

A.dabryanus MAGNRDKASDQMKWKENRGCRADLTSTGCGVGVGDKLNSITAGRGPLLVQDVFTDEMAHFDREIRIPERVVHAKGAGAFGYEVTHD 90
A.ruthenus MAGNRDKASDQMKWKENRGCRADLTSTGCGVGVGDKLNSITAGRGPLLVQDVFTDEMAHFDREIRIPERVVHAKGAGAFGYEVTHD 90
L.oculatus MAESRREKSDQMKWKESRGSKAEELITGCGVGVGDKLNACTAGRGPLLVQDVFTDEMAHFDREIRIPERVVHAKGAGAFGYEVTHD 90
P.senegalus MADSRDKASDQMKWKESRGSKAEELITGCGVGVGDKLNACTAGRGPLLVQDVFTDEMAHFDREIRIPERVVHAKGAGAFGYEVTHD 90
E.calabarius MYDTRNADSDQMKWKESRGSKAEELITGCGVGVGDKLNACTAGRGPLLVQDVFTDEMAHFDREIRIPERVVHAKGAGAFGYEVTHD 90
C.orientalis MAESRREKSDQMKWKESRGSKAEELITGCGVGVGDKLNACTAGRGPLLVQDVFTDEMAHFDREIRIPERVVHAKGAGAFGYEVTHD 90
M.cyprinoides MADNRDKASDQMKWKESRGSKAEELITGCGVGVGDKLNACTAGRGPLLVQDVFTDEMAHFDREIRIPERVVHAKGAGAFGYEVTHD 90
D.clupeioides MAENRDKASDQMKWKESRGSKAEELITGCGVGVGDKLNACTAGRGPLLVQDVFTDEMAHFDREIRIPERVVHAKGAGAFGYEVTHD 90
A.anguilla MYENRDKASDQMKWKESRGSKAEELITGCGVGVGDKLNACTAGRGPLLVQDVFTDEMAHFDREIRIPERVVHAKGAGAFGYEVTHD 90
L.peru MAENRDKASDQMKWKESRGSKAEELITGCGVGVGDKLNACTAGRGPLLVQDVFTDEMAHFDREIRIPERVVHAKGAGAFGYEVTHD 90
A.centarchus MADNRDKASDQMKWKESRGSKAEELITGCGVGVGDKLNACTAGRGPLLVQDVFTDEMAHFDREIRIPERVVHAKGAGAFGYEVTHD 90
D.rerio MADNRDKASDQMKWKESRGSKAEELITGCGVGVGDKLNACTAGRGPLLVQDVFTDEMAHFDREIRIPERVVHAKGAGAFGYEVTHD 90
H.sapiens MADNRDKASDQMKWKESRGSKAEELITGCGVGVGDKLNACTAGRGPLLVQDVFTDEMAHFDREIRIPERVVHAKGAGAFGYEVTHD 90
M.musculus MYSDSRDKASDQMKWKESRGSKAEELITGCGVGVGDKLNACTAGRGPLLVQDVFTDEMAHFDREIRIPERVVHAKGAGAFGYEVTHD 90
Consensus m r dqm w r q l tg g p dkin t g rgpllvqdv ftde mahfdreripervvhakgagafgy evthd

A.dabryanus ITKTKAKFEBHVGKRTPTAARFSTVAGPSSGSDTVRDRPGFAKRYTEEGNWDLGNNPIFFIRDEILFSPFHSHQKRNFTTHKDPD 180
A.ruthenus ITKTKAKFEBHVGKRTPTAARFSTVAGPSSGSDTVRDRPGFAKRYTEEGNWDLGNNPIFFIRDEILFSPFHSHQKRNFTTHKDPD 180
L.oculatus ITKTKAKFEBHVGKRTPTAARFSTVAGPSSGSDTVRDRPGFAKRYTEEGNWDLGNNPIFFIRDEILFSPFHSHQKRNFTTHKDPD 180
P.senegalus ITKTKAKFEBHVGKRTPTAARFSTVAGPSSGSDTVRDRPGFAKRYTEEGNWDLGNNPIFFIRDEILFSPFHSHQKRNFTTHKDPD 180
E.calabarius ITKTKAKFEBHVGKRTPTAARFSTVAGPSSGSDTVRDRPGFAKRYTEEGNWDLGNNPIFFIRDEILFSPFHSHQKRNFTTHKDPD 180
C.orientalis ITKTKAKFEBHVGKRTPTAARFSTVAGPSSGSDTVRDRPGFAKRYTEEGNWDLGNNPIFFIRDEILFSPFHSHQKRNFTTHKDPD 180
M.cyprinoides ITKTKAKFEBHVGKRTPTAARFSTVAGPSSGSDTVRDRPGFAKRYTEEGNWDLGNNPIFFIRDEILFSPFHSHQKRNFTTHKDPD 180
D.clupeioides ITKTKAKFEBHVGKRTPTAARFSTVAGPSSGSDTVRDRPGFAKRYTEEGNWDLGNNPIFFIRDEILFSPFHSHQKRNFTTHKDPD 180
A.anguilla ITKTKAKFEBHVGKRTPTAARFSTVAGPSSGSDTVRDRPGFAKRYTEEGNWDLGNNPIFFIRDEILFSPFHSHQKRNFTTHKDPD 180
L.peru ITKTKAKFEBHVGKRTPTAARFSTVAGPSSGSDTVRDRPGFAKRYTEEGNWDLGNNPIFFIRDEILFSPFHSHQKRNFTTHKDPD 180
A.centarchus ITKTKAKFEBHVGKRTPTAARFSTVAGPSSGSDTVRDRPGFAKRYTEEGNWDLGNNPIFFIRDEILFSPFHSHQKRNFTTHKDPD 180
D.rerio ITKTKAKFEBHVGKRTPTAARFSTVAGPSSGSDTVRDRPGFAKRYTEEGNWDLGNNPIFFIRDEILFSPFHSHQKRNFTTHKDPD 180
H.sapiens ITKTKAKFEBHVGKRTPTAARFSTVAGPSSGSDTVRDRPGFAKRYTEEGNWDLGNNPIFFIRDEILFSPFHSHQKRNFTTHKDPD 180
M.musculus ITKTKAKFEBHVGKRTPTAARFSTVAGPSSGSDTVRDRPGFAKRYTEEGNWDLGNNPIFFIRDEILFSPFHSHQKRNFTTHKDPD 180
Consensus kak f h g k t p a r f s t v a g p s s g s d t v r d r p g f a k r y t e e g n w d l g n n p i f f i r d e i l f s p f h s h q k r n f t t h k d p d

A.dabryanus MVWDFWLRPESLHQVFLFSDRGPIGGRHMGYGSHTFKLVNNAACEAVYCKFKHTGGIKNIPVDESSLSATNPDYSKODIYATA 270
A.ruthenus MVWDFWLRPESLHQVFLFSDRGPIGGRHMGYGSHTFKLVNNAACEAVYCKFKHTGGIKNIPVDESSLSATNPDYSKODIYATA 270
L.oculatus MVWDFWLRPESLHQVFLFSDRGPIGGRHMGYGSHTFKLVNNAACEAVYCKFKHTGGIKNIPVDESSLSATNPDYSKODIYATA 270
P.senegalus MVWDFWLRPESLHQVFLFSDRGPIGGRHMGYGSHTFKLVNNAACEAVYCKFKHTGGIKNIPVDESSLSATNPDYSKODIYATA 270
E.calabarius MVWDFWLRPESLHQVFLFSDRGPIGGRHMGYGSHTFKLVNNAACEAVYCKFKHTGGIKNIPVDESSLSATNPDYSKODIYATA 270
C.orientalis MVWDFWLRPESLHQVFLFSDRGPIGGRHMGYGSHTFKLVNNAACEAVYCKFKHTGGIKNIPVDESSLSATNPDYSKODIYATA 270
M.cyprinoides MVWDFWLRPESLHQVFLFSDRGPIGGRHMGYGSHTFKLVNNAACEAVYCKFKHTGGIKNIPVDESSLSATNPDYSKODIYATA 270
D.clupeioides MVWDFWLRPESLHQVFLFSDRGPIGGRHMGYGSHTFKLVNNAACEAVYCKFKHTGGIKNIPVDESSLSATNPDYSKODIYATA 270
A.anguilla MVWDFWLRPESLHQVFLFSDRGPIGGRHMGYGSHTFKLVNNAACEAVYCKFKHTGGIKNIPVDESSLSATNPDYSKODIYATA 270
L.peru MVWDFWLRPESLHQVFLFSDRGPIGGRHMGYGSHTFKLVNNAACEAVYCKFKHTGGIKNIPVDESSLSATNPDYSKODIYATA 270
A.centarchus MVWDFWLRPESLHQVFLFSDRGPIGGRHMGYGSHTFKLVNNAACEAVYCKFKHTGGIKNIPVDESSLSATNPDYSKODIYATA 270
D.rerio MVWDFWLRPESLHQVFLFSDRGPIGGRHMGYGSHTFKLVNNAACEAVYCKFKHTGGIKNIPVDESSLSATNPDYSKODIYATA 270
H.sapiens MVWDFWLRPESLHQVFLFSDRGPIGGRHMGYGSHTFKLVNNAACEAVYCKFKHTGGIKNIPVDESSLSATNPDYSKODIYATA 270
M.musculus MVWDFWLRPESLHQVFLFSDRGPIGGRHMGYGSHTFKLVNNAACEAVYCKFKHTGGIKNIPVDESSLSATNPDYSKODIYATA 270
Consensus mvwdfwlrpeshqv flf s d r g p i g g r h m g y g s h t f k l v n n a a c e a v y c k f k h t g g i k n i p v d e s s l s a t n p d y s k o d i y a t a

A.dabryanus NGNYFWSVFIQVMTFECAGKERNPFDLTKWSEKDEPLIEGVLNLNENNYFEVEQAFDPSNMPPGDESPDMLOGRLFYYPD 360
A.ruthenus NGNYFWSVFIQVMTFECAGKERNPFDLTKWSEKDEPLIEGVLNLNENNYFEVEQAFDPSNMPPGDESPDMLOGRLFYYPD 360
L.oculatus NGNYFWSVFIQVMTFECAGKERNPFDLTKWSEKDEPLIEGVLNLNENNYFEVEQAFDPSNMPPGDESPDMLOGRLFYYPD 360
P.senegalus SGSVFWSVFIQVMTFECAGKERNPFDLTKWSEKDEPLIEGVLNLNENNYFEVEQAFDPSNMPPGDESPDMLOGRLFYYPD 360
E.calabarius RGSVFWSVFIQVMTFECAGKERNPFDLTKWSEKDEPLIEGVLNLNENNYFEVEQAFDPSNMPPGDESPDMLOGRLFYYPD 360
C.orientalis NGNYFWSVFIQVMTFECAGKERNPFDLTKWSEKDEPLIEGVLNLNENNYFEVEQAFDPSNMPPGDESPDMLOGRLFYYPD 360
M.cyprinoides NGNYFWSVFIQVMTFECAGKERNPFDLTKWSEKDEPLIEGVLNLNENNYFEVEQAFDPSNMPPGDESPDMLOGRLFYYPD 360
D.clupeioides YNNFWSVFIQVMTFECAGKERNPFDLTKWSEKDEPLIEGVLNLNENNYFEVEQAFDPSNMPPGDESPDMLOGRLFYYPD 360
A.anguilla NGNYFWSVFIQVMTFECAGKERNPFDLTKWSEKDEPLIEGVLNLNENNYFEVEQAFDPSNMPPGDESPDMLOGRLFYYPD 360
L.peru NGNYFWSVFIQVMTFECAGKERNPFDLTKWSEKDEPLIEGVLNLNENNYFEVEQAFDPSNMPPGDESPDMLOGRLFYYPD 360
A.centarchus NGNYFWSVFIQVMTFECAGKERNPFDLTKWSEKDEPLIEGVLNLNENNYFEVEQAFDPSNMPPGDESPDMLOGRLFYYPD 360
D.rerio NGNYFWSVFIQVMTFECAGKERNPFDLTKWSEKDEPLIEGVLNLNENNYFEVEQAFDPSNMPPGDESPDMLOGRLFYYPD 360
H.sapiens TGRVFSVFIQVMTFECAGKERNPFDLTKWSEKDEPLIEGVLNLNENNYFEVEQAFDPSNMPPGDESPDMLOGRLFYYPD 360
M.musculus NGNYFWSVFIQVMTFECAGKERNPFDLTKWSEKDEPLIEGVLNLNENNYFEVEQAFDPSNMPPGDESPDMLOGRLFYYPD 360
Consensus p w i q v m t f e c a g k e r n p f d l t k w s e k d e p l i e g v l n l n e n n y f e v e q a f d p s n m p p g d e s p d m l o g r l f y y p d

A.dabryanus THRRRLG-NYLQLEVNCFKRRV-NYQRDGPMMC-FNQGGAPNYPNSFAEETQCFBTKFKVSALVRRNSSDINVOVRFEYTCV 450
A.ruthenus THRRRLG-NYLQLEVNCFKRRV-NYQRDGPMMC-FNQGGAPNYPNSFAEETQCFBTKFKVSALVRRNSSDINVOVRFEYTCV 450
L.oculatus THRRRLG-NYLQLEVNCFKRRV-NYQRDGPMMC-FNQGGAPNYPNSFAEETQCFBTKFKVSALVRRNSSDINVOVRFEYTCV 450
P.senegalus THRRRLG-NYLQLEVNCFKRRV-NYQRDGPMMC-FNQGGAPNYPNSFAEETQCFBTKFKVSALVRRNSSDINVOVRFEYTCV 450
E.calabarius THRRRLG-NYLQLEVNCFKRRV-NYQRDGPMMC-FNQGGAPNYPNSFAEETQCFBTKFKVSALVRRNSSDINVOVRFEYTCV 450
C.orientalis THRRRLG-NYLQLEVNCFKRRV-NYQRDGPMMC-FNQGGAPNYPNSFAEETQCFBTKFKVSALVRRNSSDINVOVRFEYTCV 450
M.cyprinoides THRRRLG-NYLQLEVNCFKRRV-NYQRDGPMMC-FNQGGAPNYPNSFAEETQCFBTKFKVSALVRRNSSDINVOVRFEYTCV 450
D.clupeioides THRRRLG-NYLQLEVNCFKRRV-NYQRDGPMMC-FNQGGAPNYPNSFAEETQCFBTKFKVSALVRRNSSDINVOVRFEYTCV 450
A.anguilla THRRRLG-NYLQLEVNCFKRRV-NYQRDGPMMC-FNQGGAPNYPNSFAEETQCFBTKFKVSALVRRNSSDINVOVRFEYTCV 450
L.peru THRRRLG-NYLQLEVNCFKRRV-NYQRDGPMMC-FNQGGAPNYPNSFAEETQCFBTKFKVSALVRRNSSDINVOVRFEYTCV 450
A.centarchus THRRRLG-NYLQLEVNCFKRRV-NYQRDGPMMC-FNQGGAPNYPNSFAEETQCFBTKFKVSALVRRNSSDINVOVRFEYTCV 450
D.rerio THRRRLG-NYLQLEVNCFKRRV-NYQRDGPMMC-FNQGGAPNYPNSFAEETQCFBTKFKVSALVRRNSSDINVOVRFEYTCV 450
H.sapiens THRRRLG-NYLQLEVNCFKRRV-NYQRDGPMMC-FNQGGAPNYPNSFAEETQCFBTKFKVSALVRRNSSDINVOVRFEYTCV 450
M.musculus THRRRLG-NYLQLEVNCFKRRV-NYQRDGPMMC-FNQGGAPNYPNSFAEETQCFBTKFKVSALVRRNSSDINVOVRFEYTCV 450
Consensus thrhrlg nyl q l e v n c f k r r v n y q r d g p m m c f n q g g a p n y p n s f a e e t q c f b t k f k v s a l v r r n s s d i n v o v r f e y t c v

A.dabryanus LNEDEERCLQCNAG-LKCAQFIQKRAVENEMDVHEDYGSRIQALIDKNATQAG.ENV.IRTNAPTAAASLTARE.SKM 526
A.ruthenus LNEDEERCLQCNAG-LKCAQFIQKRAVENEMDVHEDYGSRIQALIDKNATQAG.ENV.IRTNAPTAAASLTARE.SKM 526
L.oculatus LNEDEERCLQCNAG-LKCAQFIQKRAVENEMDVHEDYGSRIQALIDKNATQAG.ENV.IRTNAPTAAASLTARE.SKM 524
P.senegalus LNEDEERCLQCNAG-LKCAQFIQKRAVENEMDVHEDYGSRIQALIDKNATQAG.ENV.IRTNAPTAAASLTARE.SKM 525
E.calabarius LNEDEERCLQCNAG-LKCAQFIQKRAVENEMDVHEDYGSRIQALIDKNATQAG.ENV.IRTNAPTAAASLTARE.SKM 525
C.orientalis LNEDEERCLQCNAG-LKCAQFIQKRAVENEMDVHEDYGSRIQALIDKNATQAG.ENV.IRTNAPTAAASLTARE.SKM 529
M.cyprinoides LNEDEERCLQCNAG-LKCAQFIQKRAVENEMDVHEDYGSRIQALIDKNATQAG.ENV.IRTNAPTAAASLTARE.SKM 526
D.clupeioides LNEDEERCLQCNAG-LKCAQFIQKRAVENEMDVHEDYGSRIQALIDKNATQAG.ENV.IRTNAPTAAASLTARE.SKM 526
A.anguilla LNEDEERCLQCNAG-LKCAQFIQKRAVENEMDVHEDYGSRIQALIDKNATQAG.ENV.IRTNAPTAAASLTARE.SKM 526
L.peru LNEDEERCLQCNAG-LKCAQFIQKRAVENEMDVHEDYGSRIQALIDKNATQAG.ENV.IRTNAPTAAASLTARE.SKM 527
A.centarchus LNEDEERCLQCNAG-LKCAQFIQKRAVENEMDVHEDYGSRIQALIDKNATQAG.ENV.IRTNAPTAAASLTARE.SKM 527
D.rerio LNEDEERCLQCNAG-LKCAQFIQKRAVENEMDVHEDYGSRIQALIDKNATQAG.ENV.IRTNAPTAAASLTARE.SKM 526
H.sapiens LNEDEERCLQCNAG-LKCAQFIQKRAVENEMDVHEDYGSRIQALIDKNATQAG.ENV.IRTNAPTAAASLTARE.SKM 527
M.musculus LNEDEERCLQCNAG-LKCAQFIQKRAVENEMDVHEDYGSRIQALIDKNATQAG.ENV.IRTNAPTAAASLTARE.SKM 527
Consensus l e r n l c n a g l k a q f i q k r a v e n e m d v h e d y g s r i q a l i d k n a t q a g . e n v . i r t n a p t a a s l t a r e . s k m

Figure S1. Alignment of the full amino acid sequences of *AdCAT* with its homologs from other species. The catalase proximal active-site signature domain is marked by red box, the catalase proximal heme-ligand signature domain is marked by blue box, the N-glycosylation site and the peroxisome targeting signal are shaded in yellow and green, respectively.

Table S1. Nutrients content of diets.

| Ingredients | Contents (%) |
|-------------------|--------------|
| Amino acid | |
| Aspartic acid | 3.87 |
| Threonine | 1.52 |
| Serine | 1.75 |
| Glutamic acid | 6.37 |
| Glycine | 2.20 |
| Alanine | 2.32 |
| Valine | 2.19 |
| Methionine | 0.68 |
| Isoleucine | 1.58 |
| Leucine | 3.42 |
| Tyrosine | 1.28 |
| Phenylalanine | 1.97 |
| Lysine | 2.48 |
| Hlstdine | 1.17 |
| Arginine | 2.41 |
| Proline | 2.12 |
| Total amino acids | 37.33 |
| Nutrients content | |
| Crude protein | 41.31 |
| Crude lipid | 10.00 |
| Ash | 13.51 |
| Moisture | 9.14 |

Table S2. List of AdCu/Zn-SOD sequences used in this study. Amino acid identities (%) of Cu/Zn-SOD proteins from other species with AdCu/Zn-SOD.

| Species | Protein ID | Identity (%) with AdCu/Zn-SOD |
|-------------------------------|----------------|-------------------------------|
| <i>Acipenser ruthenus</i> | RXM97503.1 | 98.06 |
| <i>Salvelinus alpinus</i> | XP_023998922.1 | 81.17 |
| <i>Lepisosteus oculatus</i> | XP_006628266.1 | 81.17 |
| <i>Salvelinus namaycush</i> | XP_038860929.1 | 80.52 |
| <i>Pungitius pungitius</i> | XP_037322998.1 | 79.87 |
| <i>Megalops cyprinoides</i> | XP_036379360.1 | 79.22 |
| <i>Anguilla marmorata</i> | AKN46051.1 | 79.22 |
| <i>Channa striata</i> | CCQ48610.1 | 79.22 |
| <i>Scophthalmus maximus</i> | XP_035480522.1 | 79.22 |
| <i>Chanos chanos</i> | XP_030648381.1 | 79.22 |
| <i>Cynoglossus semilaevis</i> | XP_008331462.1 | 78.57 |
| <i>Danio rerio</i> | NP_571369.1 | 77.27 |
| <i>Oncorhynchus mykiss</i> | NP_001117801.1 | 77.27 |
| <i>Salmo salar</i> | NP_001117059.1 | 75.97 |
| <i>Ictalurus punctatus</i> | NP_001187921.1 | 75.66 |
| <i>Oryzias latipes</i> | XP_004076261.1 | 74.68 |
| <i>Mus musculus</i> | NP_035564.1 | 71.43 |
| <i>Homo sapiens</i> | NP_000445.1 | 68.83 |
| <i>Sus scrofa</i> | NP_001177351.1 | 66.88 |
| <i>Gallus gallus</i> | NP_990395.1 | 66.01 |

Table S3. List of AdCAT sequences used in this study. Amino acid identities (%) of CAT proteins from other species with AdCAT.

| Species | Protein ID | Identity (%) with AdCAT |
|----------------------------------|----------------|-------------------------|
| <i>Acipenser ruthenus</i> | XP_033910111.2 | 98.10 |
| <i>Lepisosteus oculatus</i> | XP_006642501.1 | 85.93 |
| <i>Polypterus senegalus</i> | XP_039600263.1 | 84.41 |
| <i>Cynops orientalis</i> | AIR07783.1 | 84.19 |
| <i>Cynops orientalis</i> | AIR07783.1 | 84.19 |
| <i>Erpetoichthys calabaricus</i> | XP_028649340.1 | 84.03 |
| <i>Lutjanus peru</i> | ANS56707.1 | 83.11 |
| <i>Archocentrus centrarchus</i> | XP_030586949.1 | 82.92 |
| <i>Denticeps clupeoides</i> | XP_028842031.1 | 82.89 |
| <i>Danio rerio</i> | AAH51626.1 | 82.89 |
| <i>Denticeps clupeoides</i> | XP_028842031.1 | 82.89 |
| <i>Anguilla anguilla</i> | XP_035250822.1 | 82.51 |
| <i>Megalops cyprinoides</i> | XP_036390602.1 | 82.32 |
| <i>Sparus aurata</i> | XP_030281034.1 | 82.16 |
| <i>Sander lucioperca</i> | XP_031172608.1 | 81.97 |
| <i>Oryzias latipes</i> | XP_004069508.1 | 81.40 |
| <i>Sus scrofa</i> | NP_999466.2 | 81.07 |
| <i>Mus musculus</i> | NP_033934.2_1 | 80.84 |
| <i>Ictalurus punctatus</i> | XP_017341362.1 | 80.04 |
| <i>Homo sapiens</i> | AAK29181.1 | 79.92 |
| <i>Gallus gallus</i> | NP_001026386.2 | 79.20 |