacggttttgaggtttctcaggaagcgttcagcggcttc
aaagaccaaaacggcaacttcctggagaacctgaaggaagatatcaaagctatcctgagcctgt

Figure 52C

Nucleotide sequence of pDu47-3

acgaggccagcttcctggctctggaaggcgaaaacatcctggacgaggcgaaggttttcgcaat
ctctcatctgaaagaactgtctgaagaaaagatcggtaaagagctggcagaacaggtgaaccat
gcactggaactgccactgcatcgccgtactcagcgtctggaagcagtatggtctatcgaggcct
accgtaaaaaggaggacgcgaatcaggttctgctggagctggcaattctggattacaacatgat
ccagtctgtataccagcgtgatctgcgtgaaacgtcccgttggtggcgtcgtgtgggtctggcg
accaaactgcactttgctcgtgaccgcctgattgagagcttctactgggccgtgggtgtagcat
tcgaaccgcaatactccgactgccgtaactccgtcgcaaaaatgttttctttcgtaaccattat
cgacgatatctacgatgtatacggcaccctggacgaactggagctgtttactgatgcagttgag
cgttgggacgtaaacgccatcaacgacctgccggattacatgaaactgtgctttctggctctgt
ataacactattaacgaaatcgcctacgacaacctgaaagataaaggtgagaacatcctgccgta
tctgaccaaagcctgggctgacctgtgcaacgctttcctgcaagaagccaagtggctgtacaac
aaatctactccgacctttgacgactacttcggcaacgcatggaaatcctcttctggcccgctgc
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gtatctccgaagaactggctaccgaaagcgtgatgaatctgatcgatgaaacctggaaaaagat
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cgagctccgtcgacaagcttgcggccgcactcgagcaccaccaccaccaccactgagatccggc
tgctaacaaagcccgaaaggaagctgagttggctgctgccaccgctgagcaataactagcataa
ccccttggggcctctaaacgggtcttgaggggtttttgctgaaaggaggaactatatccggat

Figure 53

Amino acid sequence of *P.alba* TRC (-4) (SEQ ID NO:138)

METEARRSANYEPNSWDYDYLLSSDTDESIEVYKDKAKKLEAEVRREINNEKAEFLTLLELIDN
VQRLGLGYRFESDIRGALDRFVSSGGFDAVTKTSLHGTALSFRLLRQHGFEVSQEAFSGFKDQN
GNFLENLKEDIKAILSLYEASFLALEGENILDEAKVFAISHLKELSEEKIGKELAEQVNHALEL
PLHRRTQRLEAVWSIEAYRKKEDANQVLLELAILDYNMIQSVYQRDLRETSRWWRRVGLATKLH
FARDRLIESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLDELELFTDAVERWDV
NAINDLPDYMKLCFLALYNTINEIAYDNLKDKGENILPYLTKAWADLCNAFLQEAKWLYNKSTP
TFDDYFGNAWKSSSGPLQLVFAYFAVVQNIKKEEIENLQKYHDTISRPSHIFRLCNDLASASAE
IARGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAKPFVETAINLARQS
HCTYHNGDAHTSPDELTRKRVLSVITEPILPFER

Figure 54A

Nucleotide sequence of pDu47-4 (SEQ ID NO:139)

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagc
gtgaccgctacacttgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcg
ccacgttcgccggctttccccgtcaagctctaaatcgggggctcccttagggttccgatttag
tgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcacgtagtgggccatcg
ccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgt
tccaaactggaacaacactcaaccctatctcggtctattcttttgatttataagggattttgcc
gatttcggcctattggttaaaaaatgagctgatttaacaaaaatttaacgcgaattttaacaaa
atattaacgtttacaatttcaggtggcacttttcggggaaatgtgcgcggaacccctatttgtt
tatttttctaaatacattcaaatatgtatccgctcatgaattaattcttagaaaaactcatcga
gcatcaaatgaaactgcaatttattcatatcaggattatcaataccatatttttgaaaaagccg
tttctgtaatgaaggagaaaactcaccgaggcagttccataggatggcaagatcctggtatcgg
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aaaccgttattcattcgtgattgcgcctgagcgagacgaaatacgcgatcgctgttaaaaggac
aattacaaacaggaatcgaatgcaaccggcgcaggaacactgccagcgcatcaacaatattttc
acctgaatcaggatattcttctaatacctggaatgctgttttcccggggatcgcagtggtgagt
aaccatgcatcatcaggagtacggataaaatgcttgatggtcggaagaggcataaattccgtca
gccagtttagtctgaccatctcatctgtaacatcattggcaacgctacctttgccatgtttcag
aaacaactctggcgcatcgggcttcccatacaatcgatagattgtcgcacctgattgcccgaca
ttatcgcgagcccatttatacccatataaatcagcatccatgttggaatttaatcgcggcctag
agcaagacgtttcccgttgaatatggctcataacacccttgtattactgtttatgtaagcaga
cagttttattgttcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcagaccc
cgtagaaaagatcaaaggatcttcttgagatccttttttttctgcgcgtaatctgctgcttgcaa
acaaaaaaaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttc
cgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgtagccgtagtt
aggccaccacttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttacca
gtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccgg
ataaggcgcagcggtcgggctgaacgggggttcgtgcacacagcccagcttggagcgaacgac
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aaggcggacaggtatccggtaagcggcagggtcggaacaggagagcgcacgagggagcttccag
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ttcctggccttttgctggccttttgctcacatgttctttcctgcgttatcccctgattctgtgg
ataaccgtattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccgagcgcag
cgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacgcatctgtgc
ggtatttcacaccgcatatatggtgcactctcagtacaatctgctctgatgccgcatagttaag
ccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacac
ccgctgacgcgccctgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgt
ctccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggcagctgcgg
taaagctcatcagcgtggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagct
cgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatgttaagggcggt
tttttcctgtttggtcactgatgcctccgtgtaagggggatttctgttcatgggggtaatgata

Figure 54B

Nucleotide sequence of pDu47-4

ccgatgaaacgagagaggatgctcacgatacgggttactgatgatgaacatgcccggttactgg
aacgttgtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcaggg
tcaatgccagcgcttcgttaatacagatgtaggtgttccacagggtagccagcagcatcctgcg
atgcagatccggaacataatggtgcagggcgctgacttccgcgtttccagactttacgaaacac
ggaaaccgaagaccattcatgttgttgctcaggtcgcagacgttttgcagcagcagtcgcttca
cgttcgctcgcgtatcggtgattcattctgctaaccagtaaggcaaccccgccagcctagccgg
gtcctcaacgacaggagcacgatcatgcgcacccgtggggccgccatgccggcgataatggcct
gcttctcgccgaaacgtttggtggcgggaccagtgacgaaggcttgagcgagggcgtgcaagat
tccgaataccgcaagcgacaggccgatcatcgtcgcgctccagcgaaagcggtcctcgccgaaa
atgacccagagcgctgccggcacctgtcctacgagttgcatgataaagaagacagtcataagtg
cggcgacgatagtcatgccccgcgcccaccggaaggagctgactgggttgaaggctctcaaggg
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gaggcggtttgcgtattgggcgccagggtggtttttctttcaccagtgagacgggcaacagct
gattgcccttcaccgcctggccctgagagagttgcagcaagcggtccacgctggtttgccccag
caggcgaaaatcctgtttgatggtggttaacggcgggatataacatgagctgtcttcggtatcg
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cgcccagcgccatctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcat
ttgcatggtttgttgaaaaccggacatggcactccagtcgccttcccgttccgctatcggctga
atttgattgcgagtgagatatttatgccagccagccagacgcagacgcgccgagacagaactta
atgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagatgctccacgcccagtcg
cgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcagagacatcaagaaat
aacgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagt
taatgatcagcccactgacgcgttgcgcgagaagattgtgcaccgccgctttacaggcttcgac
gccgcttcgttctaccatcgacaccaccacgctggcacccagttgatcggcgcgagatttaatc
gccgcgacaatttgcgacggcgcgtgcagggccagactggaggtggcaacgccaatcagcaacg
actgtttgcccgccagttgttgtgccacgcggttgggaatgtaattcagctccgccatcgccgc
ttccactttttcccgcgttttcgcagaaacgtggctggcctggttcaccacgcgggaaacggtc
tgataagagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccc
tgaattgactctcttccgggcgctatcatgccataccgcgaaaggttttgcgccattcgatggt
gtccgggatctcgacgctctcccttatgcgactcctgcattaggaagcagcccagtagtaggtt
gaggccgttgagcaccgccgccgcaaggaatggtgcatgcaaggagatggcgcccaacagtccc
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gaactgattgacaacgtccagcgcctgggcctgggttaccgtttcgagtctgatatccgtggtg
cgctggatcgcttcgtttcctccggcggcttcgatgcggtaaccaagacttccctgcacggtac
ggcactgtctttccgtctgctgcgtcaacacggttttgaggtttctcaggaagcgttcagcggc
ttcaaagaccaaaacggcaacttcctggagaacctgaaggaagatatcaaagctatcctgagcc

Figure 54C

Nucleotide sequence of pDu47-4

tgtacgaggccagcttcctggctctggaaggcgaaaacatcctggacgaggcgaaggttttcgc
aatctctcatctgaaagaactgtctgaagaaaagatcggtaaagagctggcagaacaggtgaac
catgcactggaactgccactgcatcgccgtactcagcgtctggaagcagtatggtctatcgagg
cctaccgtaaaaaggaggacgcgaatcaggttctgctggagctggcaattctggattacaacat
gatccagtctgtataccagcgtgatctgcgtgaaacgtcccgttggtggcgtcgtgtgggtctg
gcgaccaaactgcactttgctcgtgaccgcctgattgagagcttctactgggccgtgggtgtag
cattcgaaccgcaatactccgactgccgtaactccgtcgcaaaaatgttttctttcgtaaccat
tatcgacgatatctacgatgtatacggcaccctggacgaactggagctgtttactgatgcagtt
gagcgttgggacgtaaacgccatcaacgacctgccggattacatgaaactgtgctttctggctc
tgtataacactattaacgaaatcgcctacgacaacctgaaagataaaggtgagaacatcctgcc
gtatctgaccaaagcctgggctgacctgtgcaacgctttcctgcaagaagccaagtggctgtac
aacaaatctactccgacctttgacgactacttcggcaacgcatggaaatcctcttctggcccgc
tgcaactggtgttcgcttacttcgctgtcgtgcagaacattaaaaaggaagagatcgaaaacct
gcaaaaataccatgacaccatctctcgtccttcccatatcttccgtctgtgcaatgacctggct
agcgcgtctgcggaaattgcgcgtggtgaaaccgcaaatagcgtttcttgttacatgcgcacta
aaggtatctccgaagaactggctaccgaaagcgtgatgaatctgatcgatgaaacctggaaaaa
gatgaacaaggaaaaactgggtggtagcctgttcgcgaaaccgttcgtggaaaccgcgatcaac
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attcgagctccgtcgacaagcttgcggccgcactcgagcaccaccaccaccaccactgagatcc
ggctgctaacaaagcccgaaaggaagctgagttggctgctgccaccgctgagcaataactagca
taacccccttggggcctctaaacgggtcttgaggggtttttgctgaaaggaggaactatatccg
gat

Figure 55

Amino acid sequence of *P.alba* TRC (-5) (SEQ ID NO:140)

MTETEARRSANYEPNSWDYDYLLSSDTDESIEVYKDKAKKLEAEVRREINNEKAEFLTLLELID
NVQRLGLGYRFESDIRGALDRFVSSGGFDAVTKTSLHGTALSFRLLRQHGFEVSQEAFSGFKDQ
NGNFLENLKEDIKAILSLYEASFLALEGENILDEAKVFAISHLKELSEEKIGKELAEQVNHALE
LPLHRRTQRLEAVWSIEAYRKKEDANQVLLELAILDYNMIQSVYQRDLRETSRWWRRVGLATKL
HFARDRLIESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLDELELFTDAVERWD
VNAINDLPDYMKLCFLALYNTINEIAYDNLKDKGENILPYLTKAWADLCNAFLQEAKWLYNKST
PTFDDYFGNAWKSSSGPLQLVFAYFAVVQNIKKEEIENLQKYHDTISRPSHIFRLCNDLASASA
EIARGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAKPFVETAINLARQ
SHCTYHNGDAHTSPDELTRKRVLSVITEPILPFER

Figure 56A

Nucleotide sequence of pDu47-5 (SEQ ID NO:141)

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagc
gtgaccgctacacttgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcg
ccacgttcgccggctttccccgtcaagctctaaatcgggggctcccttagggttccgatttag
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ccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgt
tccaaactggaacaacactcaaccctatctcggtctattcttttgatttataagggattttgcc
gatttcggcctattggttaaaaaatgagctgatttaacaaaaatttaacgcgaattttaacaaa
atattaacgtttacaatttcaggtggcacttttcggggaaatgtgcgcggaacccctatttgtt
tatttttctaaatacattcaaatatgtatccgctcatgaattaattcttagaaaaactcatcga
gcatcaaatgaaactgcaatttattcatatcaggattatcaataccatatttttgaaaaagccg
tttctgtaatgaaggagaaaactcaccgaggcagttccataggatggcaagatcctggtatcgg
tctgcgattccgactcgtccaacatcaatacaacctattaatttcccctcgtcaaaaataaggt
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ttctttccagacttgttcaacaggccagccattacgctcgtcatcaaaatcactcgcatcaacc
aaaccgttattcattcgtgattgcgcctgagcgagacgaaatacgcgatcgctgttaaaaggac
aattacaaacaggaatcgaatgcaaccggcgcaggaacactgccagcgcatcaacaatattttc
acctgaatcaggatattcttctaatacctggaatgctgttttcccggggatcgcagtggtgagt
aaccatgcatcatcaggagtacggataaaatgcttgatggtcggaagaggcataaattccgtca
gccagtttagtctgaccatctcatctgtaacatcattggcaacgctacctttgccatgtttcag
aaacaactctggcgcatcgggcttcccatacaatcgatagattgtcgcacctgattgcccgaca
ttatcgcgagcccatttatacccatataaatcagcatccatgttggaatttaatcgcggcctag
agcaagacgtttcccgttgaatatggctcataacacccttgtattactgtttatgtaagcaga
cagttttattgttcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcagaccc
cgtagaaaagatcaaaggatcttcttgagatcctttttttctgcgcgtaatctgctgcttgcaa
acaaaaaaaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttc
cgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgtagccgtagtt
aggccaccacttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttacca
gtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccgg
ataaggcgcagcggtcgggctgaacgggggttcgtgcacacagcccagcttggagcgaacgac
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aaggcggacaggtatccggtaagcggcagggtcggaacaggagagcgcacgagggagcttccag
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cgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacgcatctgtgc
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ccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacac
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ctccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggcagctgcgg
taaagctcatcagcgtggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagct
cgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatgttaagggcggt
tttttcctgtttggtcactgatgcctccgtgtaagggggatttctgttcatgggggtaatgata

Figure 56B

Nucleotide sequence of pDu47-5

ccgatgaaacgagagaggatgctcacgatacgggttactgatgatgaacatgcccggttactgg
aacgttgtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcaggg
tcaatgccagcgcttcgttaatacagatgtaggtgttccacagggtagccagcagcatcctgcg
atgcagatccggaacataatggtgcagggcgctgacttccgcgtttccagacttacgaaacac
ggaaaccgaagaccattcatgttgttgctcaggtcgcagacgttttgcagcagcagtcgcttca
cgttcgctcgcgtatcggtgattcattctgctaaccagtaaggcaaccccgccagcctagccgg
gtcctcaacgacaggagcacgatcatgcgcacccgtggggccgccatgccggcgataatggcct
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cggcgacgatagtcatgccccgcgcccaccggaaggagctgactgggttgaaggctctcaaggg
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caggcgaaaatcctgtttgatggtggttaacggcgggatataacatgagctgtcttcggtatcg
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cgcccagcgccatctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcat
ttgcatggtttgttgaaaaccggacatggcactccagtcgccttcccgttccgctatcggctga
atttgattgcgagtgagatatttatgccagccagccagacgcagacgcgccgagacagaactta
atgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagatgctccacgcccagtcg
cgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcagagacatcaagaaat
aacgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagt
taatgatcagcccactgacgcgttgcgcgagaagattgtgcaccgccgctttacaggcttcgac
gccgcttcgttctaccatcgacaccaccacgctggcacccagttgatcggcgcgagatttaatc
gccgcgacaatttgcgacggcgcgtgcagggccagactggaggtggcaacgccaatcagcaacg
actgtttgcccgccagttgttgtgccacgcggttgggaatgtaattcagctccgccatcgccgc
ttccactttttcccgcgttttcgcagaaacgtggctggcctggttcaccacgcgggaaacggtc
tgataagagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccc
tgaattgactctcttccgggcgctatcatgccataccgcgaaaggttttgcgccattcgatggt
gtccgggatctcgacgctctcccttatgcgactcctgcattaggaagcagcccagtagtaggtt
gaggccgttgagcaccgccgccgcaaggaatggtgcatgcaaggagatggcgcccaacagtccc
ccggccacggggcctgccaccatacccacgccgaaacaagcgctcatgagcccgaagtggcgag
cccgatcttccccatcggtgatgtcggcgatataggcgccagcaaccgcacctgtggcgccggt
gatgccggccacgatgcgtccggcgtagaggatcgagatctcgatcccgcgaaattaatacgac
tcactataggggaattgtgagcggataacaattcccctctagaaataattttgtttaactttaa
gaaggagatatacatatgactgaaaccgaagctcgtcgttctgcgaactacgaacctaacagct
gggactatgattacctgctgtcctccgacacggacgagtccatcgaagtatacaaagacaaagc
gaaaaagctggaagccgaagttcgtcgcgagattaataacgaaaaagcagaatttctgacccctg
ctggaactgattgacaacgtccagcgcctgggcctgggttaccgtttcgagtctgatatccgtg
gtgcgctggatcgcttcgtttcctccggcggcttcgatgcggtaaccaagacttccctgcacgg
tacggcactgtctttccgtctgctgcgtcaacacggttttgaggtttctcaggaagcgttcagc
ggcttcaaagaccaaaacggcaacttcctggagaacctgaaggaagatatcaaagctatcctga

Figure 56C

Nucleotide sequence of pDu47-5

gcctgtacgaggccagcttcctggctctggaaggcgaaaacatcctggacgaggcgaaggtttt
cgcaatctctcatctgaaagaactgtctgaagaaaagatcggtaaagagctggcagaacaggtg
aaccatgcactggaactgccactgcatcgccgtactcagcgtctggaagcagtatggtctatcg
aggcctaccgtaaaaaggaggacgcgaatcaggttctgctggagctggcaattctggattacaa
catgatccagtctgtataccagcgtgatctgcgtgaaacgtcccgttggtggcgtcgtgtgggt
ctggcgaccaaactgcactttgctcgtgaccgcctgattgagagcttctactgggccgtgggtg
tagcattcgaaccgcaatactccgactgccgtaactccgtcgcaaaaatgttttctttcgtaac
cattatcgacgatatctacgatgtatacggcaccctggacgaactggagctgtttactgatgca
gttgagcgttgggacgtaaacgccatcaacgacctgccggattacatgaaactgtgctttctgg
ctctgtataacactattaacgaaatcgcctacgacaacctgaaagataaaggtgagaacatcct
gccgtatctgaccaaagcctgggctgacctgtgcaacgctttcctgcaagaagccaagtggctg
tacaacaaatctactccgacctttgacgactacttcggcaacgcatggaaatcctcttctggcc
cgctgcaactggtgttcgcttacttcgctgtcgtgcagaacattaaaaaggaagagatcgaaaa
cctgcaaaaataccatgacaccatctctcgtccttcccatatcttccgtctgtgcaatgacctg
gctagcgcgtctgcggaaattgcgcgtggtgaaaccgcaaatagcgtttcttgttacatgcgca
ctaaaggtatctccgaagaactggctaccgaaagcgtgatgaatctgatcgatgaaacctggaa
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aacctggcacgtcaatctcactgcacttatcataacggcgacgcgcatacctctccggatgagc
tgácccgcaaacgcgttctgtctgtaatcactgaaccgattctgccgtttgaacgctaaggatc
cgaattcgagctccgtcgacaagcttgcggccgcactcgagcaccaccaccaccaccactgaga
tccggctgctaacaaagcccgaaaggaagctgagttggctgctgccaccgctgagcaataacta
gcataaccccttggggcctctaaacgggtcttgaggggtttttgctgaaaggaggaactatat
ccggat

Figure 57

Amino acid sequence of *P.alba* TRC (-6) (SEQ ID NO:142)

METETEARRSANYEPNSWDYDYLLSSDTDESIEVYKDKAKKLEAEVRREINNEKAEFLTLLELI
DNVQRLGLGYRFESDIRGALDRFVSSGGFDAVTKTSLHGTALSFRLLRQHGFEVSQEAFSGFKD
QNGNFLENLKEDIKAILSLYEASFLALEGENILDEAKVFAISHLKELSEEKIGKELAEQVNHAL
ELPLHRRTQRLEAVWSIEAYRKKEDANQVLLELAILDYNMIQSVYQRDLRETSRWWRRVGLATK
LHFARDRLIESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLDELELFTDAVERW
DVNAINDLPDYMKLCFLALYNTINEIAYDNLKDKGENILPYLTKAWADLCNAFLQEAKWLYNKS
TPTFDDYFGNAWKSSSGPLQLVFAYFAVVQNIKKEEIENLQKYHDTISRPSHIFRLCNDLASAS
AEIARGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAKPFVETAINLAR
QSHCTYHNGDAHTSPDELTRKRVLSVITEPILPFER

Figure 58A

Nucleotide sequence of pDu47-6 (SEQ ID NO:143)

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagc
gtgaccgctacacttgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcg
ccacgttcgccggctttccccgtcaagctctaaatcgggggctcccttagggttccgatttag
tgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcacgtagtgggccatcg
ccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgt
tccaaactggaacaacactcaaccctatctcggtctattcttttgatttataagggattttgcc
gatttcggcctattggttaaaaaatgagctgatttaacaaaaatttaacgcgaattttaacaaa
atattaacgtttacaatttcaggtggcacttttcggggaaatgtgcgcggaacccctatttgtt
tatttttctaaatacattcaaatatgtatccgctcatgaattaattcttagaaaaactcatcga
gcatcaaatgaaactgcaatttattcatatcaggattatcaataccatatttttgaaaaagccg
tttctgtaatgaaggagaaaactcaccgaggcagttccataggatggcaagatcctggtatcgg
tctgcgattccgactcgtccaacatcaatacaacctattaatttcccctcgtcaaaaataaggt
tatcaagtgagaaatcaccatgagtgacgactgaatccggtgagaatggcaaaagtttatgcat
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aaaccgttattcattcgtgattgcgcctgagcgagacgaaatacgcgatcgctgttaaaaggac
aattacaaacaggaatcgaatgcaaccggcgcaggaacactgccagcgcatcaacaatatttttc
acctgaatcaggatattcttctaatacctggaatgctgttttcccggggatcgcagtggtgagt
aaccatgcatcatcaggagtacggataaaatgcttgatggtcggaagaggcataaattccgtca
gccagtttagtctgaccatctcatctgtaacatcattggcaacgctacctttgccatgtttcag
aaacaactctggcgcatcgggcttcccatacaatcgatagattgtcgcacctgattgcccgaca
ttatcgcgagcccatttatacccatataaatcagcatccatgttggaatttaatcgcggcctag
agcaagacgtttcccgttgaatatggctcataacacccttgtattactgtttatgtaagcaga
cagttttattgttcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcagaccc
cgtagaaaagatcaaaggatcttcttgagatcctttttttctgcgcgtaatctgctgcttgcaa
acaaaaaaaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttc
cgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgtagccgtagtt
aggccaccacttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttacca
gtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccgg
ataaggcgcagcggtcgggctgaacgggggttcgtgcacacagcccagcttggagcgaacgac
ctacaccgaactgagatacctacagcgtgagctatgagaaagcgccacgcttcccgaagggaga
aaggcggacaggtatccggtaagcggcagggtcggaacaggagagcgcacgagggagcttccag
ggggaaacgcctggtatctttatagtcctgtcgggtttcgccacctctgacttgagcgtcgatt
tttgtgatgctcgtcaggggggcggagcctatggaaaaacgccagcaacgcggcctttttacgg
ttcctggccttttgctggccttttgctcacatgttctttcctgcgttatcccctgattctgtgg
ataaccgtattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccgagcgcag
cgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacgcatctgtgc
ggtatttcacaccgcatatatggtgcactctcagtacaatctgctctgatgccgcatagttaag
ccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacac
ccgctgacgcgccctgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgt
ctccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggcagctgcgg
taaagctcatcagcgtggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagct
cgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatgttaagggcggt
tttttcctgtttggtcactgatgcctccgtgtaaggggatttctgttcatgggggtaatgata

Figure 58B

Nucleotide sequence of pDu47-6

ccgatgaaacgagagaggatgctcacgatacgggttactgatgatgaacatgcccggttactgg
aacgttgtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcaggg
tcaatgccagcgcttcgttaatacagatgtaggtgttccacagggtagccagcagcatcctgcg
atgcagatccggaacataatggtgcagggcgctgacttccgcgtttccagactttacgaaacac
ggaaaccgaagaccattcatgttgttgctcaggtcgcagacgttttgcagcagcagtcgcttca
cgttcgctcgcgtatcggtgattcattctgctaaccagtaaggcaaccccgccagcctagccgg
gtcctcaacgacaggagcacgatcatgcgcacccgtggggccgccatgccggcgataatggcct
gcttctcgccgaaacgtttggtggcgggaccagtgacgaaggcttgagcgagggcgtgcaagat
tccgaataccgcaagcgacaggccgatcatcgtcgcgctccagcgaaagcggtcctcgccgaaa
atgacccagagcgctgccggcacctgtcctacgagttgcatgataaagaagacagtcataagtg
cggcgacgatagtcatgccccgcgcccaccggaaggagctgactgggttgaaggctctcaaggg
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gaggcggtttgcgtattgggcgccagggtggtttttctttcaccagtgagacgggcaacagct
gattgcccttcaccgcctggccctgagagagttgcagcaagcggtccacgctggtttgccccag
caggcgaaaatcctgtttgatggtggttaacggcgggatataacatgagctgtcttcggtatcg
tcgtatcccactaccgagatatccgcaccaacgcgcagcccggactcggtaatggcgcgcattg
cgcccagcgccatctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcat
ttgcatggtttgttgaaaaccggacatggcactccagtcgccttcccgttccgctatcggctga
atttgattgcgagtgagatatttatgccagccagccagacgcagacgcgccgagacagaacttta
atgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagatgctccacgcccagtcg
cgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcagagacatcaagaaat
aacgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagt
taatgatcagcccactgacgcgttgcgcgagaagattgtgcaccgccgctttacaggcttcgac
gccgcttcgttctaccatcgacaccaccacgctggcacccagttgatcggcgcgagatttaatc
gccgcgacaatttgcgacggcgcgtgcagggccagactggaggtggcaacgccaatcagcaacg
actgtttgcccgccagttgttgtgccacgcggttgggaatgtaattcagctccgccatcgccgc
ttccactttttcccgcgttttcgcagaaacgtggctggcctggttcaccacgcgggaaacggtc
tgataagagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccc
tgaattgactctcttccgggcgctatcatgccataccgcgaaaggttttgcgccattcgatggt
gtccgggatctcgacgctctcccttatgcgactcctgcattaggaagcagcccagtagtaggtt
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tcactatagggaattgtgagcggataacaattcccctctagaaataattttgtttaactttaa
gaaggagatatacatatggaaactgaaaccgaagctcgtcgttctgcgaactacgaacctaaca
gctgggactatgattacctgctgtcctccgacacggacgagtccatcgaagtatacaaagacaa
agcgaaaaagctggaagccgaagttcgtcgcgagattaataacgaaaaagcagaatttctgacc
ctgctggaactgattgacaacgtccagcgcctgggcctgggttaccgtttcgagtctgatatcc
gtggtgcgctggatcgcttcgtttcctccggcggcttcgatgcggtaaccaagacttccctgca
cggtacggcactgtctttccgtctgctgcgtcaacacggttttgaggtttctcaggaagcgttc
agcggcttcaaagaccaaaacggcaacttcctggagaacctgaaggaagatatcaaagctatcc

Figure 58C

Nucleotide sequence of pDu47-6

tgagcctgtacgaggccagcttcctggctctggaaggcgaaaacatcctggacgaggcgaaggt
tttcgcaatctctcatctgaaagaactgtctgaagaaaagatcggtaaagagctggcagaacag
gtgaaccatgcactggaactgccactgcatcgccgtactcagcgtctggaagcagtatggtcta
tcgaggcctaccgtaaaaaggaggacgcgaatcaggttctgctggagctggcaattctggatta
caacatgatccagtctgtataccagcgtgatctgcgtgaaacgtcccgttggtggcgtcgtgtg
ggtctggcgaccaaactgcactttgctcgtgaccgcctgattgagagcttctactgggccgtgg
gtgtagcattcgaaccgcaatactccgactgccgtaactccgtcgcaaaaatgttttctttcgt
aaccattatcgacgatatctacgatgtatacggcaccctggacgaactggagctgtttactgat
gcagttgagcgttgggacgtaaacgccatcaacgacctgccggattacatgaaactgtgctttc
tggctctgtataacactattaacgaaatcgcctacgacaacctgaaagataaaggtgagaacat
cctgccgtatctgaccaaagcctgggctgacctgtgcaacgctttcctgcaagaagccaagtgg
ctgtacaacaaatctactccgacctttgacgactacttcggcaacgcatggaaatcctcttctg
gcccgctgcaactggtgttcgcttacttcgctgtcgtgcagaacattaaaaaggaagagatcga
aaacctgcaaaaataccatgacaccatctctcgtccttcccatatcttccgtctgtgcaatgac
ctggctagcgcgtctgcggaaattgcgcgtggtgaaaccgcaaatagcgtttcttgttacatgc
gcactaaaggtatctccgaagaactggctaccgaaagcgtgatgaatctgatcgatgaaacctg
gaaaaagatgaacaaggaaaaactgggtggtagcctgttcgcgaaaccgttcgtggaaaccgcg
atcaacctggcacgtcaatctcactgcacttatcataacggcgacgcgcatacctctccggatg
agctgacccgcaaacgcgttctgtctgtaatcactgaaccgattctgccgtttgaacgctaagg
atccgaattcgagctccgtcgacaagcttgcggccgcactcgagcaccaccaccaccaccactg
agatccggctgctaacaaagcccgaaaggaagctgagttggctgctgccaccgctgagcaataa
ctagcataaccccttggggcctctaaacgggtcttgaggggtttttgctgaaaggaggaacta
tatccggat

Figure 59

Amino acid sequence of *P.alba* TRC (-7) (SEQ ID NO:144)

MTETETEARRSANYEPNSWDYDYLLSSDTDESIEVYKDKAKKLEAEVRREINNEKAEFLTLLEL
IDNVQRLGLGYRFESDIRGALDRFVSSGGFDAVTKTSLHGTALSFRLLRQHGFEVSQEAFSGFK
DQNGNFLENLKEDIKAILSLYEASFLALEGENILDEAKVFAISHLKELSEEKIGKELAEQVNHA
LELPLHRRTQRLEAVWSIEAYRKKEDANQVLLELAILDYNMIQSVYQRDLRETSRWWRRVGLAT
KLHFARDRLIESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLDELELFTDAVER
WDVNAINDLPDYMKLCFLALYNTINEIAYDNLKDKGENILPYLTKAWADLCNAFLQEAKWLYNK
STPTFDDYFGNAWKSSSGPLQLVFAYFAVVQNIKKEEIENLQKYHDTISRPSHIFRLCNDLASA
SAEIARGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAKPFVETAINLA
RQSHCTYHNGDAHTSPDELTRKRVLSVITEPILPFER

Figure 60A

Nucleotide sequence of pDu47-7 (SEQ ID NO:145)

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagc
gtgaccgctacacttgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcg
ccacgttcgccggctttccccgtcaagctctaaatcgggggctcccttagggttccgatttag
tgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcacgtagtgggccatcg
ccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgt
tccaaactggaacaacactcaaccctatctcggtctattcttttgatttataagggattttgcc
gatttcggcctattggttaaaaaatgagctgatttaacaaaaatttaacgcgaattttaacaaa
atattaacgtttacaatttcaggtggcacttttcggggaaatgtgcgcggaacccctatttgtt
tatttttctaaatacattcaaatatgtatccgctcatgaattaattcttagaaaaactcatcga
gcatcaaatgaaactgcaatttattcatatcaggattatcaataccatatttttgaaaaagccg
tttctgtaatgaaggagaaaactcaccgaggcagttccataggatggcaagatcctggtatcgg
tctgcgattccgactcgtccaacatcaatacaacctattaatttcccctcgtcaaaaataaggt
tatcaagtgagaaatcaccatgagtgacgactgaatccggtgagaatggcaaaagtttatgcat
ttctttccagacttgttcaacaggccagccattacgctcgtcatcaaaatcactcgcatcaacc
aaaccgttattcattcgtgattgcgcctgagcgagacgaaatacgcgatcgctgttaaaaggac
aattacaaacaggaatcgaatgcaaccggcgcaggaacactgccagcgcatcaacaatattttc
acctgaatcaggatattcttctaatacctggaatgctgttttcccggggatcgcagtggtgagt
aaccatgcatcatcaggagtacggataaaatgcttgatggtcggaagaggcataaattccgtca
gccagtttagtctgaccatctcatctgtaacatcattggcaacgctacctttgccatgtttcag
aaacaactctggcgcatcgggcttcccatacaatcgatagattgtcgcacctgattgcccgaca
ttatcgcgagcccatttatacccatataaatcagcatccatgttggaatttaatcgcggcctag
agcaagacgtttcccgttgaatatggctcataacacccttgtattactgtttatgtaagcaga
cagttttattgttcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcagaccc
cgtagaaaagatcaaaggatcttcttgagatccttttttttctgcgcgtaatctgctgcttgcaa
acaaaaaaaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttc
cgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgtagccgtagtt
aggccaccacttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttacca
gtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccgg
ataaggcgcagcggtcgggctgaacgggggttcgtgcacacagcccagcttggagcgaacgac
ctacaccgaactgagatacctacagcgtgagctatgagaaagcgccacgcttcccgaagggaga
aaggcggacaggtatccggtaagcggcagggtcggaacaggagagcgcacgagggagcttccag
ggggaaacgcctggtatctttatagtcctgtcgggtttcgccacctctgacttgagcgtcgatt
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ttcctggccttttgctggccttttgctcacatgttctttcctgcgttatcccctgattctgtgg
ataaccgtattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccgagcgcag
cgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacgcatctgtgc
ggtatttcacaccgcatatatggtgcactctcagtacaatctgctctgatgccgcatagttaag
ccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacac
ccgctgacgcgccctgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgt
ctccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggcagctgcgg
taaagctcatcagcgtggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagct
cgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatgttaagggcggt
tttttcctgtttggtcactgatgcctccgtgtaagggggatttctgttcatgggggtaatgata

Figure 60B

Nucleotide sequence of pDu47-7

ccgatgaaacgagagaggatgctcacgatacgggttactgatgatgaacatgcccggttactgg
aacgttgtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcaggg
tcaatgccagcgcttcgttaatacagatgtaggtgttccacagggtagccagcagcatcctgcg
atgcagatccggaacataatggtgcagggcgctgacttccgcgtttccagactttacgaaacac
ggaaaccgaagaccattcatgttgttgctcaggtcgcagacgttttgcagcagcagtcgcttca
cgttcgctcgcgtatcggtgattcattctgctaaccagtaaggcaaccccgccagcctagccgg
gtcctcaacgacaggagcacgatcatgcgcacccgtggggccgccatgccggcgataatggcct
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tccgaataccgcaagcgacaggccgatcatcgtcgcgctccagcgaaagcggtcctcgccgaaa
atgacccagagcgctgccggcacctgtcctacgagttgcatgataaagaagacagtcataagtg
cggcgacgatagtcatgccccgcgcccaccggaaggagctgactgggttgaaggctctcaaggg
catcggtcgagatcccggtgcctaatgagtgagctaacttacattaattgcgttgcgctcactg
cccgctttccagtcgggaaacctgtcgtgccagctgcattaatgaatcggccaacgcgcgggga
gaggcggtttgcgtattgggcgccagggtggtttttcttttcaccagtgagacgggcaacagct
gattgcccttcaccgcctggccctgagagagttgcagcaagcggtccacgctggtttgccccag
caggcgaaaatcctgtttgatggtggttaacggcgggatataacatgagctgtcttcggtatcg
tcgtatcccactaccgagatatccgcaccaacgcgcagcccggactcggtaatggcgcgcattg
cgcccagcgccatctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcat
ttgcatggtttgttgaaaaccggacatggcactccagtcgccttcccgttccgctatcggctga
atttgattgcgagtgagatatttatgccagccagccagacgcagacgcgccgagacagaactta
atgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagatgctccacgcccagtcg
cgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcagagacatcaagaaat
aacgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagt
taatgatcagcccactgacgcgttgcgcgagaagattgtgcaccgccgctttacaggcttcgac
gccgcttcgttctaccatcgacaccaccacgctggcacccagttgatcggcgcgagatttaatc
gccgcgacaatttgcgacggcgcgtgcagggccagactggaggtggcaacgccaatcagcaacg
actgtttgcccgccagttgttgtgccacgcggttgggaatgtaattcagctccgccatcgccgc
ttccactttttcccgcgttttcgcagaaacgtggctggcctggttcaccacgcgggaaacggtc
tgataagagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccc
tgaattgactctcttccgggcgctatcatgccataccgcgaaaggttttgcgccattcgatggt
gtccgggatctcgacgctctcccttatgcgactcctgcattaggaagcagcccagtagtaggtt
gaggccgttgagcaccgccgccgcaaggaatggtgcatgcaaggagatggcgcccaacagtccc
ccggccacggggcctgccaccatacccacgccgaaacaagcgctcatgagcccgaagtggcgag
cccgatcttccccatcggtgatgtcggcgatataggcgccagcaaccgcacctgtggcgccggt
gatgccggccacgatgcgtccggcgtagaggatcgagatctcgatcccgcgaaattaatacgac
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gcacggtacggcactgtctttccgtctgctgcgtcaacacggttttgaggtttctcaggaagcg
ttcagcggcttcaaagaccaaaacggcaacttcctggagaacctgaaggaagatatcaaagcta

Figure 60C

Nucleotide sequence of pDu47-7

tcctgagcctgtacgaggccagcttcctggctctggaaggcgaaaacatcctggacgaggcgaa
ggttttcgcaatctctcatctgaaagaactgtctgaagaaaagatcggtaaagagctggcagaa
caggtgaaccatgcactggaactgccactgcatcgccgtactcagcgtctggaagcagtatggt
ctatcgaggcctaccgtaaaaaggaggacgcgaatcaggttctgctggagctggcaattctgga
ttacaacatgatccagtctgtataccagcgtgatctgcgtgaaacgtcccgttggtggcgtcgt
gtgggtctggcgaccaaactgcactttgctcgtgaccgcctgattgagagcttctactgggccg
tgggtgtagcattcgaaccgcaatactccgactgccgtaactccgtcgcaaaaatgttttcttt
cgtaaccattatcgacgatatctacgatgtatacggcaccctggacgaactggagctgtttact
gatgcagttgagcgttgggacgtaaacgccatcaacgacctgccggattacatgaaactgtgct
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cgaaaacctgcaaaaataccatgacaccatctctcgtccttcccatatcttccgtctgtgcaat
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gcgatcaacctggcacgtcaatctcactgcacttatcataacggcgacgcgcatacctctccgg
atgagctgacccgcaaacgcgttctgtctgtaatcactgaaccgattctgccgtttgaacgcta
aggatccgaattcgagctccgtcgacaagcttgcggccgcactcgagcaccaccaccaccacca
ctgagatccggctgctaacaaagcccgaaaggaagctgagttggctgctgccaccgctgagcaa
taactagcataaccccttggggcctctaaacgggtcttgaggggttttttgctgaaaggaggaa
ctatatccggat

Figure 61

Amino acid sequence of *P. tremu* TRC (MET) (SEQ ID NO:146)

METRRSANYEPNSWDYDYLLSSDTDESIEVHKDKAKKLEAEVRREINNEKAEFLTLLELIDNVQ
RLGLGYRFESDIRRALDRFVSSGGFDGVTKTSLHGTALSFRLLRQHGFEVSQEAFSGFKDQNGN
FLENLKEDIKAILSLYEASFLALEGENILDEAKVFAISHLKELSEEKIGKELAEQVSHALELPL
HRRTQRLEAVWSIEAYRKKEDANQVLLELAILDYNMIQSVYQRDLRETSRWWRRVGLATKLHFA
RDRLIESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLDELELFTDAVERWDVNA
INDLPDYMKLCFLALYNTINEIAYDNLKDKGENILPYLTKAWADLCNAFLQEAKWLYNKSTPTF
DDYFGNAWKSSSGPLQLIFAYFAVVQNIKKEEIENLQKYHDIISRPSHIFRLCNDLASASAEIA
RGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAKPFVETAINLARQSHC
TYHNGDAHTSPDELTRKRVLSVITEPILPFER

Figure 62A

Nucleotide sequence of pDu48 (SEQ ID NO:147)

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagc
gtgaccgctacacttgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcg
ccacgttcgccggctttccccgtcaagctctaaatcgggggctcccttagggttccgatttag
tgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcacgtagtgggccatcg
ccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgt
tccaaactggaacaacactcaaccctatctcggtctattcttttgatttataagggattttgcc
gatttcggcctattggttaaaaaatgagctgatttaacaaaaatttaacgcgaattttaacaaa
atattaacgtttacaatttcaggtggcacttttcggggaaatgtgcgcggaacccctatttgtt
tatttttctaaatacattcaaatatgtatccgctcatgaattaattcttagaaaaactcatcga
gcatcaaatgaaactgcaatttattcatatcaggattatcaataccatatttttgaaaaagccg
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aattacaaacaggaatcgaatgcaaccggcgcaggaacactgccagcgcatcaacaatatttttc
acctgaatcaggatattcttctaatacctggaatgctgttttcccggggatcgcagtggtgagt
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gccagtttagtctgaccatctcatctgtaacatcattggcaacgctacctttgccatgtttcag
aaacaactctggcgcatcgggcttcccatacaatcgatagattgtcgcacctgattgcccgaca
ttatcgcgagcccatttatacccatataaatcagcatccatgttggaatttaatcgcggcctag
agcaagacgtttcccgttgaatatggctcataacacccttgtattactgtttatgtaagcaga
cagttttattgttcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcagaccc
cgtagaaaagatcaaaggatcttcttgagatcctttttttctgcgcgtaatctgctgcttgcaa
acaaaaaaaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttc
cgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgtagccgtagtt
aggccaccacttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttacca
gtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccgg
ataaggcgcagcggtcgggctgaacgggggttcgtgcacacagcccagcttggagcgaacgac
ctacaccgaactgagatacctacagcgtgagctatgagaaagcgccacgcttcccgaagggaga
aaggcggacaggtatccggtaagcggcagggtcggaacaggagagcgcacgagggagcttccag
ggggaaacgcctggtatctttatagtcctgtcgggtttcgccacctctgacttgagcgtcgatt
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ttcctggccttttgctggccttttgctcacatgttctttcctgcgttatcccctgattctgtgg
ataaccgtattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccgagcgcag
cgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacgcatctgtgc
ggtatttcacaccgcatatatggtgcactctcagtacaatctgctctgatgccgcatagttaag
ccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacac
ccgctgacgcgccctgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgt
ctccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggcagctgcgg
taaagctcatcagcgtggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagct
cgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatgttaagggcggt
tttttcctgtttggtcactgatgcctccgtgtaagggggatttctgttcatgggggtaatgata

Figure 62B

Nucleotide sequence of pDu48

ccgatgaaacgagagaggatgctcacgatacgggttactgatgatgaacatgcccggttactgg
aacgttgtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcaggg
tcaatgccagcgcttcgttaatacagatgtaggtgttccacagggtagccagcagcatcctgcg
atgcagatccggaacataatggtgcagggcgctgacttccgcgtttccagactttacgaaacac
ggaaaccgaagaccattcatgttgttgctcaggtcgcagacgttttgcagcagcagtcgcttca
cgttcgctcgcgtatcggtgatttcattctgctaaccagtaaggcaaccccgccagcctagccgg
gtcctcaacgacaggagcacgatcatgcgcacccgtggggccgccatgccggcgataatggcct
gcttctcgccgaaacgtttggtggcgggaccagtgacgaaggcttgagcgagggcgtgcaagat
tccgaataccgcaagcgacaggccgatcatcgtcgcgctccagcgaaagcggtcctcgccgaaa
atgacccagagcgctgccggcacctgtcctacgagttgcatgataaagaagacagtcataagtg
cggcgacgatagtcatgccccgcgcccaccggaaggagctgactgggttgaaggctctcaaggg
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gaggcggtttgcgtattgggcgccagggtggtttttctttcaccagtgagacgggcaacagct
gattgcccttcaccgcctggccctgagagagttgcagcaagcggtccacgctggtttgccccag
caggcgaaaatcctgtttgatggtggttaacggcgggatataacatgagctgtcttcggtatcg
tcgtatcccactaccgagatatccgcaccaacgcgcagcccggactcggtaatggcgcgcattg
cgcccagcgccatctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcat
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atttgattgcgagtgagatatttatgccagccagccagacgcagacgcgccgagacagaacttta
atgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagatgctccacgcccagtcg
cgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcagagacatcaagaaat
aacgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagt
taatgatcagcccactgacgcgttgcgcgagaagattgtgcaccgccgctttacaggcttcgac
gccgcttcgttctaccatcgacaccaccacgctggcacccagttgatcggcgcgagatttaatc
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tgataagagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccc
tgaattgactctcttccgggcgctatcatgccataccgcgaaaggttttgcgccattcgatggt
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attgacaacgtccagcgcctgggcctgggttaccgtttcgagtctgatatccgtcgtgcgctgg
atcgcttcgtttcctccggcggcttcgatggcgtaaccaagacttccctgcacggtacggcact
gtctttccgtctgctgcgtcaacacggttttgaggtttctcaggaagcgttcagcggcttcaaa
gaccaaaacggcaacttcctggagaacctgaaggaagatatcaaagctatcctgagcctgtacg

Figure 62C

Nucleotide sequence of pDu48

aggccagcttcctggctctggaaggcgaaaacatcctggacgaggcgaaggttttcgcaatctc
tcatctgaaagaactgtctgaagaaaagatcggtaaagagctggcagaacaggtgtcccatgca
ctggaactgccactgcatcgccgtactcagcgtctggaagcagtatggtctatcgaggcctacc
gtaaaaaggaggacgcgaaccaggttctgctggagctggcaattctggattacaacatgatcca
gtctgtataccagcgtgatctgcgtgaaacgtcccgttggtggcgtcgtgtgggtctggcgacc
aaactgcactttgctcgtgaccgcctgattgagagcttctactgggccgtgggtgtagcattcg
aaccgcaatactccgactgccgtaactccgtcgcaaaaatgttttctttcgtaaccattatcga
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tgggacgtaaacgccatcaacgacctgccggattacatgaaactgtgctttctggctctgtata
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gaccaaagcctgggctgacctgtgcaacgctttcctgcaagaagccaagtggctgtacaacaaa
tctactccgacctttgacgactacttcggcaacgcatggaaatcctcttctggcccgctgcaac
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tctgcggaaattgcgcgtggtgaaaccgcaaatagcgtttcttgttacatgcgcactaaaggta
tctccgaagaactggctaccgaaagcgtgatgaatctgatcgatgaaacctggaaaaagatgaa
caaggaaaaactgggtggtagcctgttcgcgaaaccgttcgtggaaaccgcgatcaacctggca
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gctccgtcgacaagcttgcggccgcactcgagcaccaccaccaccaccactgagatccggctgc
taacaaagcccgaaaggaagctgagttggctgctgccaccgctgagcaataactagcataaccc
cttggggcctctaaacgggtcttgaggggttttttgctgaaaggaggaactatatccggat

Figure 63

Amino acid sequence of *P. tricho* (TRC) (SEQ ID NO:148)

METRRSANYEPNSWDYDYLLSSDTDESIEVYKDKAKKLEAEVRREINNEKAEFLTLLELIDNVQ
RLGLGYRFESDIRRALDRFVSSGGFDAVTKTSLHATALSFRLLRQHGFEVSQEAFSGFKDQNGN
FLENLKEDIKAILSLYEASFLALEGENILDEAKVFAISHLKELSEEKIGKDLAEQVNHALELPL
HRRTQRLEAVLSIEAYRKKEDADQVLLELAILDYNMIQSVYQRDLRETSRWWRRVGLATKLHFA
RDRLIESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLDELELFTNAVERWDVNA
IDDLPDYMKLCFLALYNTINEIAYDNLKEKGENILPYLTKAWADLCNAFLQEAKWLYNKSTPTF
DEYFGNAWKSSSGPLQLVFAYFAVVQNIKKEEIENLQKYHDIISRPSHIFRLCNDLASASAEIA
RGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAKPFVETAINLARQSHC
TYHNGDAHTSPDELTRKRVLSVITEPILPFER

Figure 64A

Nucleotide sequence of pDu49 (SEQ ID NO:149)

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagc
gtgaccgctacacttgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcg
ccacgttcgccggctttccccgtcaagctctaaatcgggggctcccttagggttccgatttag
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ccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgt
tccaaactggaacaacactcaaccctatctcggtctattcttttgatttataagggattttgcc
gatttcggcctattggttaaaaaatgagctgatttaacaaaaatttaacgcgaattttaacaaa
atattaacgtttacaatttcaggtggcacttttcggggaaatgtgcgcggaacccctatttgtt
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gcatcaaatgaaactgcaatttattcatatcaggattatcaataccatatttttgaaaaagccg
tttctgtaatgaaggagaaaactcaccgaggcagttccataggatggcaagatcctggtatcgg
tctgcgattccgactcgtccaacatcaatacaacctattaatttcccctcgtcaaaaataaggt
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ttctttccagacttgttcaacaggccagccattacgctcgtcatcaaaatcactcgcatcaacc
aaaccgttattcattcgtgattgcgcctgagcgagacgaaatacgcgatcgctgttaaaaggac
aattacaaacaggaatcgaatgcaaccggcgcaggaacactgccagcgcatcaacaatatttttc
acctgaatcaggatattcttctaatacctggaatgctgttttcccggggatcgcagtggtgagt
aaccatgcatcatcaggagtacggataaaatgcttgatggtcggaagaggcataaattccgtca
gccagtttagtctgaccatctcatctgtaacatcattggcaacgctacctttgccatgtttcag
aaacaactctggcgcatcgggcttcccatacaatcgatagattgtcgcacctgattgcccgaca
ttatcgcgagcccatttatacccatataaatcagcatccatgttggaatttaatcgcggcctag
agcaagacgtttcccgttgaatatggctcataacacccttgtattactgtttatgtaagcaga
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cgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgtagccgtagtt
aggccaccacttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttacca
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ataaggcgcagcggtcgggctgaacgggggttcgtgcacacagcccagcttggagcgaacgac
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aaggcggacaggtatccggtaagcggcagggtcggaacaggagagcgcacgagggagcttccag
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taaagctcatcagcgtggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagct
cgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatgttaagggcggt
tttttcctgtttggtcactgatgcctccgtgtaagggggatttctgttcatgggggtaatgata

Figure 64B

Nucleotide sequence of pDu49

ccgatgaaacgagagaggatgctcacgatacgggttactgatgatgaacatgcccggttactgg
aacgttgtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcaggg
tcaatgccagcgcttcgttaatacagatgtaggtgttccacagggtagccagcagcatcctgcg
atgcagatccggaacataatggtgcagggcgctgacttccgcgtttccagactttacgaaacac
ggaaaccgaagaccattcatgttgttgctcaggtcgcagacgttttgcagcagcagtcgcttca
cgttcgctcgcgtatcggtgattcattctgctaaccagtaaggcaaccccgccagcctagccgg
gtcctcaacgacaggagcacgatcatgcgcacccgtggggccgccatgccggcgataatggcct
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cggcgacgatagtcatgccccgcgcccaccggaaggagctgactgggttgaaggctctcaaggg
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cccgctttccagtcgggaaacctgtcgtgccagctgcattaatgaatcggccaacgcgcgggga
gaggcggtttgcgtattgggcgccagggtggtttttcttttcaccagtgagacgggcaacagct
gattgcccttcaccgcctggccctgagagagttgcagcaagcggtccacgctggtttgccccag
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cgcccagcgccatctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcat
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atgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagatgctccacgcccagtcg
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gaccaaaacggcaacttcctggagaacctgaaggaagatatcaaagctatcctgagcctgtacg

Figure 64C

Nucleotide sequence of pDu49

aggccagcttcctggctctggaaggcgaaaacatcctggacgaggcgaaggttttcgcaatctc
tcatctgaaagaactgtctgaagaaaagatcggtaaagatctggcagaacaggtgaaccatgca
ctggaactgccactgcatcgccgtactcagcgtctggaagcagtactgtctatcgaggcctacc
gtaaaaaggaggacgcggatcaggttctgctggagctggcaattctggattacaacatgatcca
gtctgtataccagcgtgatctgcgtgaaacgtcccgttggtggcgtcgtgtgggtctggcgacc
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cttggggcctctaaacgggtcttgaggggttttttgctgaaaggaggaactatatccggat

Figure 65

Amino acid sequence of kudzu TRC (MEA) (SEQ ID NO:150)

MEARRSANYQPNLWNFEFLQSLENDLKVEKLEEKATKLEEEVRCMINRVDTQPLSLLELIDDVQ
RLGLTYKFEKDIIKALENIVLLDENKKNKSDLHATALSFRLLRQHGFEVSQDVFERFKDKEGGF
SGELKGDVQGLLSLYEASYLGFEGENLLEEARTFSITHLKNNLKEGINTKVAEQVSHALELPYH
QRLHRLEARWFLDKYEPKEPHHQLLLELAKLDFNMVQTLHQKELQDLSRWWTEMGLASKLDFVR
DRLMEVYFWALGMAPDPQFGECRKAVTKMFGLVTIIDDVYDVYGTLDELQLFTDAVERWDVNAI
NTLPDYMKLCFLALYNTVNDTSYSILKEKGHNNLSYLTKSWRELCKAFLQEAKWSNNKIIPAFS
KYLENASVSSSGVALLAPSYFSVCQQQEDISDHALRSLTDFHGLVRSSCVIFRLCNDLATSAAE
LERGETTNSIISYMHENDGTSEEQAREELRKLIDAEWKKMNRERVSDSTLLPKAFMEIAVNMAR
VSHCTYQYGDGLGRPDYATENRIKLLLIDPFPINQLMYV

Figure 66A

Nucleotide sequence of pDu50 (SEQ ID NO:151)

tcgagcaccaccaccaccaccactgagatccggctgctaacaaagcccgaaaggaagctgagtt
ggctgctgccaccgctgagcaataactagcataaccccttggggcctctaaacgggtcttgagg
ggtttttgctgaaaggaggaactatatccggattggcgaatgggacgcgccctgtagcggcgc
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accgtcatcaccgaaacgcgcgaggcagctgcggtaaagctcatcagcgtggtcgtgaagcgat

Figure 66B

Nucleotide sequence of pDu50

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cgggttactgatgatgaacatgcccggttactggaacgttgtgagggtaaacaactggcggtat
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aggtgttccacagggtagccagcagcatcctgcgatgcagatccggaacataatggtgcagggc
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acaaatttgaaaaagacatcattaaagccctggaaaacatcgtactgctggacgaaaacaaaaa

Figure 66C

Nucleotide sequence of pDu50

gaacaaatctgacctgcacgcaaccgctctgtctttccgtctgctgcgtcagcacggtttcgag
gtttctcaggatgtttttgagcgtttcaaggataaagaaggtggtttcagcggtgaactgaaag
gtgacgtccaaggcctgctgagcctgtatgaagcgtcttacctgggtttcgagggtgagaacct
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gattgacccttcccgattaaccagctgatgtatgtctaactgcagggatccgaattcgagctc
cgtcgacaagcttgcggccgcac

Figure 67

Amino acid sequence of kudzu TRC (-4) (SEQ ID NO:152)

MEHNSRRSANYQPNLWNFEFLQSLENDLKVEKLEEKATKLEEEVRCMINRVDTQPLSLLELIDD
VQRLGLTYKFEKDIIKALENIVLLDENKKNKSDLHATALSFRLLRQHGFEVSQDVFERFKDKEG
GFSGELKGDVQGLLSLYEASYLGFEGENLLEEARTFSITHLKNNLKEGINTKVAEQVSHALELP
YHQRLHRLEARWFLDKYEPKEPHHQLLLELAKLDFNMVQTLHQKELQDLSRWWTEMGLASKLDF
VRDRLMEVYFWALGMAPDPQFGECRKAVTKMFGLVTIIDDVYDVYGTLDELQLFTDAVERWDVN
AINTLPDYMKLCFLALYNTVNDTSYSILKEKGHNNLSYLTKSWRELCKAFLQEAKWSNNKIIPA
FSKYLENASVSSSGVALLAPSYFSVCQQQEDISDHALRSLTDFHGLVRSSCVIFRLCNDLATSA
AELERGETTNSIISYMHENDGTSEEQAREELRKLIDAEWKKMNRERVSDSTLLPKAFMEIAVNM
ARVSHCTYQYGDGLGRPDYATENRIKLLLIDPFPINQLMYV

Figure 68A

Nucleotide sequence of pDu50-4 (SEQ ID NO:153)

tcgagcaccaccaccaccaccactgagatccggctgctaacaaagcccgaaaggaagctgagtt
ggctgctgccaccgctgagcaataactagcataaccccttggggcctctaaacgggtcttgagg
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Figure 68B

Nucleotide sequence of pDu50-4

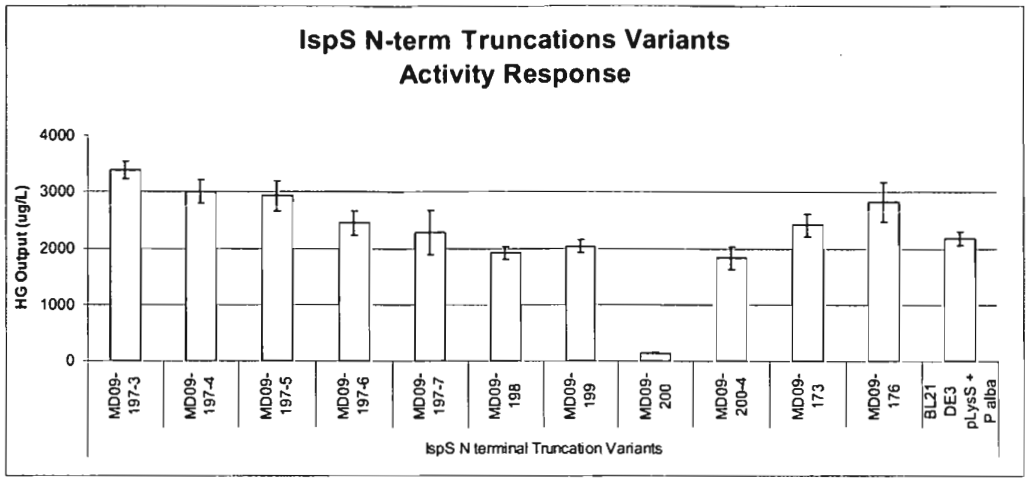
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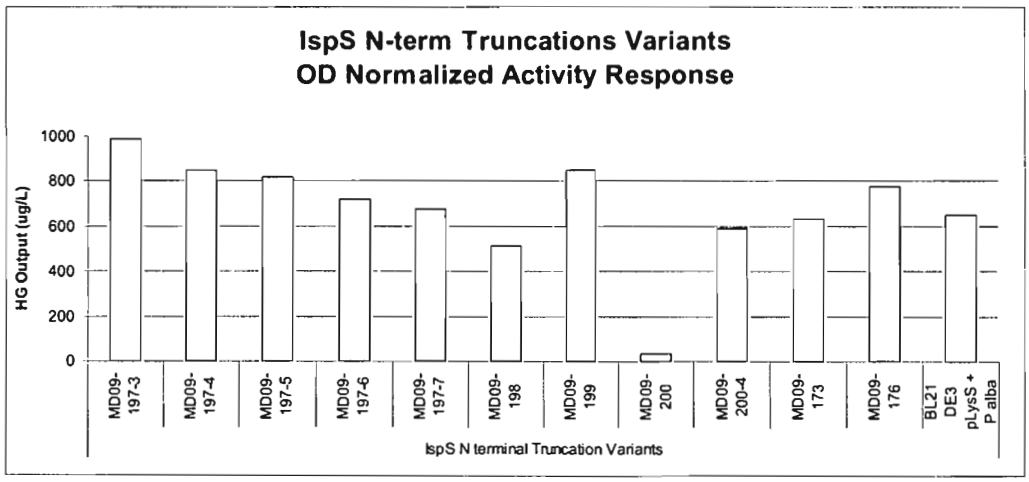
Figure 68C

Nucleotide sequence of pDu50-4

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gagctccgtcgacaagcttgcggccgcac

Figure 69


IspS N-term Truncations Variants
Activity Response
HG Output (ug/L)
4000
3000
2000
1000
0
MD09-197-3
MD09-197-4
MD09-197-5
MD09-197-6
MD09-197-7
MD09-198
MD09-199
MD09-200
MD09-200-4
MD09-173
MD09-176
BL21 DE3 pLysS + P alba
IspS N terminal Truncation Variants


IspS N-term Truncations Variants
OD Normalized Activity Response
HG Output (ug/L)
1000
800
600
400
200
0
MD09-197-3
MD09-197-4
MD09-197-5
MD09-197-6
MD09-197-7
MD09-198
MD09-199
MD09-200
MD09-200-4
MD09-173
MD09-176
BL21 DE3 pLysS + P alba
IspS N terminal Truncation Variants

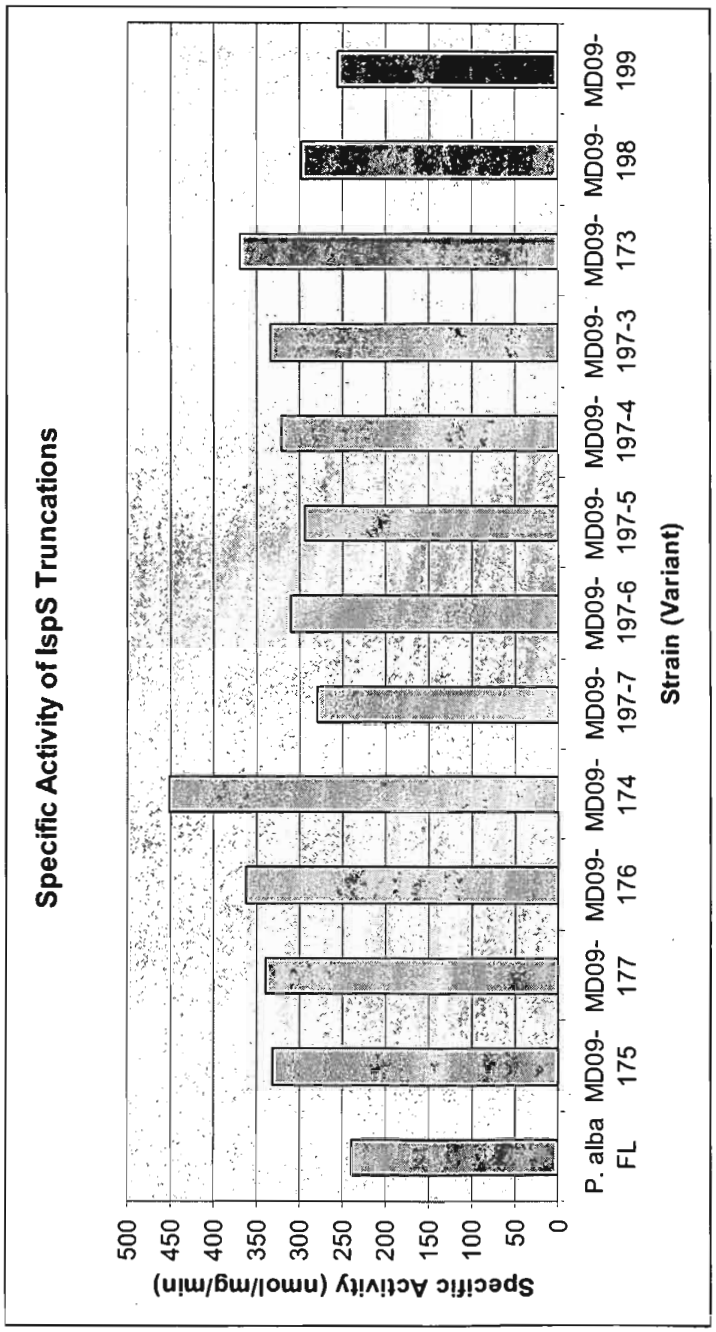

Specific Activity of IspS Truncations
Specific Activity (nmol/mg/min)
0
50
100
150
200
250
300
350
400
450
500
P. alba FL
MD09-175
MD09-177
MD09-176
MD09-174
MD09-197-7
MD09-197-6
MD09-197-5
MD09-197-4
MD09-197-3
MD09-173
MD09-198
MD09-199
Strain (Variant)

Figure 70

Figure 71

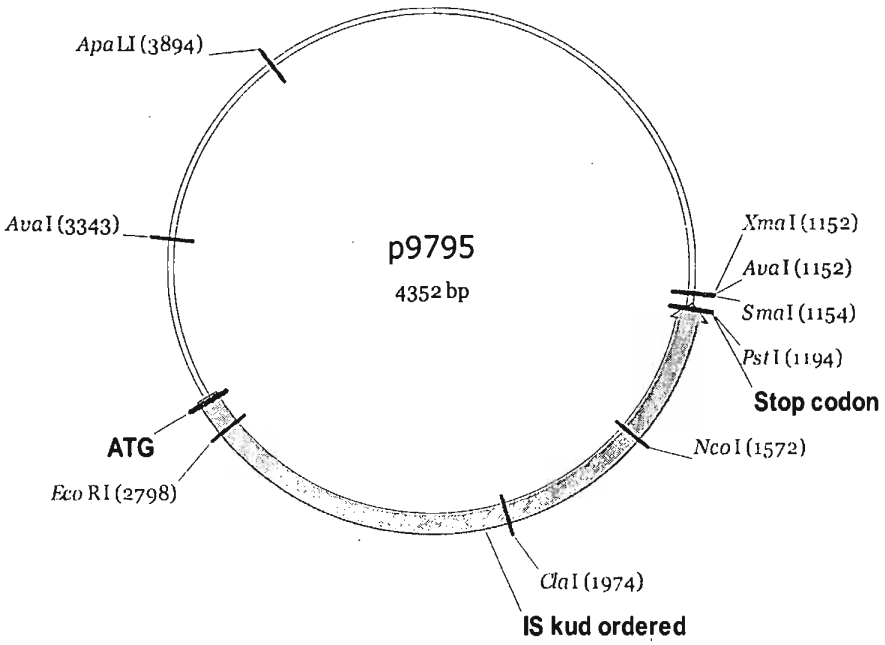

ApaLI (3894)
AvaI (3343)
p9795
4352 bp
XmaI (1152)
AvaI (1152)
SmaI (1154)
PstI (1194)
Stop codon
ATG
EcoRI (2798)
NcoI (1572)
ClaI (1974)
IS kud ordered

Figure 72A

Nucleotide sequence of p9795 (SEQ ID NO:154)

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accatatttttgaaaaagccgtttctgtaatgaaggagaaaactcaccgaggcagttcc
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cctattaatttcccctcgtcaaaaataaggttatcaagtgagaaatcaccatgagtgac
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aatcgagtgcaaccggcgcaggaacactgccagcgcatcaacaatattttcacctgaat
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Figure 72B

Nucleotide sequence of p9795

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Figure 73

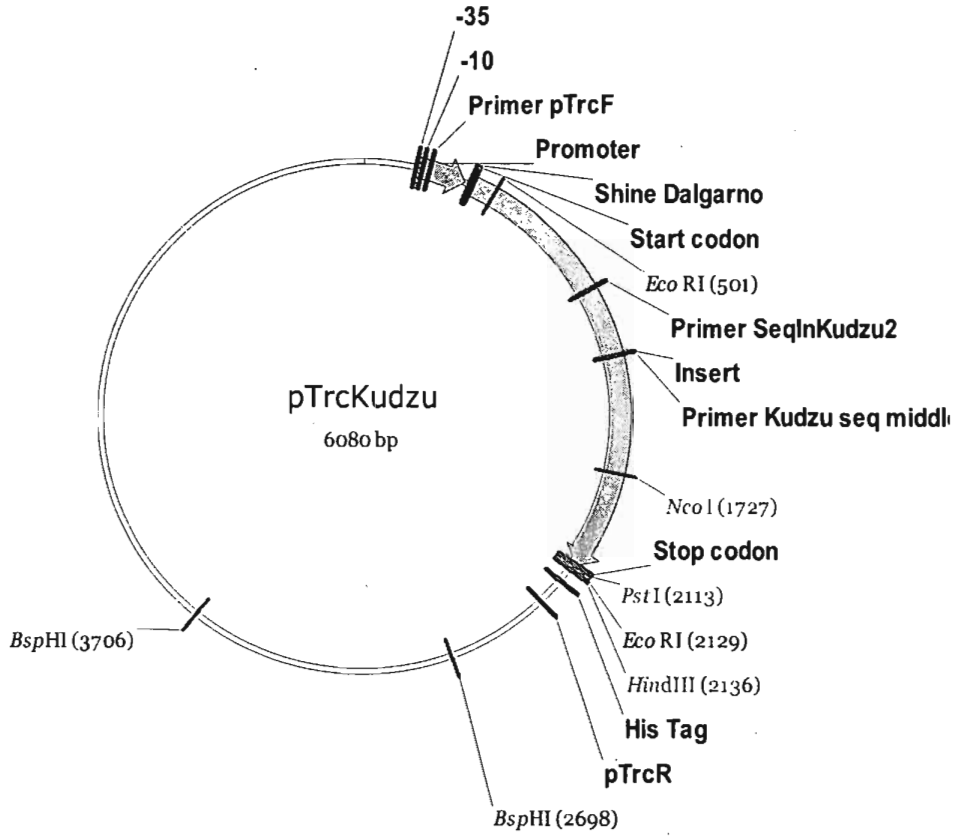

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Promoter
Shine Dalgarno
Start codon
Eco RI (501)
Primer SeqInKudzu2
Insert
Primer Kudzu seq middl
pTrcKudzu
6080 bp
Nco I (1727)
Stop codon
Pst I (2113)
Eco RI (2129)
HindIII (2136)
His Tag
pTrcR
BspHI (2698)
BspHI (3706)

Figure 74A

Nucleotide sequence of pTrcKudzu (SEQ ID NO:155)

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Figure 74B

Nucleotide sequence of pTrcKudzu

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gccacctctgacttgagcgtcgatttttgtgatgctcgtcaggggggcggagcctatgg
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gatcaattcgcgcgcgaaggcgaagcggcatgcatttacgttgacaccatcgaatggtg
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atgtgaaaccagtaacgttatacgatgtcgcagagtatgccggtgtctcttatcagacc
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Figure 74C

Nucleotide sequence of pTrcKudzu

agcggcgatggcggagctgaattacattcccaaccgcgtggcacaacaactggcgggca
aacagtcgttgctgattggcgttgccacctccagtctggccctgcacgcgccgtcgcaa
attgtcgcggcgattaaatctcgcgccgatcaactgggtgccagcgtggtggtgtcgat
ggtagaacgaagcggcgtcgaagcctgtaaagcggcggtgcacaatcttctcgcgcaac
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tgggtcaccagcaaatcgcgctgttagcgggcccattaagttctgtctcggcgcgtctg
cgtctggctggctggcataaatatctcactcgcaatcaaattcagccgatagcggaacg
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ctg

Figure 75

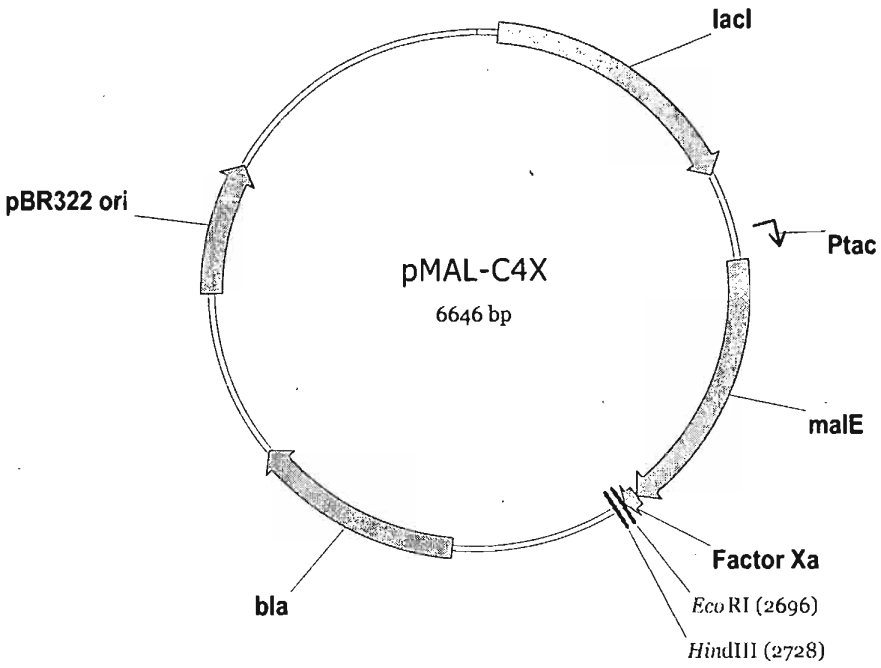

lacI
Ptac
malE
Factor Xa
EcoRI (2696)
HindIII (2728)
bla
pBR322 ori
pMAL-C4X
6646 bp

Figure 76A

Nucleotide sequence of pMAL-C4X (SEQ ID NO:156)

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agtcaattcagggtggtgaatgtgaaaccagtaacgttatacgatgtcgcagagtatgc
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cggcaagctgattgcttacccgatcgctgttgaagcgttatcgctgatttataacaaag
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aaagcgaaaggtaagagcgcgctgatgttcaacctgcaagaaccgtacttcacctggcc
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Figure 76B

Nucleotide sequence of pMAL-C4X

gtccgctttctggtatgccgtgcgtactgcggtgatcaacgccgccagcggtcgtcaga
ctgtcgatgaagccctgaaagacgcgcagactaattcgagctcgaacaacaacaacaat
aacaataacaacaacctcgggatcgagggaaggatttcagaattcggatcctctagagt
cgacctgcaggcaagcttggcactggccgtcgttttacaacgtcgtgactgggaaaacc
ctggcgttacccaacttaatcgccttgcagcacatccccctttcgccagctggcgtaat
agcgaagaggcccgcaccgatcgcccttcccaacagttgcgcagcctgaatggcgaatg
gcagcttggctgttttggcggatgagataagattttcagcctgatacagattaaatcag
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Figure 76C

Nucleotide sequence of pMAL-C4X

agataccaaatactgtccttctagtgtagccgtagttaggccaccacttcaagaactct
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ggtcgggctgaacgggggttcgtgcacacagcccagcttggagcgaacgacctacacc
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Figure 77

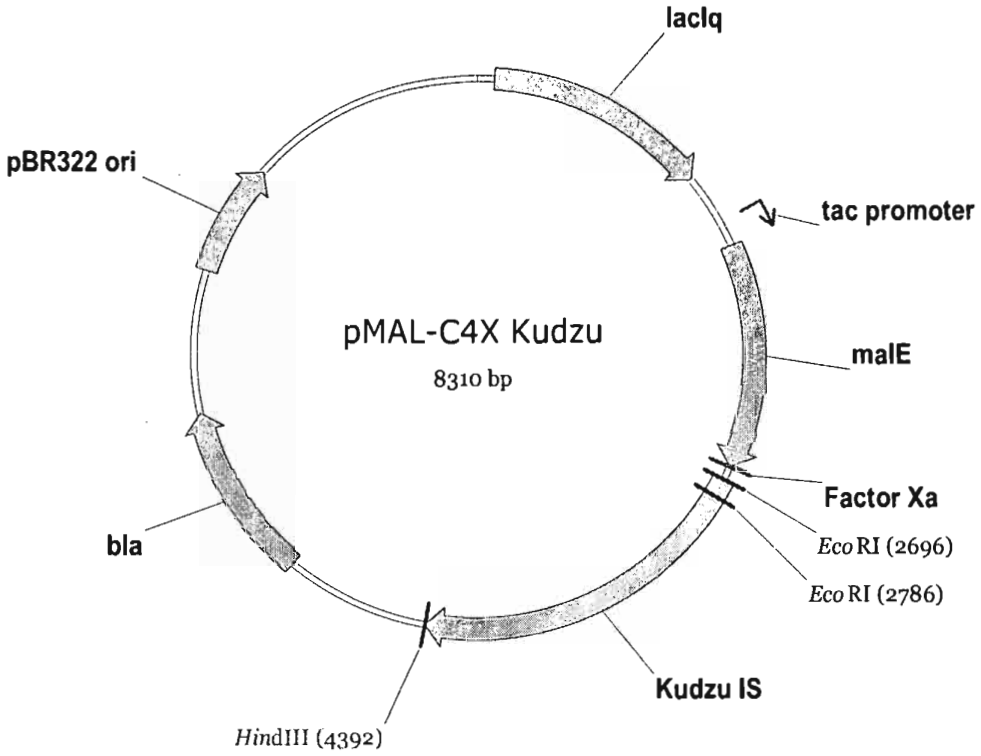

lacIq
pBR322 ori
tac promoter
pMAL-C4X Kudzu
8310 bp
malE
Factor Xa
bla
EcoRI (2696)
EcoRI (2786)
Kudzu IS
HindIII (4392)

Figure 78A

Nucleotide sequence of pMAL-C4X Kudzu (SEQ ID NO:157)

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cagctggcacgacaggtttcccgactggaaagcgggcagtgagcgcaacgcaattaatg
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Figure 78B

Nucleotide sequence of pMAL-C4X Kudzu

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ctgtcgatgaagccctgaaagacgcgcagactaattcgagctcgaacaacaacaacaat
aacaataacaacaacctcgggatcgagggaaggatttcagaattctgtgcgacctcttc
tcaatttactcagattaccgagcataattcccgtcgttccgcaaactatcagccaaacc
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gagaaagcgaccaaactggaggaagaagttcgctgcatgatcaaccgtgtagacaccca
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aacaaatctgacctgcacgcaaccgctctgtctttccgtctgctgcgtcagcacggttt
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tcaccgatgctgtagagcgctgggacgttaacgctattaacaccctgccggactatatg
aaactgtgtttcctggcactgtacaacaccgttaacgacacgtcctattctattctgaa
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Figure 78C

Nucleotide sequence of pMAL-C4X Kudzu

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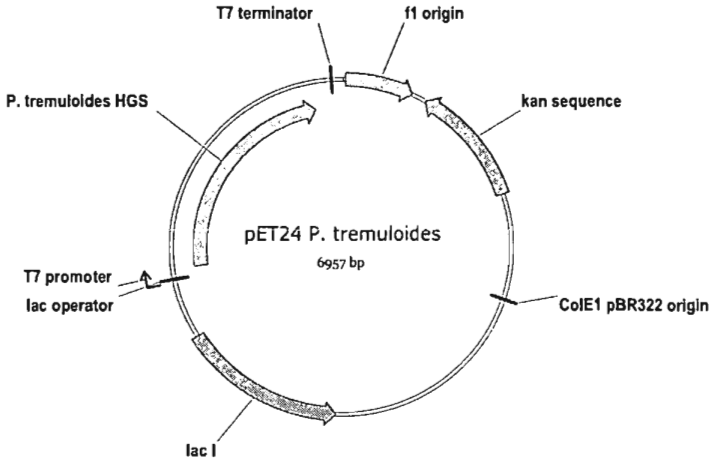
Figure 78D

Nucleotide sequence of pMAL-C4X Kudzu

gggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggcagctgcg
gtaaagctcatcagcgtggtcgtgcagcgattcacagatgtctgcctgttcatccgcgt
ccagctcgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatg
ttaagggcggttttttcctgtttggtcactgatgcctccgtgtaagggggatttctgtt
catgggggtaatgataccgatgaaacgagagaggatgctcacgatacgggttactgatg
atgaacatgcccggttactggaacgttgtgagggtaaacaactggcggtatggatgcgg
cgggaccagagaaaaatcactcagggtcaatgccagcgcttcgttaatacagatgtagg
tgttccacagggtagccagcagcatcctgcgatgcagatccggaacataatggtgcagg
gcgctgacttccgcgtttccagactttacgaaacacggaaaccgaagaccattcatgtt
gttgctcaggtcgcagacgttttgcagcagcagtcgcttcacgttcgctcgcgtatcgg
tgattcattctgctaaccagtaaggcaaccccgccagcctagccgggtcctcaacgaca
ggagcacgatcatgcgcacccgtggccaggacccaacgctgcccgaaatt

Figure 79

A.


T7 terminator
f1 origin
P. tremuloides HGS
kan sequence
pET24 P. tremuloides
6957 bp
T7 promoter
lac operator
ColE1 pBR322 origin
lac I

B.

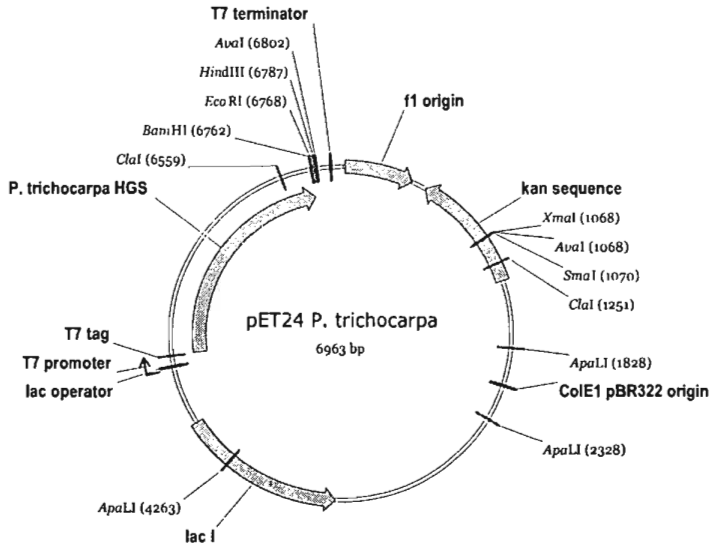

T7 terminator
AvaI (6802)
HindIII (6787)
EcoRI (6768)
BamHI (6762)
ClaI (6559)
f1 origin
P. trichocarpa HGS
kan sequence
XmaI (1068)
AvaI (1068)
SmaI (1070)
ClaI (1251)
pET24 P. trichocarpa
6963 bp
T7 tag
T7 promoter
lac operator
ApaLI (1828)
ColE1 pBR322 origin
ApaLI (2328)
ApaLI (4263)
lac I

Figure 80

Amino acid sequence of *P. tremuloides* IspS (SEQ ID NO:158)

MRCSVSTENVSFSETETETRRSANYEPNSWDYDYLLSSDTDESIEVHKDKAKKLEAEVR
REINNEKAEFLTLLELIDNVQRLGLGYRFESDIRRALDRFVSSGGFDGVTKTSLHGTAL
SFRLLRQHGFEVSQEAFSGFKDQNGNFLENLKEDIKAILSLYEASFLALEGENILDEAK
VFAISHLKELSEEKIGKELAEQVSHALELPLHRRTQRLEAVWSIEAYRKKEDANQVLLE
LAILDYNMIQSVYQRDLRETSRWWRRVGLATKLHFARDRLIESFYWAVGVAFEPQYSDC
RNSVAKMFSFVTIIDDIYDVYGTLDELELFTDAVERWDVNAINDLPDYMKLCFLALYNT
INEIAYDNLKDKGENILPYLTKAWADLCNAFLQEAKWLYNKSTPTFDDYFGNAWKSSSG
PLQLIFAYFAVVQNIKKEEIENLQKYHDIISRPSHIFRLCNDLASASAEIARGETANSV
SCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAKPFVETAINLARQSHCTYH
NGDAHTSPDELTRKRVLSVITEPILPFER

Figure 81A

Nucleotide sequence of P. tremuloides pET24a (SEQ ID NO:159)

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgc
gcagcgtgaccgctacacttgccagcgccctagcgcccgctcctttcgctttcttccct
tcctttctcgccacgttcgccggctttccccgtcaagctctaaatcgggggctcccttt
agggttccgatttagtgctttacggcacctcgaccccaaaaaacttgattagggtgatg
gttcacgtagtgggccatcgccctgatagacggtttttcgccctttgacgttggagtcc
acgttctttaatagtggactcttgttccaaactggaacaacactcaaccctatctcggt
ctattcttttgatttataagggattttgccgatttcggcctattggttaaaaaatgagc
tgatttaacaaaaatttaacgcgaattttaacaaaatattaacgtttacaatttcaggt
ggcacttttcggggaaatgtgcgcggaacccctatttgtttatttttctaaatacattc
aaatatgtatccgctcatgaattaattcttagaaaaactcatcgagcatcaaatgaaac
tgcaatttattcatatcaggattatcaataccatatttttgaaaaagccgtttctgtaa
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tcgctgttaaaaggacaattacaaacaggaatcgaatgcaaccggcgcaggaacactgc
cagcgcatcaacaatattttcacctgaatcaggatattcttctaatacctggaatgctg
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ttgatggtcggaagaggcataaattccgtcagccagtttagtctgaccatctcatctgt
aacatcattggcaacgctacctttgccatgtttcagaaacaactctggcgcatcgggct
tcccatacaatcgatagattgtcgcacctgattgcccgacattatcgcgagcccattta
tacccatataaatcagcatccatgttggaatttaatcgcggcctagagcaagacgtttc
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ctttttccgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagt
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cacccgccaacacccgctgacgcgccctgacgggcttgtctgctcccggcatccgctta
cagacaagctgtgaccgtctccgggagctgcatgtgtcagaggttttcaccgtcatcac

Figure 81B

Nucleotide sequence of P. tremuloides pET24a

cgaaacgcgcgaggcagctgcggtaaagctcatcagcgtggtcgtgaagcgattcacag
atgtctgcctgttcatccgcgtccagctcgttgagtttctccagaagcgttaatgtctg
gcttctgataaagcgggccatgttaagggcggttttttcctgtttggtcactgatgcct
ccgtgtaaggggatttctgttcatgggggtaatgataccgatgaaacgagagaggatg
ctcacgatacgggttactgatgatgaacatgcccggttactggaacgttgtgagggtaa
acaactggcggtatggatgcggcgggaccagagaaaaatcactcagggtcaatgccagc
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gataacaattcccctctagaaataattttgtttaactttaagaaggagatatacatatg

Figure 81C

Nucleotide sequence of P. tremuloides pET24a

cgttgtagcgtgtccaccgaaaatgtgtctttctctgaaactgaaaccgaaacgcgtcg
ttctgcgaactacgaacctaacagctgggactatgattacctgctgtcctccgacacgg
acgagtccatcgaagtacacaaagacaaagcgaaaaagctggaagccgaagttcgtcgc
gagattaataacgaaaaagcagaatttctgaccctgctggaactgattgacaacgtcca
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gcggccgcactcgagcaccaccaccaccaccactgagatccggctgctaacaaagcccg
aaaggaagctgagttggctgctgccaccgctgagcaataactagcataaccccttgggg
cctctaaacgggtcttgaggggtttttgctgaaaggaggaactatatccggat

Figure 82

Amino acid sequence of *P. trichocharpa* IspS (SEQ ID NO:160)

MRCSVSTENVSFTETETETRRSANYEPNSWDYDYLLSSDTDESIEVYKDKAKKLEAEVR
REINNEKAEFLTLLELIDNVQRLGLGYRFESDIRRALDRFVSSGGFDAVTKTSLHATAL
SFRLLRQHGFEVSQEAFSGFKDQNGNFLENLKEDIKAILSLYEASFLALEGENILDEAK
VFAISHLKELSEEKIGKDLAEQVNHALELPLHRRTQRLEAVLSIEAYRKKEDADQVLLE
LAILDYNMIQSVYQRDLRETSRWWRRVGLATKLHFARDRLIESFYWAVGVAFEPQYSDC
RNSVAKMFSFVTIIDDIYDVYGTLDELELFTNAVERWDVNAIDDLPDYMKLCFLALYNT
INEIAYDNLKEKGENILPYLTKAWADLCNAFLQEAKWLYNKSTPTFDEYFGNAWKSSSG
PLQLVFAYFAVVQNIKKEEIENLQKYHDIISRPSHIFRLCNDLASASAEIARGETANSV
SCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAKPFVETAINLARQSHCTYH
NGDAHTSPDELTRKRVLSVITEPILPFER

Figure 83A

Nucleotide sequence of P. trichocharpa pET24a (SEQ ID NO:161)

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgc
gcagcgtgaccgctacacttgccagcgccctagcgcccgctcctttcgctttcttcccct
tcctttctcgccacgttcgccggctttccccgtcaagctctaaatcgggggctcccttt
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acgttctttaatagtggactcttgttccaaactggaacaacactcaaccctatctcggt
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tgatttaacaaaaatttaacgcgaattttaacaaaatattaacgtttacaatttcaggt
ggcacttttcggggaaatgtgcgcggaacccctatttgtttatttttctaaatacattc
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tgcaatttattcatatcaggattatcaataccatatttttgaaaaagccgtttctgtaa
tgaaggagaaaactcaccgaggcagttccataggatggcaagatcctggtatcggtctg
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aacatcattggcaacgctacctttgccatgtttcagaaacaactctggcgcatcgggct
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tacccatataaatcagcatccatgttggaatttaatcgcggcctagagcaagacgtttc
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cacccgccaacacccgctgacgcgccctgacgggcttgtctgctcccggcatccgctta
cagacaagctgtgaccgtctccgggagctgcatgtgtcagaggttttcaccgtcatcac

Figure 83B

Nucleotide sequence of P. trichocharpa pET24a

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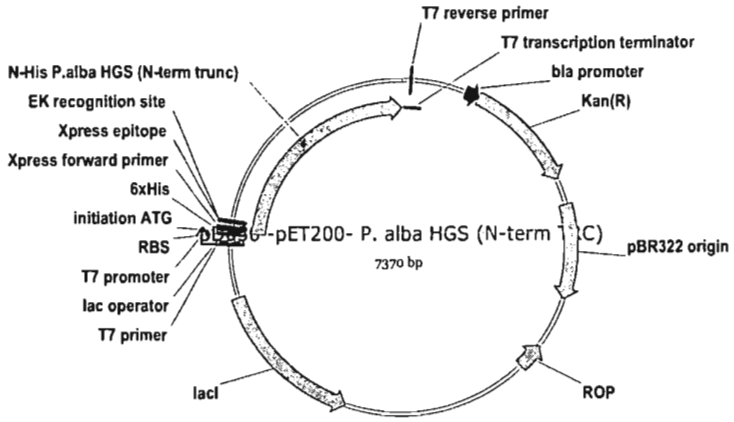
Figure 83C

Nucleotide sequence of P. trichocharpa pET24a

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agcccgaaaggaagctgagttggctgctgccaccgctgagcaataactagcataacccc
ttggggcctctaaacgggtcttgaggggtttttgctgaaaggaggaactatatccgga
t

Figure 84

A.


T7 reverse primer
T7 transcription terminator
N-His P.alba HGS (N-term trunc)
bla promoter
EK recognition site
Kan(R)
Xpress epitope
Xpress forward primer
6xHis
initiation ATG
RBS
T7 promoter
lac operator
T7 primer
lacI
ROP
pBR322 origin
7370 bp

B.

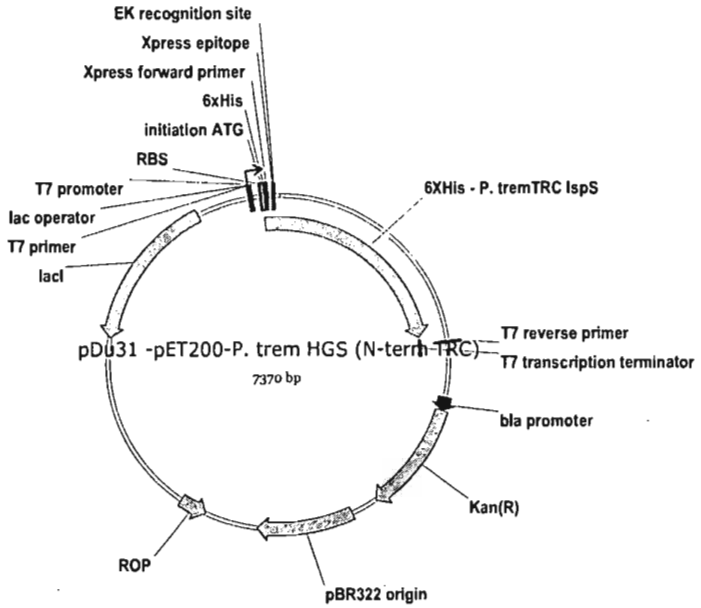

EK recognition site
Xpress epitope
Xpress forward primer
6xHis
initiation ATG
RBS
T7 promoter
6XHis - P. tremTRC IspS
lac operator
T7 primer
lacI
T7 reverse primer
T7 transcription terminator
bla promoter
Kan(R)
ROP
pBR322 origin
7370 bp

Figure 84C

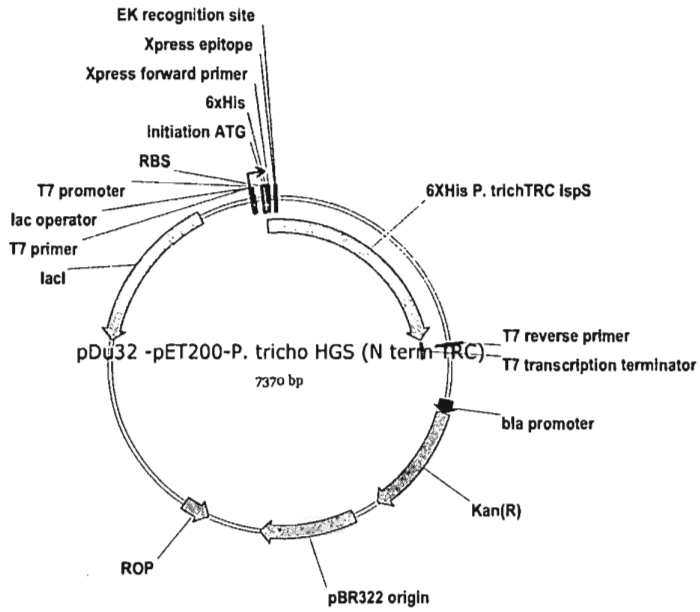

EK recognition site
Xpress epitope
Xpress forward primer
6xHis
Initiation ATG
RBS
T7 promoter
lac operator
T7 primer
lacI
6XHis P. trichTRC IspS
T7 reverse primer
T7 transcription terminator
pDu32 -pET200-P. tricho HGS (N term TRC)
7370 bp
bla promoter
Kan(R)
ROP
pBR322 origin

Figure 85

Amino acid sequence of IspS variant P. albaTRC-pET200 (SEQ ID NO:162)

MRGSHHHHHHGMASMTGGQQMGRDLYDDDDKDHPFTMRRSANYEPNSWDYDYLLSSDTD
ESIEVYKDKAKKLEAEVRREINNEKAEFLTLLELIDNVQRLGLGYRFESDIRGALDRFV
SSGGFDAVTKTSLHGTALSFRLLRQHGFEVSQEAFSGFKDQNGNFLENLKEDIKAILSL
YEASFLALEGENILDEAKVFAISHLKELSEEKIGKELAEQVNHALELPLHRRTQRLEAV
WSIEAYRKKEDANQVLLELAILDYNMIQSVYQRDLRETSRWWRRVGLATKLHFARDRLI
ESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLDELELFTDAVERWDVNA
INDLPDYMKLCFLALYNTINEIAYDNLKDKGENILPYLTKAWADLCNAFLQEAKWLYNK
STPTFDDYFGNAWKSSSGPLQLVFAYFAVVQNIKKEEIENLQKYHDTISRPSHIFRLCN
DLASASAEIARGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAK
PFVETAINLARQSHCTYHNGDAHTSPDELTRKRVLSVITEPILPFER

Figure 86A

Nucleotide Sequence of pDu30 (SEQ ID NO:163)

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tgccaccgctgagcaataactagcataaccccttggggcctctaaacgggtcttgagga
gttttttgctgaaaggaggaactatatccggatatcccgcaagaggcccggcagtaccg
gcataaccaagcctatgcctacagcatccagggtgacggtgccgaggatgacgatgagc
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tagttaagccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccga
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Figure 86B

Nucleotide Sequence of pDu30

cagacaagctgtgaccgtctccgggagctgcatgtgtcagaggttttcaccgtcatcac
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atgtctgcctgttcatccgcgtccagctcgttgagtttctccagaagcgttaatgtctg
gcttctgataaagcgggccatgttaagggcggttttttcctgtttggtcactgatgcct
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Figure 86C

Nucleotide Sequence of pDu30

ggctggcctggttcaccacgcgggaaacggtctgataagagacaccggcatactctgcg
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ctatcatgccataccgcgaaaggttttgcgccattcgatggtgtccgggatctcgacgc
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cgcaaacgcgttctgtctgtaatcactgaaccgattctgccgtttgaacgctaa

Figure 87

Amino acid sequence of IspS variant *P.trem*TRC-pET200 (SEQ ID NO:164)

MRGSHHHHHHGMASMTGGQQMGRDLYDDDDKDHPFTMRRSANYEPNSWDYDYLLSSDTD
ESIEVHKDKAKKLEAEVRREINNEKAEFLTLLELIDNVQRLGLGYRFESDIRRALDRFV
SSGGFDGVTKTSLHGTALSFRLLRQHGFEVSQEAFSGFKDQNGNFLENLKEDIKAILSL
YEASFLALEGENILDEAKVFAISHLKELSEEKIGKELAEQVSHALELPLHRRTQRLEAV
WSIEAYRKKEDANQVLLELAILDYNMIQSVYQRDLRETSRWWRRVGLATKLHFARDRLI
ESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLDELELFTDAVERWDVNA
INDLPDYMKLCFLALYNTINEIAYDNLKDKGENILPYLTKAWADLCNAFLQEAKWLYNK
STPTFDDYFGNAWKSSSGPLQLIFAYFAVVQNIKKEEIENLQKYHDIISRPSHIFRLCN
DLASASAEIARGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAK
PFVETAINLARQSHCTYHNGDAHTSPDELTRKRVLSVITEPILPFER

Figure 88A

Nucleotide sequence of pDu31 (SEQ ID NO:165)

cgtcgttctgcgaactacgaacctaacagctgggactatgattacctgctgtcctccga
cacggacgagtccatcgaagtacacaaagacaaagcgaaaaagctggaagccgaagttc
gtcgcgagattaataacgaaaaagcagaatttctgaccctgctggaactgattgacaac
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acgaggcagcgcggctatcgtggctggccacgacgggcgttccttgcgcagctgtgctc
gacgttgtcactgaagcgggaagggactggctgctattgggcgaagtgccggggcagga
tctcctgtcatctcaccttgctcctgccgagaaagtatccatcatggctgatgcaatgc

Figure 88B

Nucleotide sequence of pDu31

ggcggctgcatacgcttgatccggctacctgcccattcgaccaccaagcgaaacatcgc
atcgagcgggcacgtactcggatggaagccggtcttgtcgatcaggatgatctggacga
agagcatcaggggctcgcgccagccgaactgttcgccaggctcaaggcgcgcatgcccg
acggcgaggatctcgtcgtgacacatggcgatgcctgcttgccgaatatcatggtggaa
aatggccgcttttctggattcatcgactgtggccggctgggtgtggcggaccgctatca
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gcttcctcgtgctttacggtatcgccgctcccgattcgcagcgcatcgccttctatcgc
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gttctccgcaagaattgattggctccaattcttggagtggtgaatccgttagcgaggtg
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Figure 88C

Nucleotide sequence of pDu31

gaggcagacaaggtatagggcggcgcctacaatccatgccaacccgttccatgtgctcg
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cctaatgagtgagctaacttacattaattgcgttgcgctcactgcccgctttccagtcg
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caaatgggtcgggatctgtacgacgatgacgataaggatcatcccttcaccatg

Figure 89

Amino acid sequence of IspS variant P.trichTRC-pET200 (SEQ ID NO:166)

MRGSHHHHHHGMASMTGGQQMGRDLYDDDDKDHPFTMRRSANYEPNSWDYDYLLSSDTD
ESIEVYKDKAKKLEAEVRREINNEKAEFLTLLELIDNVQRLGLGYRFESDIRRALDRFV
SSGGFDAVTKTSLHATALSFRLLRQHGFEVSQEAFSGFKDQNGNFLENLKEDIKAILSL
YEASFLALEGENILDEAKVFAISHLKELSEEKIGKDLAEQVNHALELPLHRRTQRLEAV
LSIEAYRKKEDADQVLLELAILDYNMIQSVYQRDLRETSRWWRRVGLATKLHFARDRLI
ESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTLDELELFTNAVERWDVNA
IDDLPDYMKLCFLALYNTINEIAYDNLKEKGENILPYLTKAWADLCNAFLQEAKWLYNK
STPTFDEYFGNAWKSSSGPLQLVFAYFAVVQNIKKEEIENLQKYHDIISRPSHIFRLCN
DLASASAEIARGETANSVSCYMRTKGISEELATESVMNLIDETWKKMNKEKLGGSLFAK
PFVETAINLARQSHCTYHNGDAHTSPDELTRKRVLSVITEPILPFER

Figure 90A

Nucleotide Sequence of pDu32 (SEQ ID NO:167)

cgtcgttctgcgaactacgaacctaacagctgggactatgattacctgctgtcctccga
cacggacgagtccatcgaagtatacaaagacaaagcgaaaaagctggaagccgaagttc
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gtccagcgcctgggcctgggttaccgtttcgagtctgatatccgtcgtgcgctggatcg
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tctcctgtcatctcaccttgctcctgccgagaaagtatccatcatggctgatgcaatgc

Figure 90B

Nucleotide Sequence of pDu32

ggcggctgcatacgcttgatccggctacctgcccattcgaccaccaagcgaaacatcgc
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agagcatcaggggctcgcgccagccgaactgttcgccaggctcaaggcgcgcatgcccg
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Figure 90C

Nucleotide Sequence of pDu32

gaggcagacaaggtatagggcggcgcctacaatccatgccaacccgttccatgtgctcg
ccgaggcggcataaatcgccgtgacgatcagcggtccaatgatcgaagttaggctggta
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Figure 91

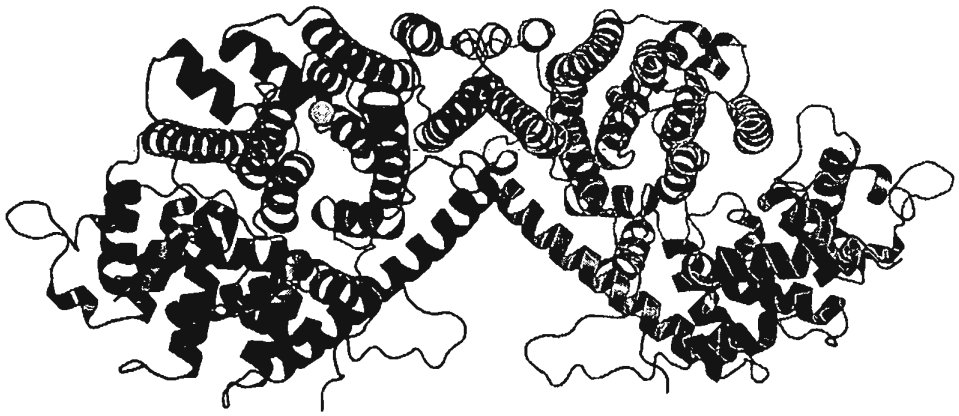


Figure 92

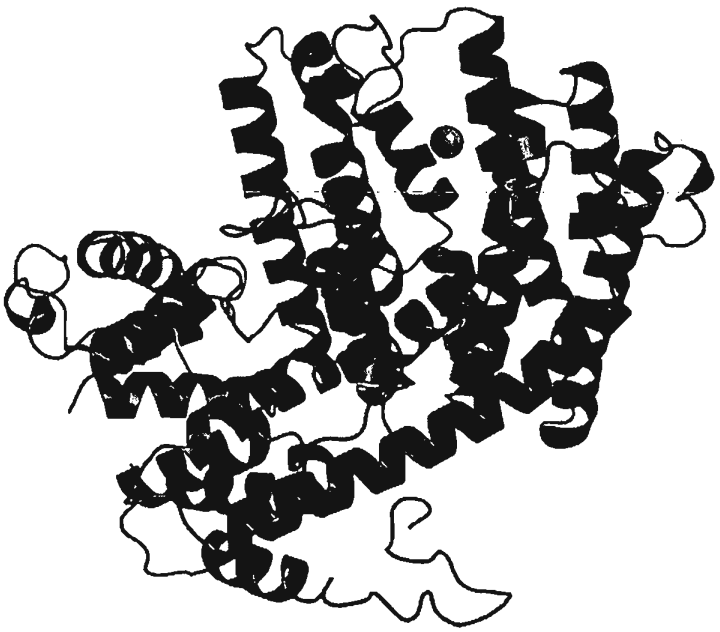


Figure 93

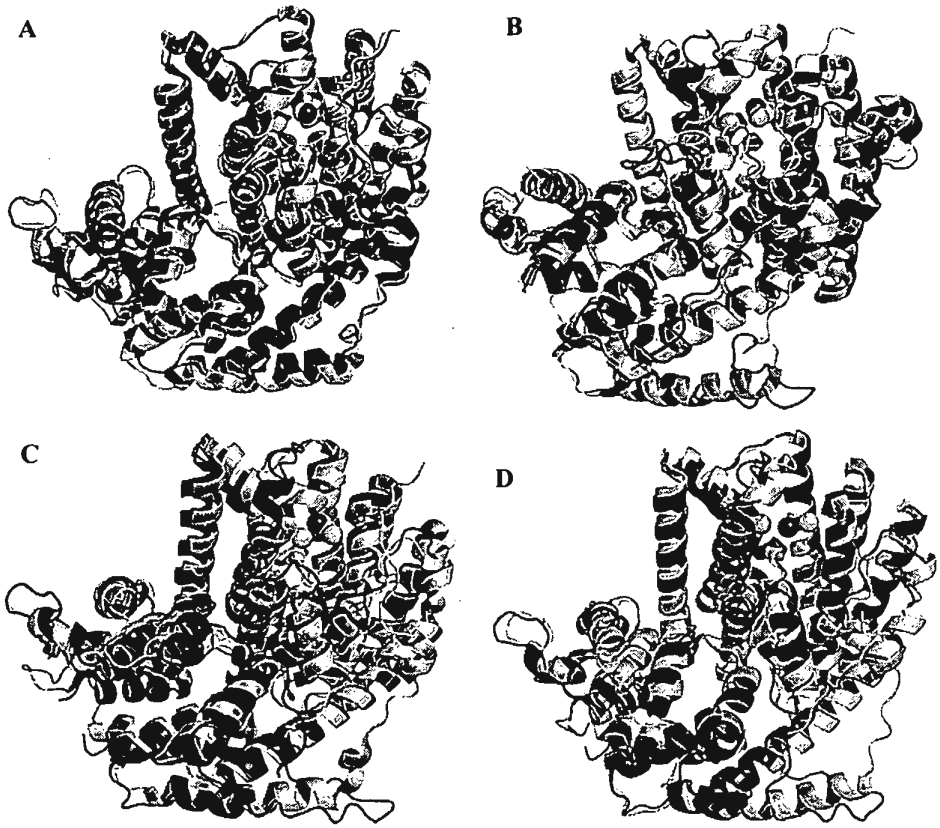


Figure 94

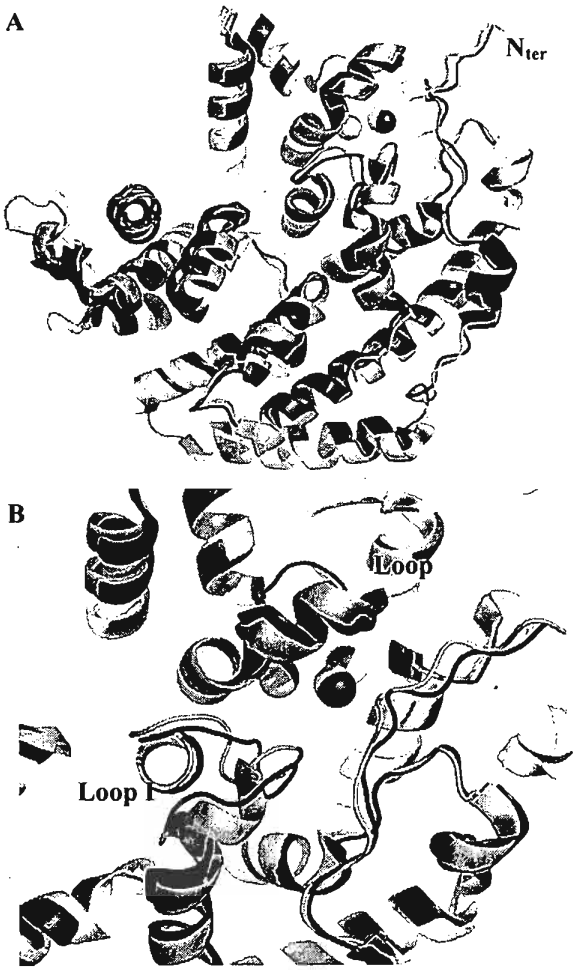


Figure 95

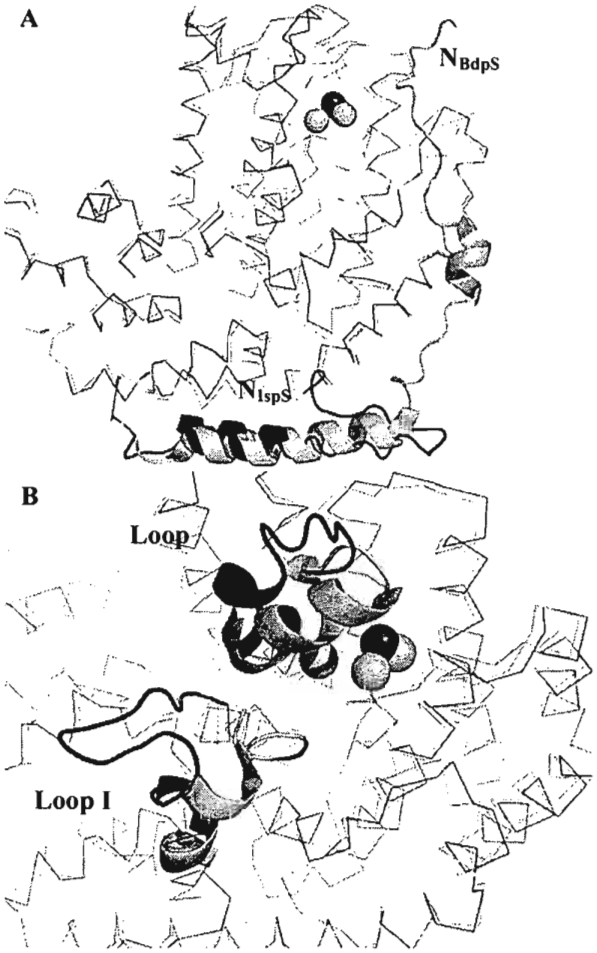


Figure 96

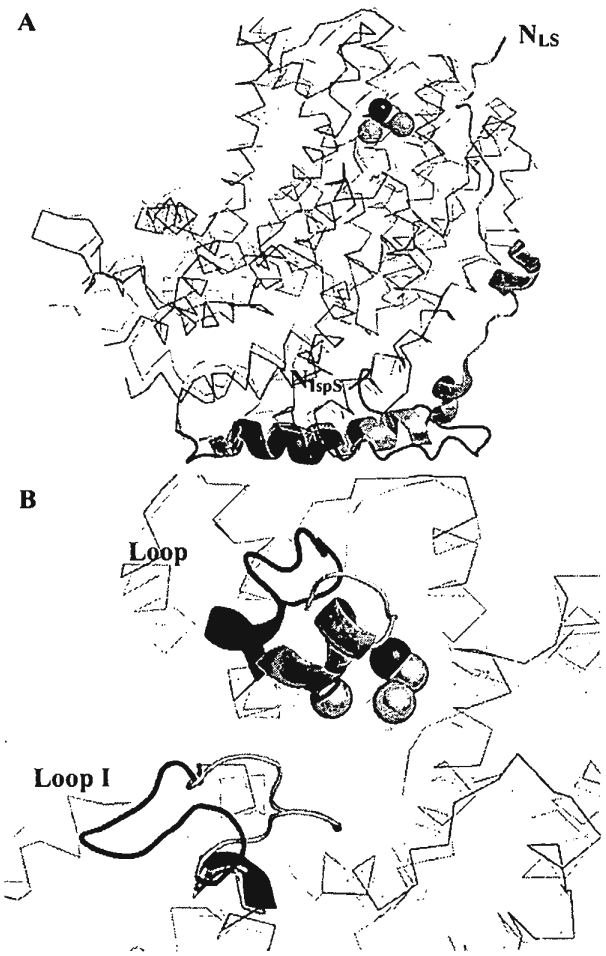


Figure 97

