

Supporting Information

Enantioselectivity in Vanadium-Dependent Haloperoxidases of Different Marine Sources for Sulfide Oxidation to Sulfoxides

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Table S1. Sequence Information

Enzyme	Originism	Sequence
<i>CiVCPO</i>	<i>Curvularia inaequalis</i>	MGSVTPIPLPKIDEPEEYNTNYILFWNHVGLELNRVTHTVGGPLTGPPLSAR ALGMLHLAIHDAYFSICPPTDFTTFLSPDTENAAYRLPSPNGANDARQAVA GAALKMLSSLYMKPVEQPNPNPGANISDNAYAQLGLVLD RSVLEAPGGV DRESASFMFGEDVADVFFALLNDPRGASQEGYHPTPGRYKFDDETHPVV LIPVDPNNPNGPKMPFRQYHAPFYGKTTKRFATQSEHFLADPPGLRSNAD ETA EYDDAVRVAIAMGGAQALNSTKRSPWQTAQGLYWAYDGSNLIGTPP RFYNQIVRRIAVTYKKEEDLANSEVNNADFARLFALVDVACTDAGIFSWKE KWEFEFWRPLSGVRDDGRPDHGD PFWLT LGAPATNTNDIPKPPFPAYPS GHATFGGAVFQMVERRYYNGRVGTWKDDEPDNIAIDMMISEELNGVNRD LRQPYDPTAPIEDQPGIVRTRIVRHFD SAWELMFENAI S RIFLG VHWRFDA AAARDILIP TTTKDVYAVDNNGATVFQNVEDIRYTT RGTREDPEGLFPIGGV PLGIEIADEIFNNGLKPTPEIQMPQETPVQKPVGQQPVKGMWEEEQAP VVKEAP
<i>HwVCPO</i>	<i>Hortaea</i>	MIPLHQRPEDTDYNKNYVLYWNHVALELVRLTHTETASGAVNGPPLVAR

	<i>werneckii</i>	MLGILHLAIHDAFFALHNTAGISTYLSPTQSAPYRLPDILDARDGRQAVAGA AITVLEDQYFVSHPSESFSANDQAEQLRRYITAFAPDTLSSSYRFGYEVGKA MLKLLAIKQDEPGTDQDSYMPSQGQYRFFHDPTNPVVVSSVDPNDPESPK RASRVAHAPFYGMTAKRLAVQYRIGKDQTEHIIADPPVGFGEADMPEYVD ALRDVYRMGGRTLNTRRPWQTAAAHFWAYDGSNLIGVPLRLYNQILR TVAWDHRPDKRIPDSKNNVEFARLFALCNAAMADAGIFAWQEKYCFEF WRPLSGVREASTDLIVRNRNGMVEGIPDPDRPPTMDDGTVALQDPFW LELGAPNTNSNRIPKPAFPAYPSGHATFGAACFQMMRLYYKNSHRDGIA DFDIDGPDNIAFDVFSDEQDGRNRDNLRNPFDPNPIDDQPGIVRALWKR RFGSLWEALWENAI SRVWLGVHWRFD AFSPKDALVRNPTPTTVSSKTDSP LLYAVETDHSTRYKPLAEVRYTSTGTRDRPGKNFPVGGVPLGIGIANDIFQ GGLRPTAQNKQPSGRHRCGRLGKP
<i>AdVCPO</i>	<i>Alternaria didymospora</i>	MTIDFTPVELPVVEEDAEYNWNYILFWNNVGLELNRVTHTFGALKAGPPL SPRALGMLQLAVHDAYFAIHPSAGFTTFLTPGAEDGAYRLPDPSYAKDARQ AVAGAAIAMLSKLYMKPKVVRSPISHNAYAQLQHVLDISVTKAPAACDPA SSSFIFGKAVATAVFDLLFHKEGADQSGYSPKPGPFKNDEPTHHPVELIPVD ANIPDGDKMPRRQYHAPYYGETAKRFGTQTEHMLADPPGIRCAGEVAEY DDAIREVYAMGGAPGLNTTKRTPHQTVQGMFWAYDGPKLIGTPPRLYNQ IVRKIAVTYKKDNDLVNSEVNNADFARLLALVNVAMTDAGIFAWKEKWEF EFWRPLSGVRDDVLRDPEGKASTAAIHSGLASAPQLQNSDEAPFKPPFPAY PSGHATFGAAAFQMVRKYNGRLGKWATTSRDIAVEMFVSEELNGVSR DLSNPYDPKR PITDQPGIVPTRMPRRFSSCWEMMFENAVSRIFLGVHWRF DAAAGQDILIPTTKDVYAVDDKGAALFKNVEDIRYKTKGTRKGHKGLLP GVPLGIEIANEIYNNKLSPTPPGEQPMPPQHQPGRKKGELAEAKDEE QAPMMDVAP
<i>SIVCPO</i>	<i>Stemphylium lycopersici</i>	MDPVTPIPLPKIEEPEDYNTNYILYWHHVGLEHNRVTHTVGGPQTGPPI RALGMLQLAAHDAYFAINPSCDFTTFLTPGAENAAAYRLPDNLGANDARQA VAGASIKMLSELYSKPVTPQPNPNPGANISDNAYEQLVLDRSIADAPGGV DQASASFVFGQAVAEVFFNLLFHPPGASQEGYHPTPGRYKFDDEPTHPVV

		<p>LIPVNPNNPDGPKMPFRQYHGPFYGTSAKRLGTQTEHMIADPPGIRSAAD</p> <p>EGAEYDDSIKVAIAMGGAIGLNSTKRSPYQTTQGIYWAYDGSNLIGTPPRF</p> <p>YNQIVRRIAVTYKKESDLAASETNNADFARLLALNVNACADAGIFSWKEKW</p> <p>EFEFWRPLSGVRDDGRPDHGDPPFWLTGAPATNTNDIPKPPFPAYPSGH</p> <p>ATFGGAAFQMVERRYYNGRVGTWKNDEPDTIAIDMMVSEELNGLSRDLR</p> <p>QPYDPSAPITDQPGIVRTRVVRHFSSAWELMFENAIKRLFLGVHWRFDAA</p> <p>AARDILIPTTTTKDVYAKDENGATVFQNVEDVRYTTLGTREGHEGLPIGGVP</p> <p>LGIGIADEIFESGLRPTPVERQPMGDGGEGVGGRKEEVMVVDGGMWEG</p> <p>EQVPAMDQAP</p>
<i>CcVCPO</i>	<i>Curvularia clavata</i>	<p>MGSVTPIPLPKIDEPEEYNTNYILFWNHVGLELNRVTHTVGGPLTGPPLSAR</p> <p>ALGMLHLAIHDAYFSIYPPTNFTTFLSPDAENAAAYRLPSPNGANDARQAVA</p> <p>GAALKMLTSLYMKPVEEPNPNPGANISDNAYAQLALVIDRSVLKAPGGVD</p> <p>RESASFMFGEAVADVFFALLNDPRGASQEGYHPTPGRYKFDDEPTHVPVLI</p> <p>PVDPNPNPNGPKKPFQYHAPFYGKTTKRFATQSEHFLADPPGLRSNADET</p> <p>AEYDDSIKVAIAMGGAQALNSTKRSPWQTAQGLFWAYDGSNLIGTPPRFY</p> <p>NQIVRRIAVTYKKEEDLANSEVNNADFARLFALVDVACTDAGIFSWKEKWE</p> <p>YEFWRPLSGVRDDGRPDHGDPPFWLTGAPATNTNDIPKPPFPAYPSGHA</p> <p>TFGGAVFQMVERRYYNGRVGTWKDDEPDNIAIDMVICEELNGLNRDLRQP</p> <p>YDPTAPIEDQPGIVRTRIVRHFDSAWEELMFENAIKRLFLGVHWRFDAAAAR</p> <p>DILIPTTTTKDVYAVDNNGATVFQNVEDIRYTTKGTREDREGLFPIGGVPLGIE</p> <p>IADEIFNNGLRPTPELQPMPPQTPVQKPVGQQTIKGAWSSEEEAPVVKEA</p> <p>P</p>
<i>EtVCPO</i>	<i>Exserohilum turcica Et28A</i>	<p>MDPVTPILPQIDEPEEYNTNYILYWHHIGLELNRLTHTVGGPQTGPPIKAR</p> <p>ALGMLQLAAHDAYFAINPSAEFSTFLTPGAENAEYRLPDNLGADDARQAV</p> <p>AGASLKMLTELYMKPVVQSNPNPGANISDRAYAQLALFIEQSSAEAPGGV</p> <p>DRASASFLFGEAVADVFFKLLFHPPGASQDGYHPTPGRYRFDDEPTHVPVL</p> <p>IPVDPNPNPNGPKKPFQYHGPFYGTAKRFATQTEHILADPPGLRSAANET</p> <p>AEYDDSIKVAIAMGGAPGLNSTKRSPYQTAQGIFWAYDGSNLIGTPPRLYN</p> <p>QIVRRIAVTYKKEEDLANSEVNNADFARLLALNVNACADAGIFSWKEKWEF</p>

		<p>EFWRPLSGVRDDGRPDHGDPPFWLTGAPATNTNDIPFKPPFPAYPSGHAT</p> <p>FGGAVFQMVERRYYNGRVGTWKDDEPDNIAIDMMVSEELNLSRDLRQP</p> <p>YDPTAPITDQPGIVRTRIERHFNSAWEMMLENAISRIFLGVHWRFDAAAA</p> <p>RDILIPTVTKDVYAIDNNGASVFQNAEDVRYSTRGTREGHDGLFPIGGVPL</p> <p>GIEIADEIFNAGLKPTPPEAQMPQPPYVQKPPYKGESQSTMWEEHAQA</p> <p>MDEAP</p>
AnVBPO (1QI9)	<i>Ascophyllum nodosum</i>	<p>QTCSTSDADDPTPPNERDDEAFASRVAAAKRELEGTGTVQCINNETDL</p> <p>AAKFHKSLPHDDLQVDADFAALEDICLNGDLSICEDVPVGNSEGDVPG</p> <p>RLVNPTAAFAIDISGPAFSATTIPPVPTLPSPELAAQLAEVYWMALARDVPF</p> <p>MQYGTDDITVTAAANLAGMEGFPNLDAVSIGSDGTVDPLSQLFRATFVG</p> <p>ETGPFISQLLVNSFTIDSITVEPKQETFAPDVNYMVFDEWLNINQNGGPPA</p> <p>GPELLDDELRFVRNARDLARVTFTDNINTEAYRGALILLGLDAFNRAVG</p> <p>PFIDIDRQAGFVNFGISHYFRLIGAAELAQRSSWYQKWQVHRFARPEALG</p> <p>GTLHLTIKELNADFDSLLENAELLKRVAAINAAQNPNNEVTYLLPQAIQE</p> <p>GSPTHPSYPSGHATQNGAFATVLKALIGLDRGGDCYPDPVYPDDDGLKLID</p> <p>FRGSCLTFEGEINKLAVNVAFRQMLGIHYRFDGIQGLLGETITVRTLHQE</p> <p>LMTFAEESTFEFRLFTGEVIKLFQDGTFTIDGFKCPGLVYTGVENCVS</p>
<i>FdVBPO</i>	<i>Fucus distichus</i>	<p>MLCHAADTTRGSPMPDGTGVLRLLTSEQRAKGWRRQLEGEKSLGFHPSETP</p> <p>YIKYLEGSETWKKVKLPTDGISASKILGKIMARVRIATALAVVLAAPCLAFDE</p> <p>VTASGVFP EEHKHTGEGRHLQTCTNSDDALDPTAPNRRDNVAFASRRDA</p> <p>ARRERDGTGTVQCITNGETDLATMFHKSLPHDELQVTTADDFAILEDICLN</p> <p>GDFSICEDVPAGDPAGRLVNPTAAFAIDISGPAFSATTIPPVPTLSSPELAAQ</p> <p>LAELYWMALARDVPFMQYGTDEITTTAAANLAGMGGFPNLDAVSIGSDG</p> <p>TVDPFSQLFRATFVG VETGPFVQLLVNSFTIDAITVEPKQETFAPDLNYMVD</p> <p>FDEWLNINQNGGPPAGPEELDEELRFIRNARDLARVSFVDNINTEAYRGSLL</p> <p>LELGAFSRPGINGPFIDSDRQAGFVNFGTSHYFRLIGAAELAQRASCYQKW</p> <p>QVHRFARPEALGGTLHNTIAGDLDAFDISLLENDELLKRVAEINAAQNPN</p> <p>NEVTYLLPQAIQVGSPTHPSYPSGHATQNGAFATVLKALIGLDRGGECFPN</p> <p>PVFPSDDGLELINFEGACLTYEGEINKLAVNVAFRQMLGIHYRFDGIQGLL</p>

		LGETITVRTLHQELMTFAEEATFEFRLFTGEVIKLFQDGTFSIDGDMCSGLVY TGVADCQA
<i>SjVBPO</i>	<i>Saccharina japonica</i>	MKRVRPTQPRALYSAFSRRHVACALLCVVSCIFVSFNHQTFVGLTALLAAFP PCLGYDEPAEPTQPLLSGSVCRVRDSDLDFDPVPRAKVTLLKRLAIKDEFVS GPTCHINNGDEENVPLFAGQFHKTLPHDKFGQVDEDAYKKLQECIFTSDIN VCDDVPSGAKKNGAKLTNPLGGTAHQVAGADSDNIFIPTPDSLLSERLAAQ QSEVYWMALARDIPFGEFATNDLIRLAAENLQGLPAFKGLNIPRSKGGKID PVTDLFRTTWPGVTTGPVVSQFMLSDFLIDSINVTPKADPLTPFTDYMTSF QPWLDVQNGASDVTDTFDSENPRFIRNGRDLATISFRDLLYTEAFRAALILF TQGALGGSIGPYEEAERQQGFATFGAPHILTAMGSASSSTRHAWYQKWQ VHRMLRPEAYGGLVHNTLMKNVITPLPDSILRNTELLNRVEVHNQKMNG DGEKTFLLPMASAQGSPTHPAYPSGHAINVGAYITSLKAFLGFEGQRCFP DPVVSNNEGTERIPYVPSGREIVGECINDKGKKVDGLTYEGELNKVSANVLI GRSHLGVHWRMDGVYGALVGEVSAVRRLLQQLPGLAEARPNDLKRKEI PPATYNFRLYSGKMLELYGANLYKLDGKLCEGAFTGDDFCDEVQEDDYESF EHIVEDLAKFSLHTEL
<i>EsVBPO</i>	<i>Ectocarpus siliculosus</i>	MKAFVGIAALLAASPPCLGATSNEEHQPTHPLLSGSVCRVRDSDLFSPTER AKVTLQKRVDATAKEEFQVGPTCHITNGDETNVPDFIGQFHKSLPHDKFGTV SKTSYQKLLDCVFSADVNVCDQVPSGASARGAKMINPLGGTAHQVDGAD SDNVFITTPDGVLSEELAAQMAEVYWMALTRDIPFSEFATNSLVRAAAENL ERLPAFKGLNIPKSAGGKIDPVQDLFRTDWPGVTAGPVVSQLLLSDFIDNI VVPKQVTLVKEMDYMTTFQDWLDVQNGASKVKTEFVDEDKPLFIRNGR DLAALAFTDLLYTEAFRAALVMFRQGILSSAEGPYSTSERQVGFATFGEPHIL TSLAASSSTRHAWYAKWQVHRVLRPEAYGGLVHNTLTGRLHTPLPKAILQ NTELLNRVRTHNAKNGDGKGGHGDGTYLLPMAVAEGSPVHPAYPSGH AINLGAYITTLKAFLGFELGQRCYLGDLVVSNDGKRIEYVPRKGETCIDQN GREVQGLTYEGELNKVASNVIIGRSHIGVHYRMDGVYGALMGETSAVRRLL QQELPNLSEARDTKGSIPPASYKFRLYSGKVLELLAKDIFKLDGRTCKGLYTG DDFCDEHQDGGHYLEHLVNKGGDFAFHVEL

<i>CcVBPO</i>	<i>Chondrus crispus</i>	MSDMSTEISPRQQEAYDIRVAAATLALARDRKRKVFEPNGEEDRYFRPNS QILSYLGSYTKGLPHNRSTALVTSPNHFVRVQAIIDSGEPADFIKVPLGPRPA LEFTTEEECIAANLFKSGIATRNDSDPACLRAWESMGAGLVFDLEGPDAQ AVGMPPAPTLDSDDELVAEISELYWMALLRDVRFDTFTNPGPIRRRAINTLNR TTWIRAARDPPDSLTPQERARLRGPFNPSSIFRGTLPGDDVGPYLSQFLLVG TEGIGGAQDRADGFISYGAHRIDQVRVRHATKELDYMTSWEAFDVGNGA DVAGRDTFESGSDAFRFITPRDLATYVHFDALYQAYLNACLILLDNKVKFD QGIPMGEPDFNGNQGIPFQDPDFKDHQRGFAHFGGPHILSLVTEVATRAL KAVRFQKFNTHRRLRPEAVGGIERFNSNPDDPQFQDVKPLFEALDEDML RRVASHNREQNERSDFGMPRADDFNPAGDTLETMLLPMAFPEGSPMHP SYGAGHATVAGACVTVLKAFFQHDATAIDFCYVPSDDGSRLDDASHTLNKK LTVEGELNKVCSNISIGRNWAGVHYFTDYIESILLGEQIALGILEEQMLTFPET FTMTVPLFSGGFRTLISTSDP
<i>HhVBPO</i>	<i>Halomicronema hongdechloris</i>	MSFYRIAGRVVSQATGAGLSGLRVEVWDKDLIFDDFLAQATTTDAQGAQFQ VQFDDTSFRDFIWFDRLPDLYFKVFDGNQLIKSTADSVLWNSRDRNQTVV LPVERAPSLALSPPGARGDGAPPAICLFNPPNIPGARLWDRRLQALEVRRQ AAELARRPAHPEHLSNGEELLYRDTDNQPSHIANYTKGLPHDDRGLLSAD AYQRFVRGBIDSGDTRDFQDTPLGLRTGMASNFPIGSLTPNARNYRCGP GKVPAGANTFDLEGPDAQAVTMPPAPTLDSPELLAEMVEVYTMALLRDIP FAKFDSAPEIQQAIDRLNATDWIQSPDALALSPEEESRLRSPFTRQTVFRGIA PGDEVGPYLSQFLLVGNTGLGDAQAISDGYIQYGSIRADQVRVVAAPYRDY MTTWEAWLDVQNGADFRGLELYADDPKFRFMATPRDLATYVHYDALYE AYLNACLIMLSLGVPFDPGIPFQRADHIDKQGGFAHFGGPHILSLVTEVATR ALKAVRFQKFNVHRRARPEAIGGLIHRYASGDRQEFMPVEPLVNGFGESFL EEIADHNRRQNQHSDRSGDASAGSNSYLLPMAFPEGSPMHPAYGAGHG TVAGACVTILKAFFDHGYELPVCYQPSVDGAQLESVTLDRPLTVGAELNKLA ANIAIGRNWAGVHYFTDYIESIRLGEAIALGILEEQKLTGENFSMTIPLFDG GTIRI

<i>CpVBPO</i>	<i>Corallina pilulifera</i>	MGIPADNLQSRKASFDTRVAAAELALNRGVVPSFANGEELLYRNPDNDP TDPSFIASFTKGLPHDDNGAIIDPDDFLAFVRAINSGDEKEIADLTLPARDP ETGLPIWRSDLANSLELEVRGWENSSAGLTFDLEGPDAQSIAMPPAPVLTS PELVAEIAELYLMALGREIEFSEFDSPKNAEYIQFAIDQLNGLEWFNTPAKLG DPPAEIRRRRGVTVGNLFRGILPGSEVGPYLSQYIIVGSKQIGSATVGNKTL VSPNAADEFDGEIAYGSITISQRVRIATPGRDFMTDLKVFLDVQDAADFRG FESYEPGARLIRTIRDLATWVHFDALYEAYLNACLILLANGVPFDPNLPFQQ EDKLDNQDVFNFGSAHVLSLVTEVATRALKAVRYQKFNIHRRRLPEATGG LISVNKIAPQKGESIFPEVDLAVEELGDILEKAEISNRKQNIADGDPDPDPSFL LPMAFAEGSPFHPSYSGSHAVVAGACVTILKAFFDSGIEIDQVFEVDKDED KLVKSSFKGTTLVAGELNKLADNIAIGRNMAGVHYFSDQFESLLLGEQVAIG ILEEQSLTYGENFFFFNLPKFDGTTIQI
<i>LepVBPO</i>	<i>Leptolynghya</i> sp. BC1307	MESRKKRALDLRTAAAKVAYDRAHAQHWANGEELRYRFEDVSNKERAG QPSHLANYTKGLPHDEKDGLICCSADYQQFVRGIDSGDSRDFRDTPLGPKG SETQEIQIEWKSHYTQQHKADVRAWESAGAGLLFDLEGPDCQSITMPPAP VLDSDELVAEVAEVEYEMALLRDVPFVDFGCNPEVGAAIDRLNKLTFWQNT PLPLTDAAQARRRGQLTAQTAFRGVAVGDDTGPYISQFLLRGTPELGGDR DGVFDGLVAYGAMAFTNKVRTATPYKDYMTTWEWWLDVQNGADLRGK ETYENC DNKYR FITTPRDLATYVHYDALYQAYLNATLALMALKVPFDPGVP FQGRDRQDHQQGFAHFGGPHILSLVTEVATRALKAVRYQKFNVHRRRLPE AIAGRIHQWRETQAPNLAPVSQLSNKISDTLHQVSQHNRVQNEKFLAELS ADGCSDRLKQEFDGENYLLPMAFPEGSPMHPSYGAGHATVAGACITILKA FFDHGYVLPQPYVVS RNGTQLESVQDSTLTLTVEGELNKLAAANIAIGRDWA GVHYFTDYYESMRLGEQIALGILEEQKLT YGENFSMTVPLLDGGCARI
<i>CoVBPO</i>	<i>Corallina officinalis</i>	MGIPADNLQSRKASFDTRVSAAELALARGVVPSLANGEELLYRNPDPEN GDPSFIVSFTKGLPHDDNGAIIDPDDFLAFVRAINSGDEKEIADLTLPARDP DTGLPIWRSDLANSLELEVRGWENSSAGLTFDLEGPDAQSIAMPPAPVLTS PELIAEIAELYLMALGREIEFSEFDSPKNAEYIQFAIDQLNGLEWFNTPAMLG DPPAEIRRRRGVTVGNLFRGILPGSEVGPYLSQYIIVGSKQIGSATGGNKTLL

		VSPNAADEFDGEIAYGSITISQRVRIATPGRDFMTDLKVFLDVQDAADFRG FESYEPGARLIRTIRDLATWVHFDALYEAYLNACLILLANRVFPDPNIPFQQE DKLDNQDVFVNFGDAHVLSLVTEVATRALKAVRYQKFNIHRRLRPEATGG LISVNKIAAEKGESVFPEVDLAVEELEDILEKAEISNRKQNIADGDPDPDPSFL LPQAFAGSPFHPSYSGSHAVVAGACVTILKAFFDSNFQIDQVFEVDKDED KLVKSSFKGTLTVAGELNKLADNIAIGRNMAGVHYFSDQFESILLGEQVAIGI LEEQSLTYGENFFFNLPKFDGTTIQI
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1 AnVBPO
 2 EsVBPO
 3 FdVBPO MLCHAADTTTRGSPMPDGTGVLRLLTSEQRAKGWRRQLEGEKSLGFHPSETPYIKYLEGSET
 4 SjVBPOMKRVRPTQP

1 AnVBPO
 2 EsVBPOMKAFVGI AALLAASPPCLGATSNEEHQPT HPL
 3 FdVBPO WKKVKLPDTDGISASKILGKIMARVRIATALAVVLAAPCLA FDEVTA SGVFPEEHKHT GEG
 4 SjVBPO RALYSAFSRRRHVACALLCVVSCIFVSFNHQTFVGLTALLA AFPPCLGYDEP..AEP TQPL

1 AnVBPO ... Q T C S T S D D A D D P T P F N E R D D E A F A S R V A A A K R E L E G T G T V C O I N N G E T D L A A K
 2 EsVBPO L S G S V C R . V R D S L D F L S P T E R A K V T L O K R V D T A K E E F Q . V G P T C H I T N G D E T N V P D F I G Q
 3 FdVBPO R H L Q T C T N S D D A L D P T A P N R R D N V A F A S R R D A A R R E R D G T G T V C O I T N G E T D L A T M
 4 SjVBPO L S G S V C R . V R D S L D F L D P V F R A K V T L L K R L A L A K D E F S . V G P T C H I N N G D E E N V P L F A G Q

1 AnVBPO F H K S L P H D D L G Q V D A D A F A A L E D C I L N G D L S I C E D V P V G N S E G D P V G R L V N P T A A F A I D I
 2 EsVBPO F H K S L P H D K F G T V S K T S Y Q K L L D C V F S A D V N V C D Q V P S G . . A S A R G A K M I N P L G G T A H Q V
 3 FdVBPO F H K S L P H D E L G Q V T A D D F A I L E D C I L N G D F S I C E D V P A G D P A G R L V N P T A A F A I D I
 4 SjVBPO F H K T L P H D K F G Q V D E D A Y K K L Q E C I F T S D I N V C D D V P S G . . A K K N G A K L T N P L G G T A H Q V

1 AnVBPO S G P A F S A T T I P P V P T L S P E L A A Q L A E V Y W M A L A R D V P F M Q Y G T D D I T V T A A A N L A G M E G
 2 EsVBPO D G A D S D N V F I T T P D G V L S E E L A A Q M A E V Y W M A L T R D I P F S E F A T N S L V R A A A E N L E R L P A
 3 FdVBPO S G P A F S A T T I P P V P T L S P E L A A Q L A E L Y W M A L A R D V P F M Q Y G T D E I T T T A A A N L A G M G G
 4 SjVBPO A G A D S D N I F I P T P D S L L S E R L A A Q Q S E V Y W M A L A R D I P F G E F A T N D L I R L A A E N L Q G L P A

1 AnVBPO F P N L D A V S I G S D G T V D P L S Q L F R A T F V G V E T G P F I S Q L L V N S F T D S I T V E P K Q E T F A P D
 2 EsVBPO F K G L N I P K S A G . G K I D P V Q D L F R T D W P G V T A G P V V S Q L L L S D F A I D N I V P P K Q V T L V K E
 3 FdVBPO F P N L D A V S I G S D G T V D P F S Q L F R A T F V G V E T G P F V Q L L V N . S F T I D A T T V E P K Q E T F A P D
 4 SjVBPO F K G L N I P R S K G . G K I D P V T D L F R T T W P G V T G P V V S Q F M L S D F L I D S I N V T P K A D P L T P F

1 AnVBPO V N Y M V D E D E W L N I Q N G G P P A G P E L . L D D E L R F V R N A R D L A R V T F T D N I N T E A Y R G A L I L L
 2 EsVBPO M D Y M T T F Q D W L D V Q N G A S K V K T E F V D E D K P L F T R N G R D L A A L A F T D L L Y T E A F R A A L V M F
 3 FdVBPO L N Y M V D F D E W L N I Q N G G P P A G P E E . L D E L R F I R N A R D L A R V S F V D N I N T E A Y R G S L I L L
 4 SjVBPO T D Y M T S F Q P W L D V Q N G A S D V D T T F D S E N . P R F I R N G R D L A T I S F R D L L Y T E A F R A A L I L F

1 AnVBPO G L D A F N R A G V N G P F I D I D R O A G F V N F G I S H Y F R L I G A A E L A Q R S S W Y Q K V Q V H R F A R P E A
 2 EsVBPO R Q G I L S . . S A E G P Y S T S E R Q V G F A T F G E P H I L T S L A A S S S S T R H A W Y A K V Q V H R V I R P E A
 3 FdVBPO E L G A F S R P G I N G P F I D S D R O A G F V N F G T S H Y F R L I G A A E L A Q R A S C Y Q K V Q V H R F A R P E A
 4 SjVBPO T Q G A L G . . G S I G P Y E A E R Q Q G F A T F G A P H I L T A M G S A S S S T R H A W Y Q K V Q V H R M I R P E A

1 AnVBPO L G G T L E H T I T K G E L N A D F D L S I L E N A E L L K R V A A I N A A Q N P N N E V T Y L L P O A I Q E G
 2 EsVBPO Y G G L V E N T I T G R L H T P L P K A I L Q N T E L L N R V R T H N A K C N G D G K G H G D G T Y L L P M A V A E G
 3 FdVBPO L G G T L E H T I A G D L D A D F D I S L L E N D E L L K R V A E I N A A Q N P N N E V T Y L L P O A I Q V G
 4 SjVBPO Y G G L V E N T L M K N V I T P L P D S I L R N T E L L N R V E V H N Q K M N G D G E K T E L L P M A S A Q G

1 AnVBPO S P T H S Y P S G H A T Q N G A F A T V L K A L I G L D R G G D C Y P . D P V Y P D D C L K L I D F R
 2 EsVBPO S P V H P A Y P S G H A I N L G A Y I T T L K A F L G F E L G Q R C Y L G D L V S N D E C T K R I E Y V P R K G . . .
 3 FdVBPO S P T H S Y P S G H A T Q N G A F A T V L K A L I G L D R G G E C F P . N P V F P S D D C L E L I N F E
 4 SjVBPO S P S H P A Y P S G H A I N V G A Y I T S L K A F L G F E A G Q R C F P . D P V V S N N E C T E R I P Y V P S G R E I V

1 AnVBPO G S C L T F E G E I N K L A V N V A F G R Q M L G H Y R F D G I O G L L G E T I T V R T L H Q E
 2 EsVBPO E T C I D Q N G R E V Q G L T Y E G E I N K V A S N V I I G R S H I G V H Y R M D G V Y G A L M G E T S A V R R L Q O E
 3 FdVBPO G A C L T Y E G E I N K L A V N V A F G R Q M L G H Y R F D G I O G L L G E T I T V R T L H Q E
 4 SjVBPO G E C I N D K G K K V D G L T Y E G E I N K V S A N V L I G R S H L G V H R M D G V Y G A L V G E V S A V R R L Q O E

	510	520	530	540	550
1 AnVBPO	LMTFAEES.....	TFEFRLFTGEVIKLF	QDGTFTIDGFKCPGL	VYTGVENCV	
2 EsVBPO	LPNLSEAR....DTKGSIPPA	SYKFRLYSGKVL	LLAKDIFKLDGRTCKG	LYTGDDFC	CD
3 FdVBPO	LMTFAEEA.....	TFEFRLFTGEVIKLF	QDGTFSIDGDMCSGL	VYTGVDAC	CQ
4 SjVBPO	LPGLAARPNDLKRKEIPPA	TYNFRLYSGKMLELY	GANLYKLDGKLC	EGAFTGDDFC	CD

1 AnVBPO	S.....
2 EsVBPO	EHQ.DGGHYLEHLVNKGGDFAFHVEL
3 FdVBPO	A.....
4 SjVBPO	EVQEDDYESFEHIVEDLAKFSLHTEL

Figure S1. Sequence Alignments of *AnVBPO* with putative VHPOs (Amino acids marked in red are the binding sites and active sites provided by uniprot).

1 CpVBPO
 2 CoVBPO
 3 HhVBPO MSFYRIAGRVVSQATGAGLSGLRVEVWDKDLIFDDFLAQATTDAQAFQVQFDDTSFRDF
 4 CcVBPO
 5 LepVBPO

1 CpVBPO
 2 CoVBPO
 3 HhVBPO IWFDRLPDLYFKVFDGNQLIKSTADSVLWNSRDRNQTVVLPVERAPSLALSPPGARGDGA
 4 CcVBPO
 5 LepVBPO

1 CpVBPOMGIPADNLQS**RAKASF**DT**RVAAAE**LALNRGVVPSFANG**EELL**YRNPDPDN.
 2 CoVBPOMGIPADNLQS**RAKASF**DT**RVSAAE**LALARGVVPSLAN**GEELL**YRNPDPEN.
 3 HhVBPO PPAICLFNPPNIPGARLWDRRLQALEVRRQ**AAELARR**PAHPEHLS**NGEELL**YRDTDN..
 4 CcVBPOMSDMSTEISP**RQQEAY**DIR**VAAATLALAR**DRKKRVFEPNGEEDRYFRPNS.
 5 LepVBPOMES**RKKRAL**DL**RTAAAK**VAYDR**AHAQHWA**N**GEELL**YR**FE**DVSNK

1 CpVBPO ...TD**PSF**IAS**FTKGLPHDDN**.**GAI**IDPDD**FLAFVRA**IN**SGDEKE**IADLT**LGPA**.....
 2 CoVBPO ...GD**PSF**IV**SFTKGLPHDDN**.**GAI**IDPDD**FLAFVRA**IN**SGDEKE**IADLT**LGPA**.....
 3 HhVBPO ...Q**PSH**IAN**YTKGLPHDDR**.**GLL**SDADAY**QRFVR**GID**SGD**TRDFQDT**PLGLR**.....
 4 CcVBPO ...Q**ILS**Y**LGSYTKGLPHNR**STALVTSFNH**FVRVQA**ID**SGE**PADFIKVP**LGPR**PALEFT
 5 LepVBPO ERAGQ**PSH**L**ANYTKGLPHDE**KD**GLI**CCSAD**YQQFVR**GID**SGD**S**RD**FRD**TF****LGPK**.....

1 CpVBPORDPE**TGLPIWR**SDLAN**SLELEVRG**WENSS**AGLT**FD**LEGPD**AQ**SI**AMP**PAP**VLTSP
 2 CoVBPORDPDT**TGLPIWR**SDLAN**SLELEVRG**WENSS**AGLT**FD**LEGPD**AQ**SI**AMP**PAP**VLTSP
 3 HhVBPOTGMA**SNFPIG**SLTWPNARNYRCGP**GKVP**GAGNT**FDLEGPD**AQ**AV**TM**PAP**TLDS
 4 CcVBPO TEEECIAANLFKSGIATRND**SFDEA**CL**RAWES**MG**AGLV**FD**LEGPD**AQ**AV**GM**PAP**TLDS
 5 LepVBPOGSET**QEQIEWK**SHYT**QQHK**AD**VRA**WES**AG**AGL**L**FD**LEGPD**CQ**SI**TM**PAP**VLTSD

1 CpVBPO **ELVAE**IAELYLMAL**GREIE**F**SSE**DSPKNAEY**IQFAID**QLNGLE**WFNT**PAK**LG**D..PPAEI
 2 CoVBPO **ELIAE**IAELYLMAL**GREIE**F**SSE**DSPKNAEY**IQFAID**QLNGLE**WFNT**PAM**LG**D..PPAEI
 3 HhVBPO **ELLAEM**VEVYTMAL**LRDIP**TA**KED**...SAPE**IQAID**RLNATDW**IQSP**DALAL..SPEEE
 4 CcVBPO **ELVAE**ISELYWMAL**LRDVR**FT**DET**...NPGPIRR**AIN**TLNRIT**WIRA**ARD**PP**DSL**TP**QER
 5 LepVBPO **ELVAE**VAEVYEMAL**LRDVP**F**VD**EG...CNPE**VGA**AID**RLN**KLT**WFQ**N..TP**LP**L..TDAAQ

1 CpVBPO **RRRRG**EVTVG**NLFRGILPG**SE**VG**PYLSQY**IIVG**SKQIGSATVG**NKTL**VSP**NA**ADEF**DGEI**
 2 CoVBPO **RRRRG**EVTVG**NLFRGILPG**SE**VG**PYLSQY**IIVG**SKQIGSATGG**NKTL**VSP**NA**ADEF**DGEI**
 3 HhVBPO **SRLRS**PF**TRQ**TV**FRGIAP**GDE**VG**PYLSQ**FL**LVG.....NTGLG**DAQA**ISDGYI
 4 CcVBPO **ARLRG**PFNP**SIF**RG**TLPG**DD**VG**PYLSQ**FL**LVG.....TEGI**GGAQ**DRAD**GFI**
 5 LepVBPO **ARRRG**QL**TAQ**TA**FRG**VAV**GDT**TPY**ISQ**FL**LRG**.....TP**ELG**CD**RD**GVF**DGLV**

1 CpVBPO **AYGS**ITIS**Q**RVRI**ATP**GRD**FM**DLK**VFLDVQ**DAAD**FRG**...**FES**YEPGAR**LIR**TI**RD**LAT
 2 CoVBPO **AYGS**ITIS**Q**RVRI**ATP**GRD**FM**DLK**VFLDVQ**DAAD**FRG**...**FES**YEPGAR**LIR**TI**RD**LAT
 3 HhVBPO **QYGS**IRAD**Q**RVRV**AAP**YRD**YMT**WE**AW**LDVQ**NG**AD**FRG**LEL**YAD**DP**KFR**EMAT**PR**DLAT
 4 CcVBPO **SYGA**HRID**Q**RVRH**AT**KE**LDY**MT**SWEA**FLDVQ**NG**AD**VAG**RD**TFES**GSDA**FR**IT**TP**RD**LAT**
 5 LepVBPO **AYGA**MA**FTN**KVRT**ATP**Y**KDY**MT**TWE**W**W**LDVQ**NG**AD**LRG**KET**YEN**CD**NK**YR**FI**IT**TP**RD**LAT**

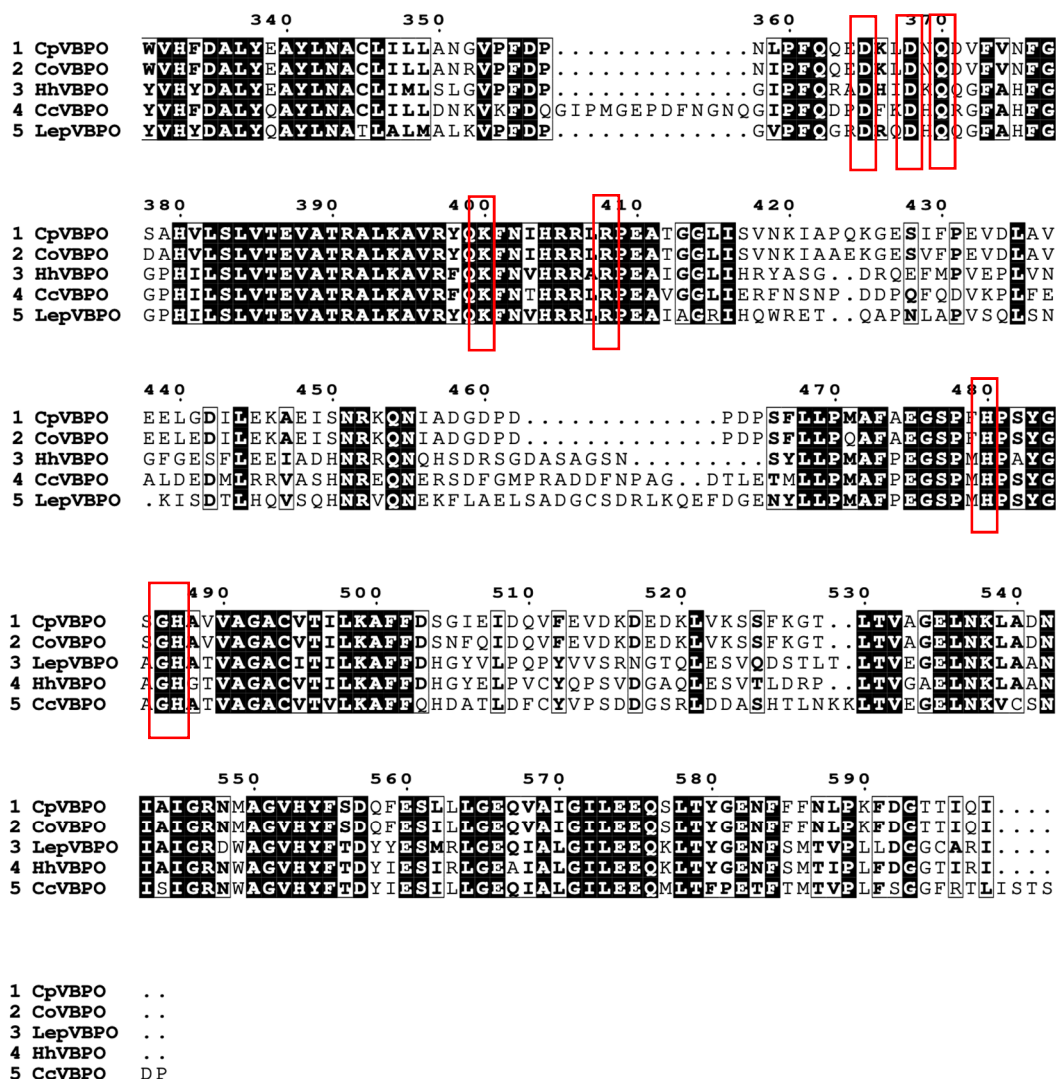


Figure S2. Sequence Alignments of *CpVBPO* with putative VHPOs (Amino acids marked in red are the binding sites and active sites provided by uniprot).

1 CiVCPO .MGSVTPPIPLPKIDEPEEYNTNYILFWNHVGLLELNRRVTHTVGGP..LTGPPLSARALGML
2 CcVCPO .MGSVTPPIPLPKIDEPEEYNTNYILFWNHVGLLELNRRVTHTVGGP..LTGPPLSARALGML
3 EtVCPO .MDPVTPPIPLPKIDEPEEYNTNYILYWHHIGLELNRLTHTVGGP..QTGPPI SARALGML
4 SlVCPO .MDPVTPPIPLPKIEEPEDYNTNYILYWHHIGLELNRRVTHTVGGP..QTGPPI SARALGML
5 AdVCPO MTIDFTPVELPVVEEDAEYNWNYILFWNNVGLLELNRRVTHTFGAL..KAGPPLSPRALGML
6 HwVCPOMIPPLHQRPEDTDYKNYVLYWNHVALELVRLTHTETASGAVNGPPLVARMLGIL

1 CiVCPO HLAIHDAFYFSICPP TDTFTTFLSPD TENAAYRLPSPNGANDARQAVAGAAALKMLS LYMKP
2 CcVCPO HLAIHDAFYFSIYPPTNFTTFLSPDAENAAAYRLPSPNGANDARQAVAGAAALKMLTSLYMKP
3 EtVCPO QLAAHDAFYFAINPSAEFSTFLTPGAENAAAYRLPDLNGADDARQAVAGASLKMLTELYMKP
4 SlVCPO QLAAHDAFYFAINPSCDFTTFLTPGAENAAAYRLPDLNGANDARQAVAGASIKMLSELYSKP
5 AdVCPO QLAVHDAFYFAIHP SAGFTTFLTPGAEDGAYRLPDP SYAKDARQAVAGAAIAMLSKLYMKP
6 HwVCPO HLAIHDAFFALHNTAGISTYLSPTQSAPYRLPDLLDARDGRQAVAGAAITVLEDQYFVS

1 CiVCPO VEQPNPNPGANISDNAYAOQLGLVLD RSVLEAPG GVDRESASFMFGEADVAFV FALLNDP.
2 CcVCPO VEEPNPNPGANISDNAYAOQLALVID RSVLKAAPG GVDRESASFMFGEADVAFV FALLNDP.
3 EtVCPO VVQSNPNPGANISDRAYAOQLALFIEQSSAEAPG GVDRESASFMLFGEADVAFVFKLLFHP.
4 SlVCPO VTQPNPNPGANISDNAYAOQLLELVLD RSIADAPG GVDQASASFVFGQAVAEVFNLLFHP.
5 AdVCPO KVVPR....SPISHNAYAOQLQHVLDSVTKAPAACDPASSSFIFGKAVATAVFDLLFHK.
6 HwVCPO H.....PSEFSANDQAEQLLRRIITAFAP...DTLSSSYRFGYEVGKAMLKLLAIKQ

1 CiVCPO ..RGASOEGYHPTPGRYKFDDEPTHPVVLIPVDPNNE NGPKMPFRQYHAPFYGKTTKRFA
2 CcVCPO ..RGASOEGYHPTPGRYKFDDEPTHPVVLIPVDPNNE NGPKMPFRQYHAPFYGKTTKRFA
3 EtVCPO ..PGASQDGYHPTPGRYRFDDEPTHPVVLIPVDPNNE NGPKMPFRQYHGPFYGTAKRFA
4 SlVCPO ..PGASOEGYHPTPGRYKFDDEPTHPVVLIPVDPNNE DGPKMPFRQYHGPFYGTSAKRFG
5 AdVCPO ..EGADQSGYS PKPGPFKFNDDEPTHPVELIPVDANIPD GDKMPFRQYHAPFYGETAKRFG
6 HwVCPO DEPGTDQDSYMP SQGYRFFHDP TNPVVVSSVDENDESEKRA SRVAHAPFYGMTAKRFA

1 CiVCPO TOS.....EHFLADPPGLRSNADETA EYDDAVRVAIAMGGAQALNSTKRSPWQTAQGL
2 CcVCPO TOS.....EHFLADPPGLRSNADETA EYDD SIRVAIAMGGAQALNSTKRSPWQTAQGL
3 EtVCPO TQT.....EHILADPPGLRSAANETA EYDD SIRVAIAMGGAQALNSTKRSPYQTAQGI
4 SlVCPO TQT.....EHMIADPPGIRSAADEGA EYDD SIRVAIAMGGAIGLNSTKRSPYQTTQGI
5 AdVCPO TQT.....EHMLADPPGIR. CAGEVA EYDDAIREVYAMGGAQALNTTKRTPHQTVQGM
6 HwVCPO VOYRIGKDQT EHI IADPPVGFGEADMP. EYVDALRDVYRMGGRT E LNTTTRRPWQTA AAAH

1 CiVCPO YWAYDGSNLIGTPPRFYNQIVRRIAV TYKKEEDLANSEVNNADFARLFALVDVACTDAGI
2 CcVCPO FWAYDGSNLIGTPPRFYNQIVRRIAV TYKKEEDLANSEVNNADFARLFALVDVACTDAGI
3 EtVCPO FWAYDGSNLIGTPPRLYNQIVRRIAV TYKKEEDLANSEVNNADFARLLALVNACADAGI
4 SlVCPO YWAYDGSNLIGTPPRFYNQIVRRIAV TYKKEEDLAASETNNAADFARLLALVNACADAGI
5 AdVCPO FWAYDGP KLIGTPPRLYNQIVRKIAV TYKKDNDLVNSEVNNADFARLLALVNAMTADAGI
6 HwVCPO FWAYDGSNLIGVPLRLYNQILRTVAWDHRPDKRIPDSDKNNVEFARLFALCNAMADAGI

1 CiVCPO FSWKEKWEFEFWRPLSGVRDD.....GRPDHG.....DPFWL
2 CcVCPO FSWKEKWEFEFWRPLSGVRDD.....GRPDHG.....DPFWL
3 EtVCPO FSWKEKWEFEFWRPLSGVRDD.....GRPDHG.....DPFWL
4 SlVCPO FSWKEKWEFEFWRPLSGVRDD.....GRPDHG.....DPFWL
5 AdVCPO FAWKEKWEFEFWRPLSGVRDD.....VLRDPEGKASTAA.....IHSGL
6 HwVCPO FAWQEKYCFE FWRPLSGVREASTDLIVRNRNGMVEGTPDPRPPTMDDGTVALQDPFWL

1 CiVCPO T LGAPATNTNDIPFKPPFPAYBSGHATFGGAVFQMVRRYYN...GRVGTWKDDEPDNIA
2 CcVCPO T LGAPATNTNDIPFKPPFPAYBSGHATFGGAVFQMVRRYYN...GRVGTWKDDEPDNIA
3 EtVCPO T LGAPATNTNDIPFKPPFPAYBSGHATFGGAVFQMVRRYYN...GRVGTWKDDEPDNIA
4 SlVCPO T LGAPATNTNDIPFKPPFPAYBSGHATFGGA FQMVRRYYN...GRVGTWKNDDEPDNIA
5 AdVCPO ASAPQLQNSDEAPFKPPFPAYBSGHATFGAAAFQMVRRYYN...GRIGKWATTSRDTIA
6 HwVCPO ELGAPNTNSNRIPFKPAFPAYBSGHATFGAACTQMMREYYKNSHRDGIADFIDGPDNIA

	380	390	400	410	420	430																																																			
1 CiVCPO	T	L	G	A	P	A	T	N	T	N	D	I	P	F	K	P	P	F	P	A	P	S	G	H	A	T	F	G	A	V	F	O	M	V	R	R	Y	N	...	G	R	V	G	T	W	K	D	E	P	D	N	I	A				
2 CeVCPO	T	L	G	A	P	A	T	N	T	N	D	I	P	F	K	P	P	F	P	A	P	S	G	H	A	T	F	G	A	V	F	O	M	V	R	R	Y	N	...	G	R	V	G	T	W	K	D	E	P	D	N	I	A				
3 EtVCPO	T	L	G	A	P	A	T	N	T	N	D	I	P	F	K	P	P	F	P	A	P	S	G	H	A	T	F	G	A	V	F	O	M	V	R	R	Y	N	...	G	R	V	G	T	W	K	D	E	P	D	N	I	A				
4 SlVCPO	T	L	G	A	P	A	T	N	T	N	D	I	P	F	K	P	P	F	P	A	P	S	G	H	A	T	F	G	A	A	F	O	M	V	R	R	Y	N	...	G	R	V	G	T	W	K	N	D	E	P	D	T	I	A			
5 AdVCPO	A	S	A	P	Q	L	O	N	S	D	E	A	P	F	K	P	P	F	P	A	P	S	G	H	A	T	F	G	A	A	A	F	O	M	V	R	K	Y	N	...	G	R	L	G	K	W	A	T	T	S	R	D	T	I	A		
6 HwVCPO	E	L	G	A	P	N	T	N	S	N	R	I	P	F	K	P	A	F	P	A	P	S	G	H	A	T	F	G	A	A	C	F	O	M	R	L	Y	K	N	S	H	R	D	G	I	A	D	E	D	I	D	G	P	D	N	I	A

	440	450	460	470	480	490																																																						
1 CiVCPO	I	D	M	M	I	S	E	E	L	N	G	V	N	R	D	L	R	Q	P	Y	D	P	T	A	P	I	E	D	Q	P	G	I	V	R	T	R	I	V	R	H	F	D	S	A	W	E	L	M	F	E	N	A	I	S	R	I	F	L	G	V
2 CeVCPO	I	D	M	V	I	S	E	E	L	N	G	L	N	R	D	L	R	Q	P	Y	D	P	T	A	P	I	E	D	Q	P	G	I	V	R	T	R	I	V	R	H	F	D	S	A	W	E	L	M	F	E	N	A	I	S	R	I	F	L	G	V
3 EtVCPO	I	D	M	V	S	E	E	L	N	G	L	S	R	D	L	R	Q	P	Y	D	P	T	A	P	I	T	D	Q	P	G	I	V	R	T	R	I	E	R	H	F	N	S	A	W	E	M	M	L	E	N	A	I	S	R	I	F	L	G	V	
4 SlVCPO	I	D	M	M	V	S	E	E	L	N	G	L	S	R	D	L	R	Q	P	Y	D	P	S	A	P	I	T	D	Q	P	G	I	V	R	T	R	V	R	H	F	S	S	A	W	E	L	M	F	E	N	A	I	S	R	I	F	L	G	V	
5 AdVCPO	V	E	M	F	V	S	E	E	L	N	G	V	S	R	D	L	S	N	P	Y	D	P	K	R	P	I	T	D	Q	P	G	I	V	P	T	R	M	P	R	R	F	S	S	C	W	E	M	M	F	E	N	A	V	S	R	I	F	L	G	V
6 HwVCPO	F	D	F	V	S	D	E	Q	D	G	R	N	R	D	N	L	R	N	P	F	D	P	N	V	P	I	D	D	Q	P	G	I	V	R	A	L	W	K	R	R	F	G	S	L	W	E	A	L	W	E	N	A	I	S	R	V	L	G	V	

	500	510	520	530	540																																																						
1 CiVCPO	H	W	R	F	D	A	A	A	A	R	D	I	L	I	P	...	T	T	K	D	V	Y	A	V	D	N	N	G	A	T	V	F	O	N	V	E	D	I	R	Y	T	T	R	G	T	R	E	D	P	E									
2 CeVCPO	H	W	R	F	D	A	A	A	A	R	D	I	L	I	P	...	T	T	K	D	V	Y	A	V	D	N	N	G	A	T	V	F	O	N	V	E	D	I	R	Y	T	T	K	G	T	R	E	D	R	E									
3 EtVCPO	H	W	R	F	D	A	A	A	A	R	D	I	L	I	P	...	T	T	K	D	V	Y	A	I	D	N	N	G	A	S	V	F	O	N	A	E	D	V	R	Y	S	T	R	G	T	R	E	G	H	D									
4 SlVCPO	H	W	R	F	D	A	A	A	A	R	D	I	L	I	P	...	T	T	K	D	V	Y	A	K	D	E	N	G	A	T	V	F	O	N	V	E	D	V	R	Y	T	T	L	G	T	R	E	G	H	E									
5 AdVCPO	H	W	R	F	D	A	A	A	G	Q	D	I	L	I	P	...	T	T	K	D	V	Y	A	V	D	D	K	G	A	A	L	F	K	N	V	E	D	I	R	Y	K	T	K	G	T	R	K	G	H	K									
6 HwVCPO	H	W	R	F	D	A	F	S	P	K	D	A	L	V	R	N	P	T	P	T	T	V	S	S	K	T	D	S	P	L	L	Y	A	V	E	T	D	H	S	T	R	Y	K	P	L	A	E	V	R	Y	T	S	T	G	T	R	D	R	P

	550	560	570	580	590	600																																																						
1 CiVCPO	G	.	L	F	P	I	G	G	V	P	L	G	I	E	I	A	D	E	I	F	N	N	G	L	K	P	T	P	E	I	O	P	M	P	Q	E	T	P	V	Q	K	P	V	G	Q	Q	P	V	K	G	...	M	W	E	E	E	E	Q		
2 CeVCPO	G	.	L	F	P	I	G	G	V	P	L	G	I	E	I	A	D	E	I	F	N	N	G	L	R	P	T	P	E	L	O	P	M	P	Q	Q	T	P	V	Q	K	P	V	G	Q	Q	T	I	K	G	...	A	W	S	E	E	E	E		
3 EtVCPO	G	.	L	F	P	I	G	G	V	P	L	G	I	E	I	A	D	E	I	F	N	A	G	L	K	P	T	P	E	A	O	P	M	P	Q	.	P	P	Y	V	Q	K	P	P	Y	G	K	E	S	Q	S	T	M	W	E	E	E	H		
4 SlVCPO	G	.	L	L	P	I	G	G	V	P	L	G	I	E	I	A	D	E	I	F	E	S	G	L	R	P	T	P	V	E	R	O	P	M	G	D	G	G	E	G	V	G	G	R	K	E	E	V	M	V	D	G	M	W	E	G	E	Q		
5 AdVCPO	G	.	L	L	P	I	G	G	V	P	L	G	I	E	I	A	N	E	I	Y	N	N	K	L	S	P	T	P	P	G	E	O	P	M	P	Q	P	P	Q	H	Q	G	P	.	.	P	R	K	K	G	E	L	A	E	A	K	D	E	E	Q
6 HwVCPO	G	K	N	F	P	V	G	G	V	P	L	G	I	E	I	A	N	D	I	F	Q	G	G	L	R	P	T	A	Q	N	K	O	P	S	G	R	H	R	C	G	R	L	G	K	P		

1 CiVCPO	A	P	V	V	K	E	A	P
2 CeVCPO	A	P	V	V	K	E	A	P
3 EtVCPO	A	Q	A	M	D	E	A	P
4 SlVCPO	V	P	A	M	D	Q	A	P
5 AdVCPO	A	P	M	M	D	V	A	P
6 HwVCPO

Figure S3. Sequence Alignments of *CiVCPO* with putative VHPOs (Amino acids marked in red are the binding sites and active sites provided by uniprot).

Table S2. Molecular docking results of MPS molecular with *AnVBPO* and *CpVBPO*

Protein	Binding Energy (kcal/mol)	Number in Cluster	Intermolecular Energy (kcal/mol)	Electrostatic Energy (kcal/mol)	Internal Energy (kcal/mol)
<i>AnVBPO</i>	-3.32	174	-3.59	-0.18	-0.04
<i>CpVBPO</i>	-3.71	180	-3.98	-0.09	-0.04

GC chromatograms

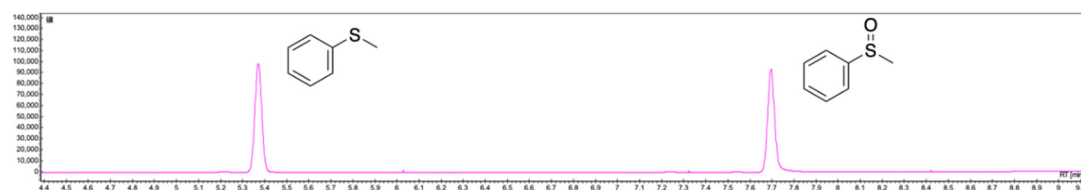


Figure S4. Representative GC chromatogram of **1a** and **1b**.

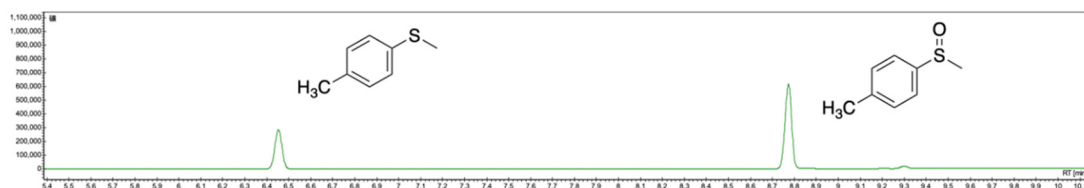


Figure S5. Representative GC chromatogram of **2a** and **2b**.

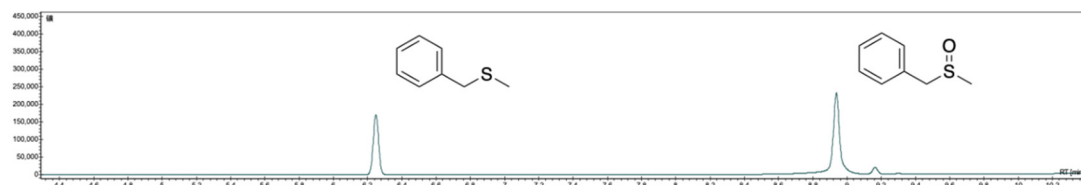


Figure S6. Representative GC chromatogram of **3a** and **3b**.

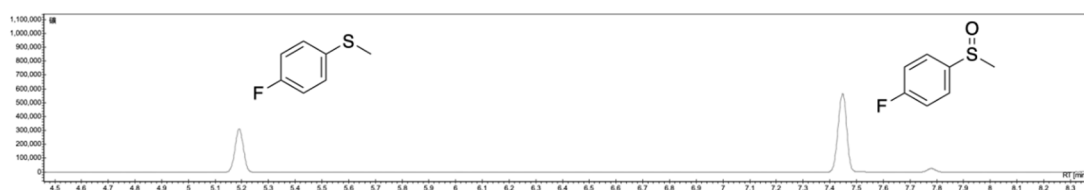


Figure S7. Representative GC chromatogram of **4a** and **4b**.

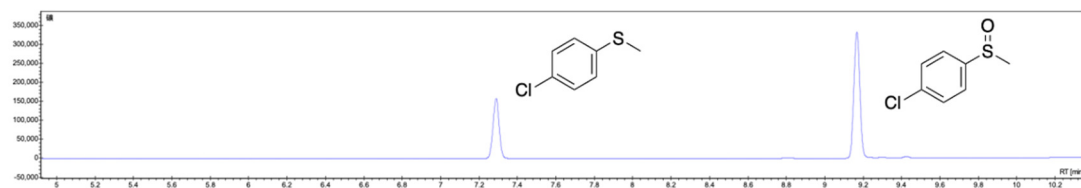


Figure S8. Representative GC chromatogram of **5a** and **5b**.

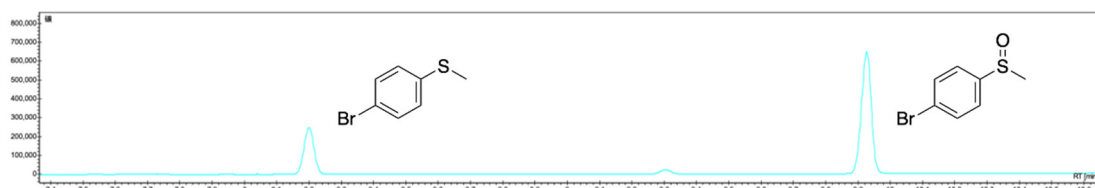


Figure S9. Representative GC chromatogram of **6a** and **6b**.

HPLC chromatograms

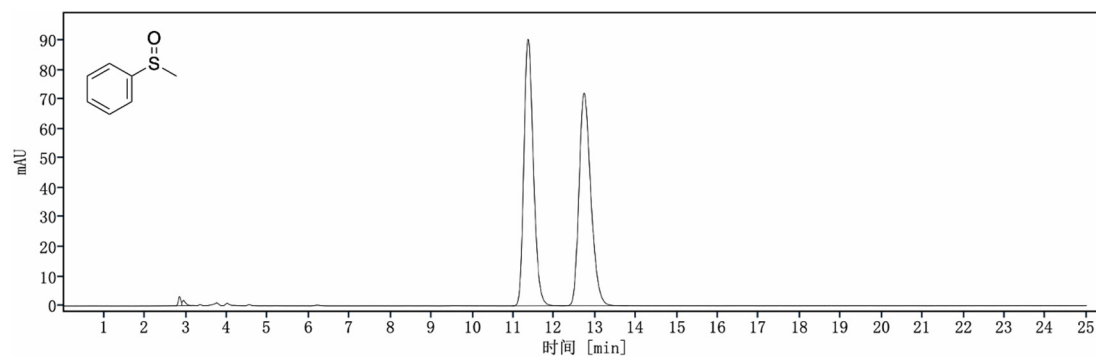
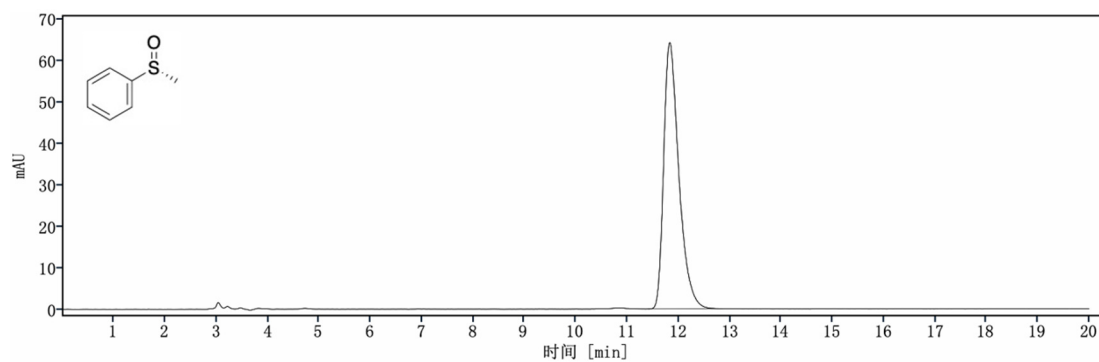


Figure S10. Representative chiral HPLC chromatogram of **1b**

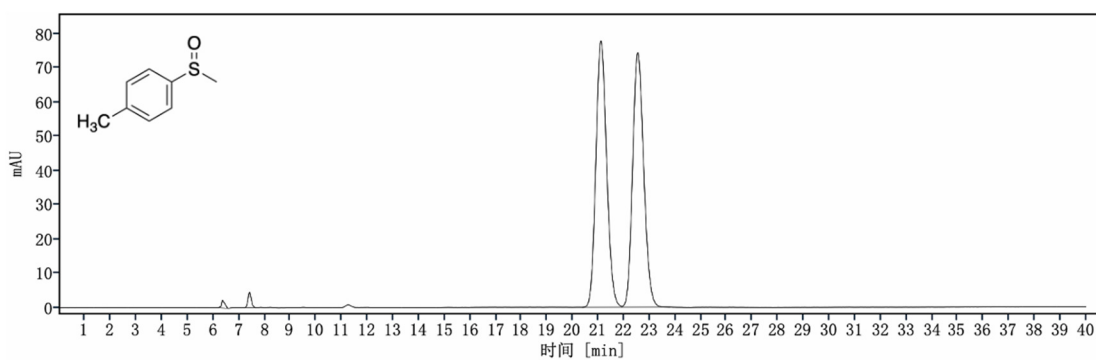


Figure S11. Representative chiral HPLC chromatogram of **2b**

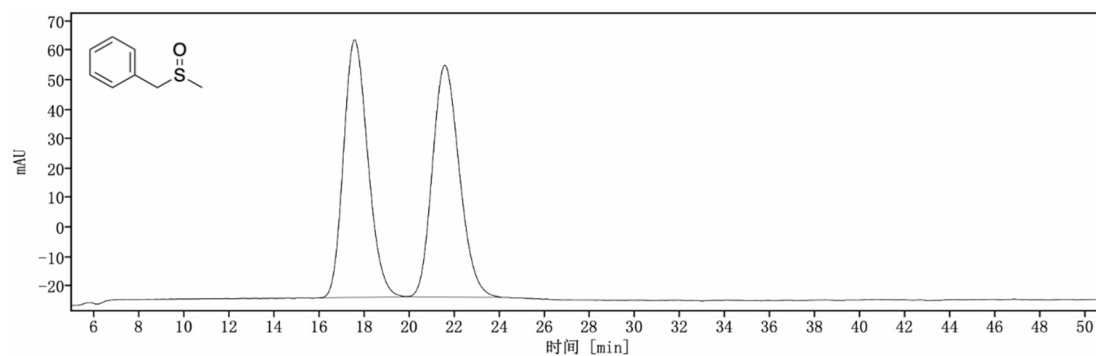


Figure S12. Representative chiral HPLC chromatogram of **3b**

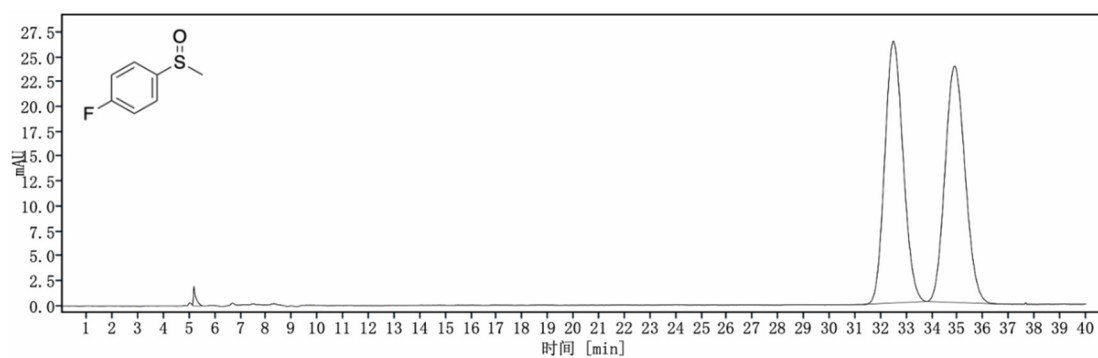


Figure S13. Representative chiral HPLC chromatogram of **4b**

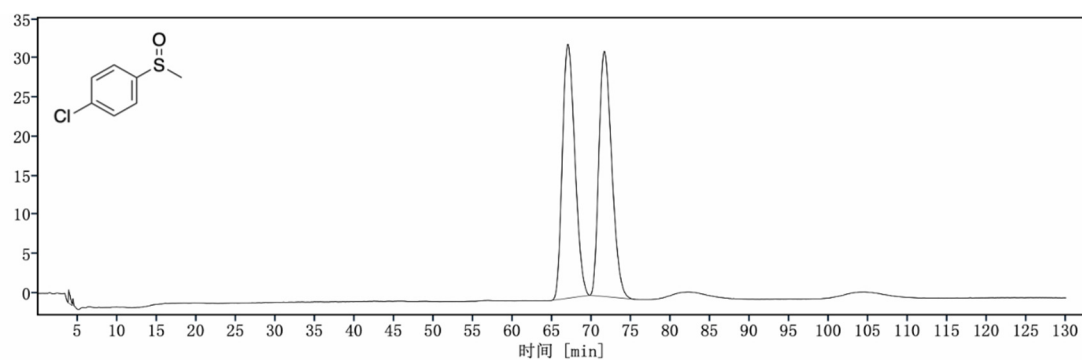


Figure S14. Representative chiral HPLC chromatogram of **5b**

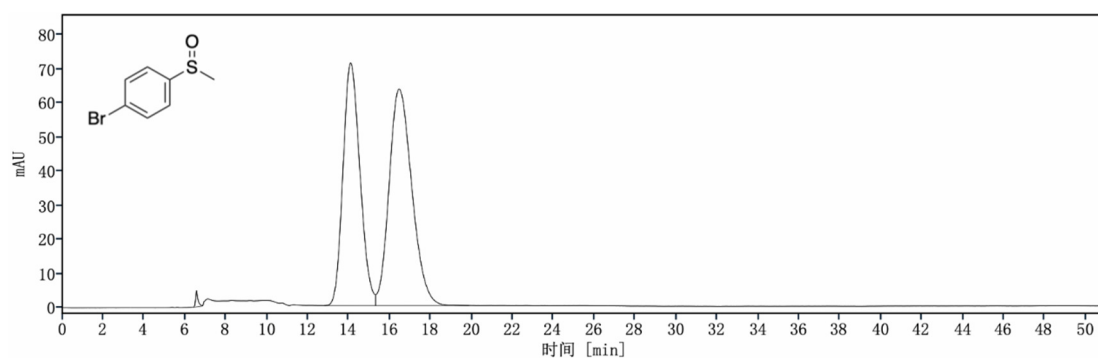


Figure S15. Representative chiral HPLC chromatogram of **6b**

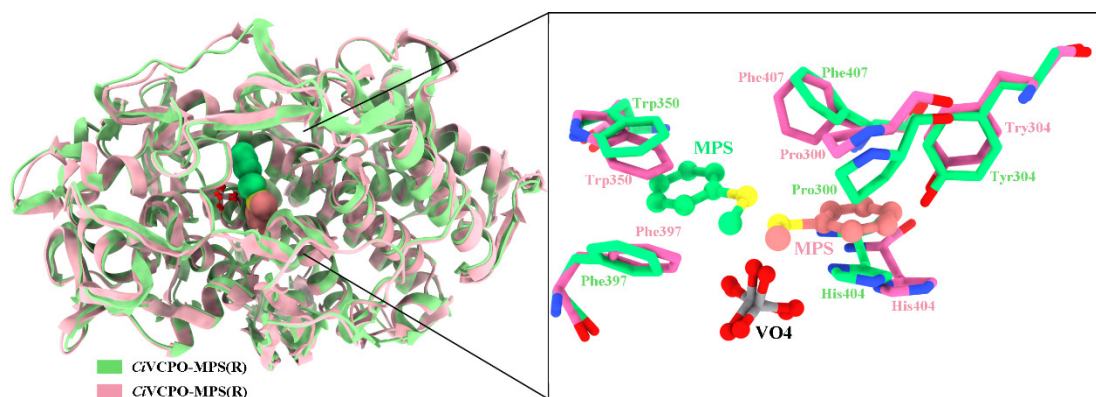


Figure S16. The analysis of MPS molecule binding to *CiVCPO* active site, which is clear that MPS can bind to the left and right sides of the VO_4^{3-} moiety in the substrate-binding pockets of *CiVCPO*, respectively, which leading to the poor enantioselectivities.

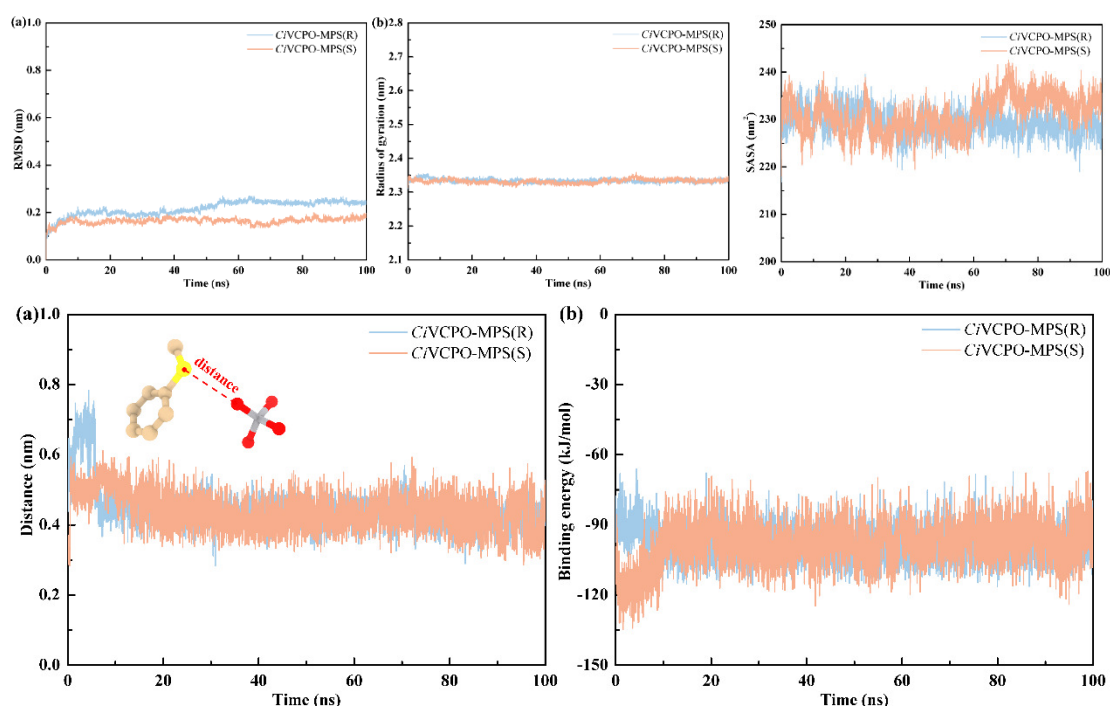


Figure S17. Molecular dynamics (MD) simulations analysis. Backbone RMSD (a); Backbone Rg (b); Total SASA (c); The change in catalytic atomic distance between MPS and VO_4^{3-} (d); and the change in binding energy between MPS and the protein (e) versus simulation time..

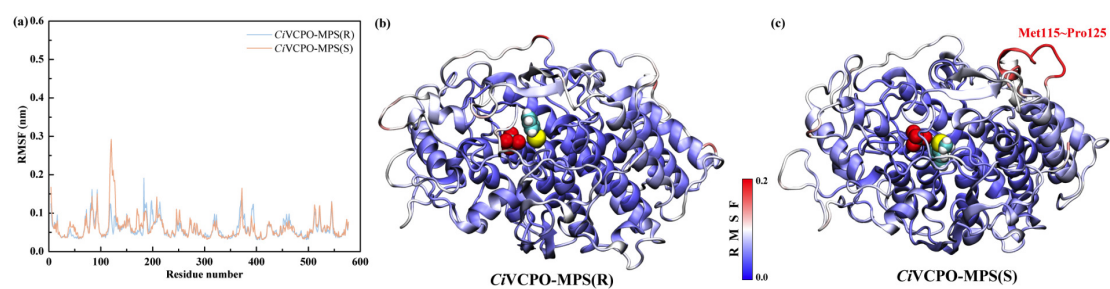


Figure S18. The distribution of root mean square fluctuation (RMSF) for both systems (a and c) and the corresponding regions exhibiting notable alterations in protein structure (b and d).