**Supplementary Tables**

**Supplementary Table 1 GenBank accession numbers of the proteins used for phylogenetic analysis** **and** **multiple sequence alignments**

|  |  |
| --- | --- |
| Protein name | GenBank Accession number |
| AT4G08620 (AtSultr1;1) | NP\_192602.1 |
| AT1G78000.1 (AtSultr1;2) | NP\_001321366.1 |
| AT1G22150.1(AtSultr1;3) | NP\_001319061.1 |
| AT5G10180.1(AtSultr2;1) | NP\_196580.1 |
| AT1G77990.1(AtSultr2;2) | NP\_565165.2 |
| AT3G51895.1(AtSultr3;1) | NP\_190758.2 |
| AT4G02700.1(AtSultr3;2) | NP\_192179.1 |
| AT1G23090.1(AtSultr3;3) | NP\_173722.1 |
| AT3G15990.1(AtSultr3;4) | NP\_188220.1 |
| AT5G19600.1(AtSultr3;5) | NP\_568377.1 |
| AT5G13550.1(AtSultr4;1) | NP\_196859.1 |
| AT3G12520.1(AtSultr4;2)MdSultr3;1aMdSultr3;1bMdSultr3;1cMdSultr3;1dMdSultr3;3aMdSultr3;3bMdSultr3;4MdSultr3;5MdSultr4;2 | NP\_187858.1XP\_008390997.2XP\_008390930.1XP\_008368821.2XP\_008366542.1RXH70282.1XP\_008389211.3TQE04443.1RXH74574.1XP\_008371139.1 |
| MhSultr3;1aPaSultr3;1PbSuLTR3;1PpSultr3;1PtSultr3;1 | MZ634458XP\_021828165.1XP\_009371954.1XP\_007225118.1XP\_002314667.2 |

**Supplementary Table 2 The primers used for cloning, subcellular localization, and vector construction of *MhSultr3;1a***

|  |  |
| --- | --- |
| Primer name | Primer sequence(5’-3’) |
| MhSultr3;1a-F | ATGGGCAACGCAGATTATGA |
| MhSultr3;1a-R | AACATTGCCATCTTGTCTGTTTG |
| MhSultr3;1a-EFMhSultr3;1a-ER | GGGGACAAGTTTGTACAAAAAAGCAGGCTTCATGGGCAACGCAGATTATGAGGGGACCACTTTGTACAAGAAAGCTGGGTTAACATTGCCATCTTGTCTGTTTG |
| MhSultr3;1a-YF | ctgctgcagtctagagaattcATGGGCAACGCAGATTATGAG |
| MhSultr3;1a-YR | aagaagtccaaagctggatccAACATTGCCATCTTGTCTGTTTGT |

**Supplementary Table 3 The primers used for confirming transgenic apple calli**

|  |  |  |
| --- | --- | --- |
| Primer name | Primer sequence(5’-3’) | Used for |
| NeoR-F  | CTATTCGGCTATGACTGGGC | gDNA-PCR |
| NeoR-RMhSultr3;1aMhSultr3;1a | AATATCACGGGTAGCCAACGGGAATCACCATTGCCAGTCTGCTAACAACCTTCCCCAACA | qRT-PCR |

**Supplementary Table 4 The primers for qRT-PCR of *MdSultr* genes**

|  |  |  |  |
| --- | --- | --- | --- |
| Gene ID | Gene name | Forward primes | Reverse primes |
| MDP0000085223 | MdSultr3;1a | GGAATCACCATTGCCAGTCT | GCTAACAACCTTCCCCAACA |
| MDP0000216466 | MdSultr3;1b | TTTGTGCCTCCATTGGTGTA | AAGTCCACGACAAACCCAAG |
| MDP0000231619 | MdSultr3;1c | TTCCTGATGACCCTTTGAGG | CCAAGAATTGGTGGCAAGTT |
| MDP0000311618 | MdSultr3;1d | GCGGAGTTTTGGGTTGTTTA | AGGTCTCCAAACGACAATGG |
| MDP0000145668 | MdSultr3;3a | ACTGGCATTATTGCCCTCAC | TTCGACATTGCTGTCTTTGC |
| MDP0000190006 | MdSultr3;3b | AAGGAGTGGTCATGGCAAAC | TGAAAAACCAGCATGTTCCA |
| MDP0000317974 | MdSultr3;4 | TTTCCCAGACAACCCACTTC | CCAACAATTGGAGGCAAACT |
| MDP0000167489 | MdSultr3;5 | CTCCACTTTTCGTGGTGGTT | AGTAATAGCCGCAGCCTTCA |
| MDP0000141450 | MdSultr4;2 | AGGCCTGGTGGACTATGATG | ATATGCGGGTTTGCTGATTC |
|  | Md-actin | TAAGGCTGGATTTGCTGGAG | GCATCTTTCTGACCCATTCC |

**Supplementary Table 5 List of putative motifs of *MdSultr* proteins**

|  |  |  |  |
| --- | --- | --- | --- |
| Motif | Conservative sequence | Width  | Pfam domain  |
| 1 | EGIAVGRSFAAFKNYHIDGNKEMIAIGMMNIVGSCTSCYLTTGPFSRSAV | 50 | Sulfate\_transp (PF00916) |
| 2 | MVTLLFLTPLFHYTPLVVLSAIIITAMLGLIDYEAAIHLWKVDKYDFLVC | 50 | Sulfate\_transp (PF00916) |
| 3 | LKETFFPDDPLRQFKNQPPSRKLILGLQYFFPILEWAPRYT | 41 | Not found  |
| 4 | MKSVFSQRHEWRWESAVLGCCFLFFLLLTRYFSKKKPKLFWISAMAPLVS | 50 | Sulfate\_transp (PF00916) |
| 5 | PSASNIPGVLILQIDAPIYFANTNYLRERILRWIYEEEDRIKS | 43 | STAS (PF01740) |
| 6 | PQGISYAKLANLPPIIGLYSSFVPPLIYA | 29 | Sulfate\_transp (PF00916) |
| 7 | LAFTATFFAGIFQASLGLLRLGFIVDFLSHATIVGFMAGAATVVCLQQLK | 50 | Sulfate\_transp (PF00916) |
| 8 | FLTHAEKHGIQVIGHLKKGJNPPSFNDLVFGSPYLATAIKTGIITGIIAL | 50 | Sulfate\_transp (PF00916) |
| 9 | RYVILDMSAVATIDTSGITMLEEVRKSIDKRGJKLVJANPRGEVMKKLQK | 50 | STAS (PF01740) |
| 10 | GVVFISVZIGLAIAVGISLFRVLLYVARPRTFVLGNIPGSSIYRNIDQY | 49 | Not found  |
| 11 | MLGSSKDLAVGTVAVASLLIASMLGEEVS | 29 | Sulfate\_transp (PF00916) |
| 12 | NYNAGAKTAMSNIVM | 15 | Not found  |
| 13 | WIYLTVAEAVAACSFMLHTTK | 21 | Not found  |
| 14 | KSDJISGITIASLAI | 15 | Not found  |
| 15 | EESPHRVEIPPPQPFIKVLKS | 21 | Not found  |
| 16 | LGJKHFTHKTDVVSV | 15 | Not found  |
| 17 | EBPTLYLQ | 8 | Not found  |
| 18 | DCCSPTRINIZEQQP | 15 | Not found  |