**Supplementary material**

Table S1. The primers used in the real-time qPCR and protein expression in this study.

|  |  |  |
| --- | --- | --- |
| Primer names | Primer sequences (5´to 3´) | Tm (oC) |
| CSP1 Unigene |  |  |
| Qt-7258-F-1 | CCTTCCCTCAAGCGGACACC  | 64.0  |
| Qt-7258-R-1 | GACCTACAGGATCGCAGGGG | 64.0  |
| Csp2 |  |  |
| Qt-7942-F-1 | CGGGCTGACGAAAAGTACACA | 60.0  |
| Qt -7942-R-1  | TCCATCAGGTGAGCAGTTGCC | 61.9  |
| CSP3 |  |  |
| Qt-14536-F-1 | GTGCAGCGACAGGCAAAGG | 61.9  |
| Qt -14536-R-1  | AGCGAACTCTTCGCGGTTTTT | 58.0  |
| CSP4 |  |  |
| Qt-15053-F-1 | CATTGCGGTGGAGGTGCAAG | 61.9  |
| Qt -15053-R-1  | TGTCCAGGGCACACAAGAG | 59.7  |
| CSP 5 |  |  |
| Qt-16280-F-1 | TCACTTACGGTCGCCCTGAC | 60.0  |
| Qt -16280-R-1  | CCCTGAGGAGCCTGTCGTTT | 60.0  |
| CSP6 |  |  |
| Qt-22250-F-1 | GGGATCCGGACGGCTCTTAC | 64.0  |
| Qt -22250-R-1  | TGGCGAGGCGTATCTGTTCA | 59.8  |
| CSP7 |  |  |
| Qt-24279-F-1 | AGTGAACGTCAGAAGAAGGGGG | 61.9  |
| Qt -24279-R-1  | CCATCAGCTGCTCCCACAAAT | 60.0  |
| CSP8 |  |  |
| Qt-24637-F-1 | GCAGCAAGTGTAGCGAGAAGC | 61.9  |
| Qt -24637-R-1  | GCTTCCCGTAGGGTCGTACTT | 61.9  |
| Actin gene from monochamus |  |  |
| qt-β-Actin-F-3049-F-1 | CGCCCCATCCACCATGAAGA | 60.0  |
| qt-β-Actin-R -1 | AGAGGGAGGCGAGGATGGAT  | 60.0  |
| For Purification  |  |  |
| CSP5 |  |  |
| CSP5-F | CGGGAATTCATGAATGAACTGGTGTATCTC | 64.5  |
| CSP5-R | CGCTCGAGTTAATCCTCATTTAACCAATCT | 64.0  |

**Table S2.** Binding affinities of the recombinant *M. alternatus* CSP5 to 13 volatiles of pine trees at acid and neutral environment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Numbers | Chemical compounds | pH7.4 | pH5.0 | Purity (%) |
| IC50(μM) | Ki(μM) | IC50(μM) | Ki(μM) |
| 1 | （+）-Limonene oxide | 64.22 | 40.85 | 53.94 | 38.89 | 97 |
| 2 | p-cymene | 53.95 | 34.32 | 446.24 | 321.73 | 99 |
| 3 | S-(-)-Limomeme | 928.93 | 590.92 | 43.53 | 31.38 | 99 |
| 4 | terpinolene | 104.17 | 66.27 | 37.27 | 26.87 | 85 |
| 5 | α-terpinolene | 37.41 | 23.80 | 33.28 | 23.99 | 90 |
| 6 | (+)-α-pinene | 37.68 | 23.97 | 15.92 | 11.48 | 99 |
| 7 | (+)-β-pinene | 35.02 | 22.28 | 9.75 | 7.03 | 99 |
| 8 | (-)-Isolongifolene | 69.49 | 44.20 | 11.26 | 8.12 | 98 |
| 9 | myrcene | 50.14 | 31.90 | 8.24 | 5.94 | 85 |
| 10 | β-Caryophyllene | 48.42 | 30.80 | 32.65 | 23.54 | 98.5 |
| 11 | Butylated hydroxytoluene | 53.13 | 33.80 | 30.13 | 21.72 | 98 |
| 12 | Camphor | 43.4 | 27.61 | 36.75 | 26.50 | 95 |
| 13 | 2-methoxy-4-vinylphenol | 340.69 | 216.72 | 707.04 | 509.76 | 97 |