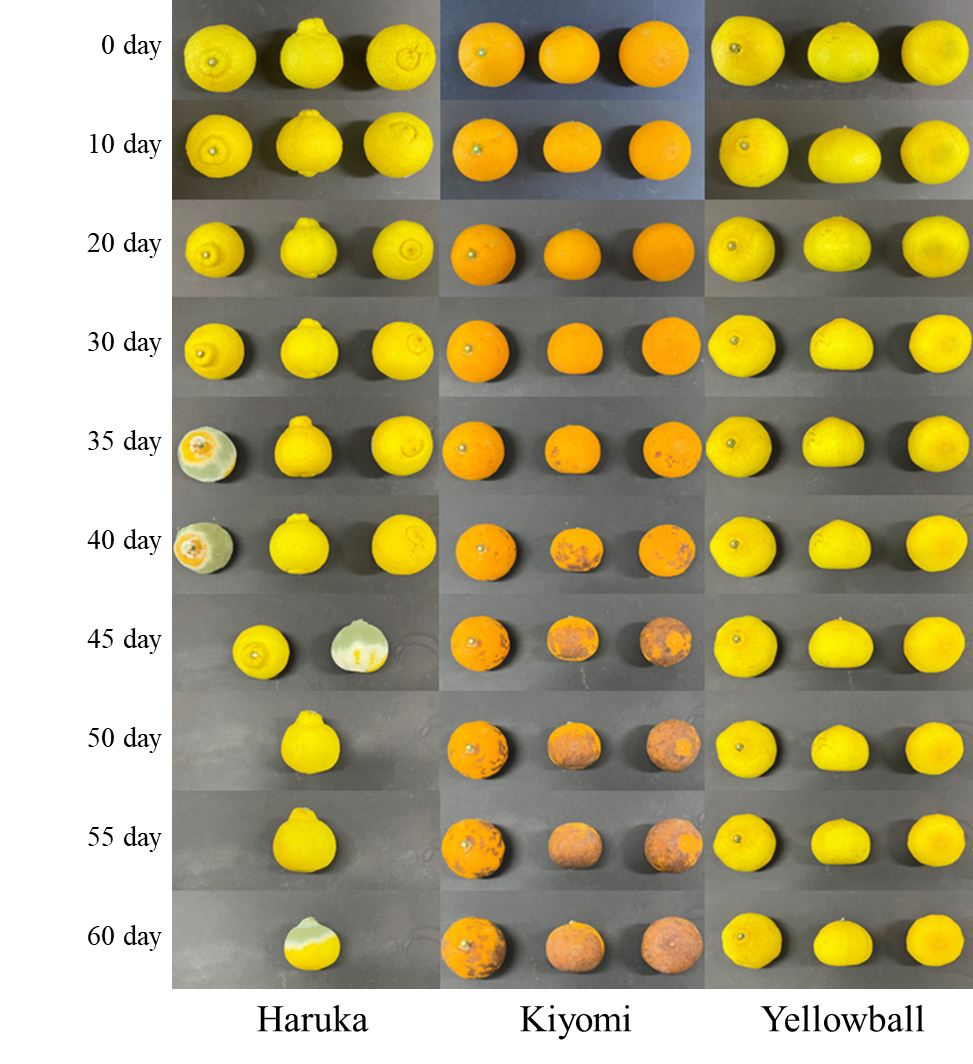
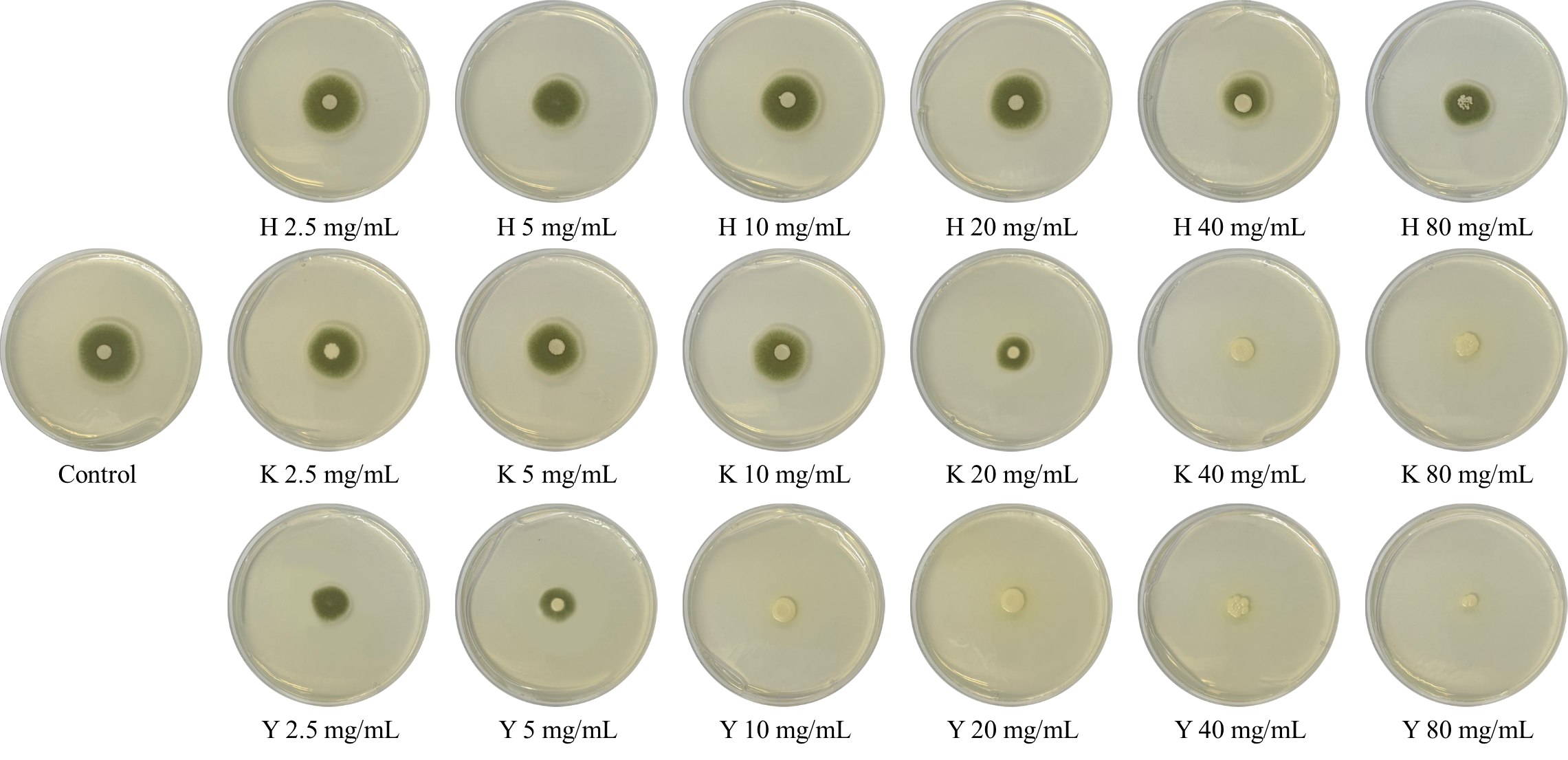
**Supplementary material**

**Table S1.** Weight, width, length, and peel thickness of Haruka, Kiyomi, and Yellowball.

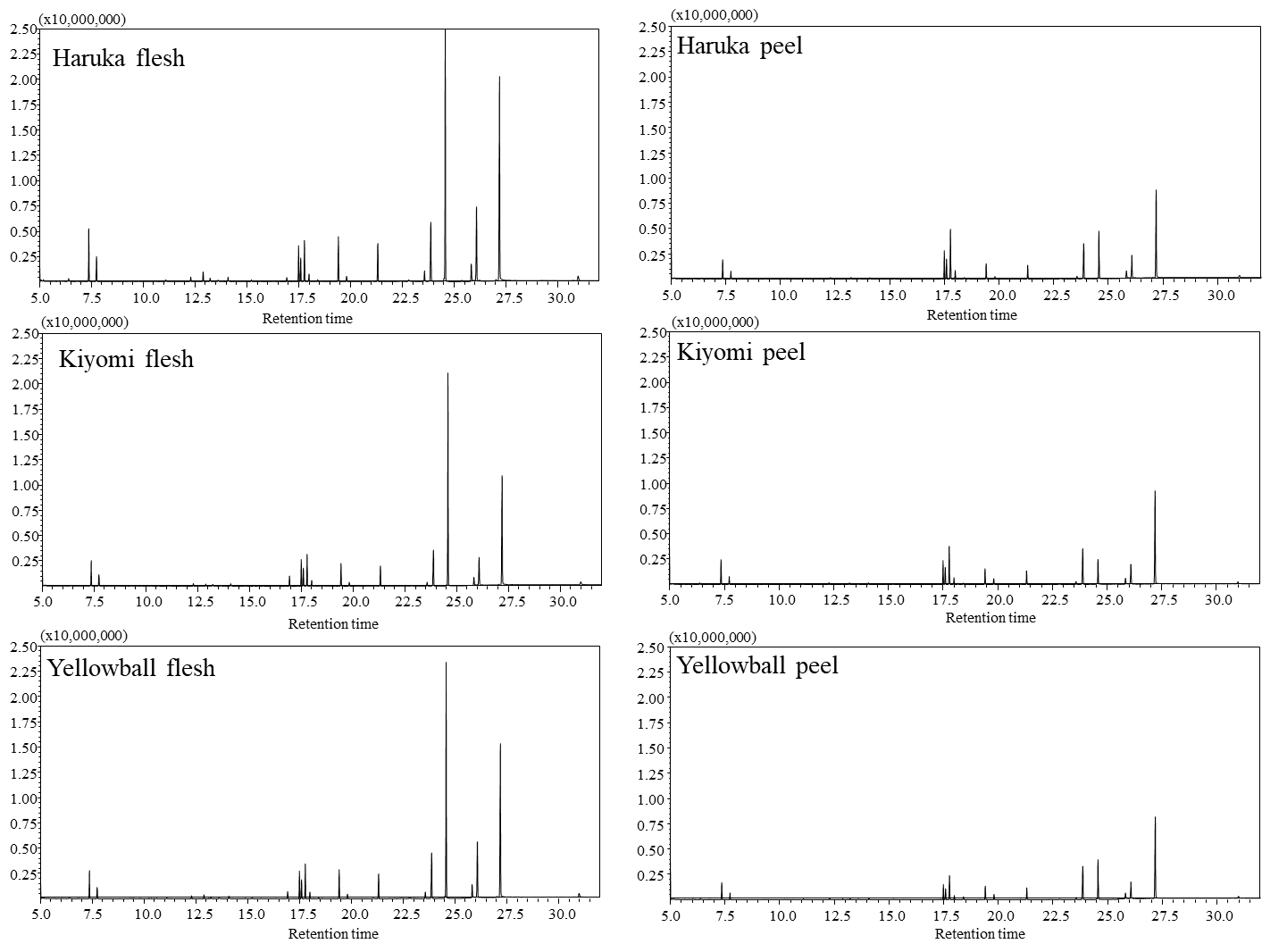
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Weight (g) | Width (cm) | Length (cm) | Peel thickness (cm) |
| Haruka | 331.49 ± 29.46 | 10.63 ± 0.38 | 10.09 ± 0.42 | 0.90 ± 0.09 |
| Kiyomi | 250.69 ± 18.83 | 9.39 ± 0.39 | 8.92 ± 0.37 | 0.68 ± 0.12 |
| Yellowball | 273.74 ± 15.47 | 9.76 ± 0.60 | 9.32 ± 0.37 | 0.44 ± 0.03 |



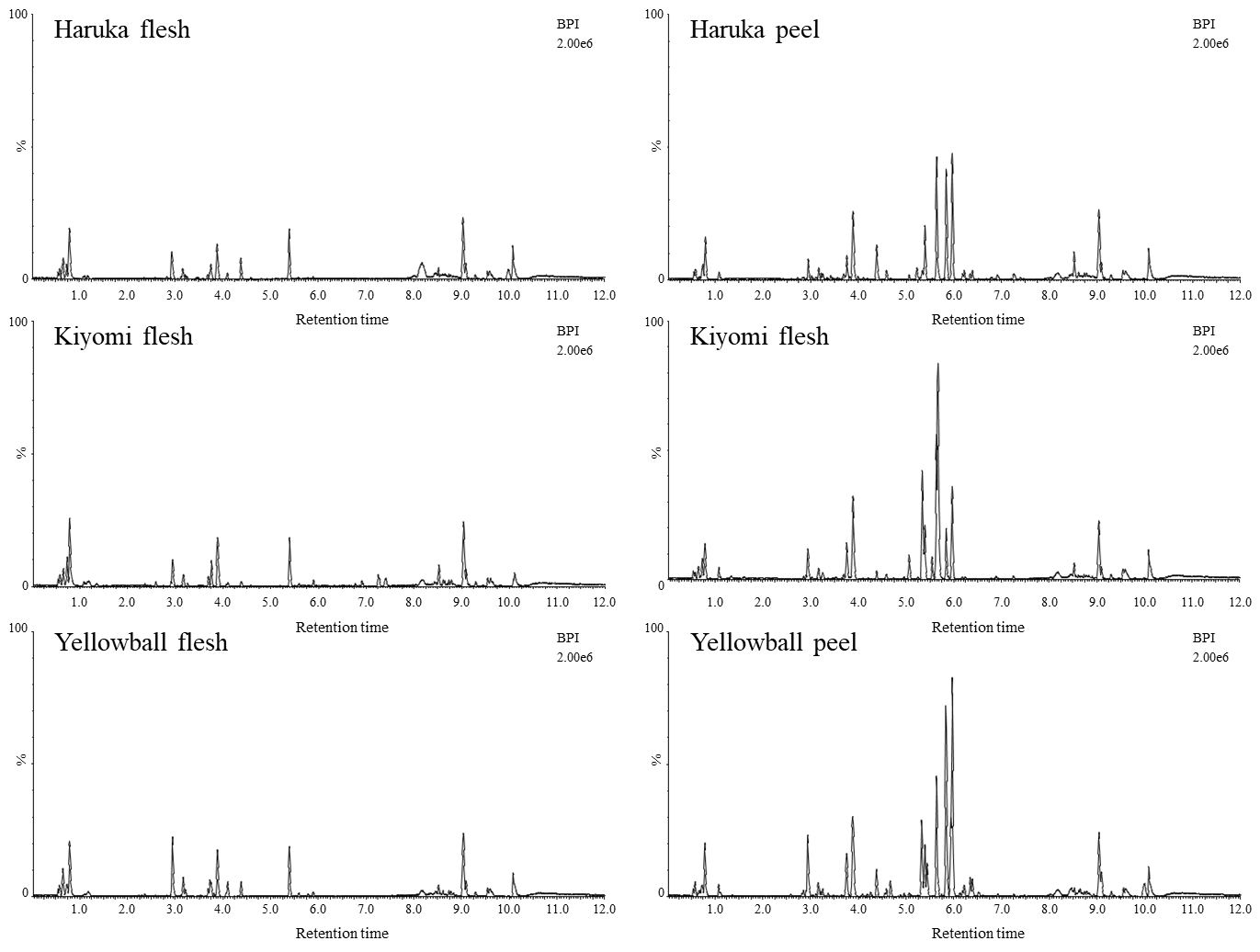
**Figure S1.** Appearance changes of Haruka, Kiyomi, and Yellowball during storage for 60 days at 25 °C.



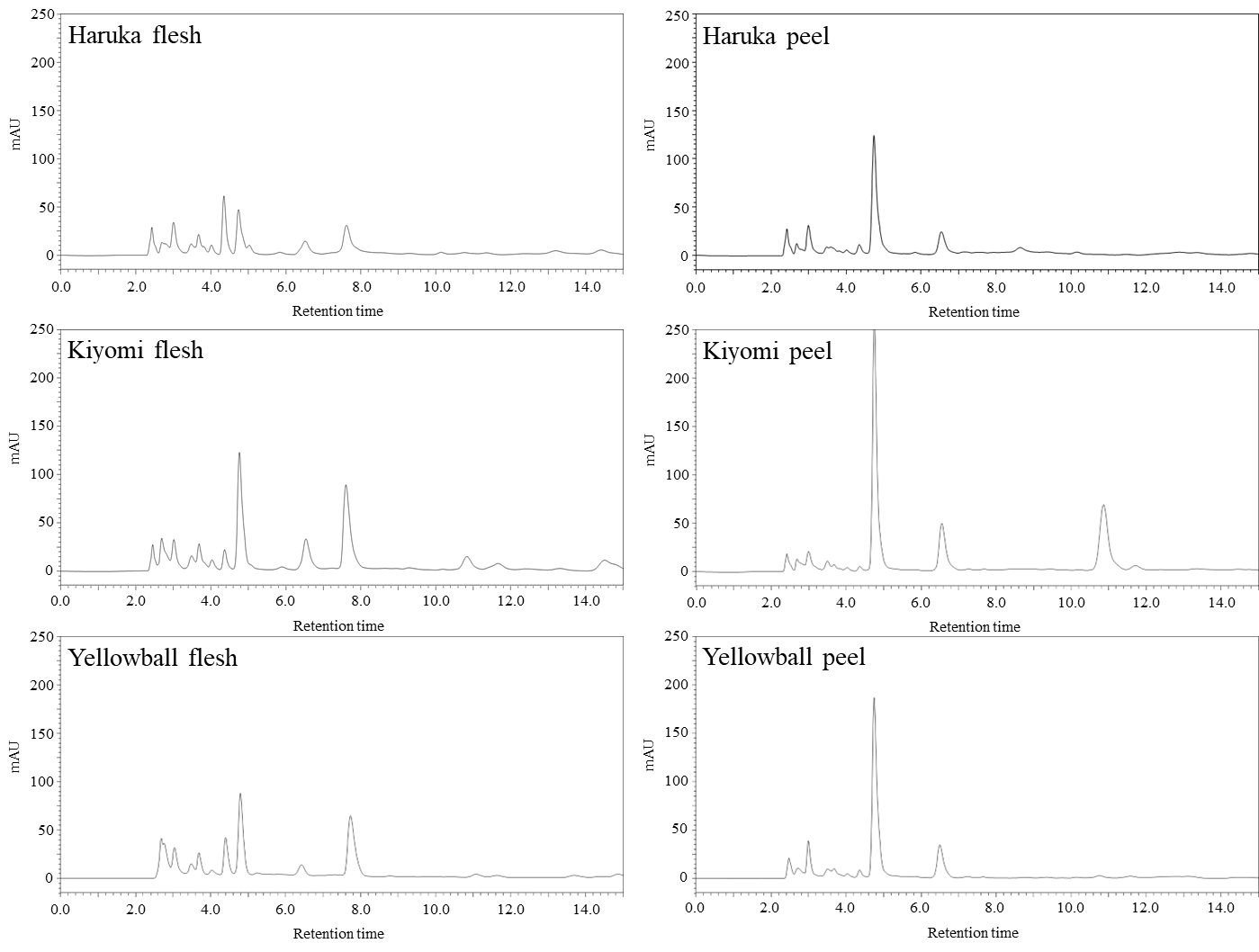
**Figure S2.** Growth inhibition test of peel extracts on citrus green mold (*Penicillium digitatum*) with different concentration (2.5‒80 mg/mL). H, haruka; K, Kiyomi; Y, Yellowball.



**Figure S3.** Representative chromatograms of citrus metabolites analyzed by GC-MS.



**Figure S4.** Representative chromatograms of citrus metabolites analyzed by UPLC-Q-TOF MS.



**Figure S5.** Representative chromatograms of organic acids analyzed by HPLC at 220 nm.



**Figure S6.** Representative chromatograms of carotenoids analyzed by HPLC at 450 nm.

**Table S2**. Identification of major metabolite by GC-MS.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| RT | Compounds | RI | VIP | *p*-value |
| 6.34 | glycine | 1051 | 1.21 | 2.45 × 10‒2 |
| 10.22 | proline | 1293 | 0.94 | 1.54 × 10‒6 |
| 13.48 | 4-aminobutanoic acid | 1525 | 1.32 | 1.10 × 10‒10 |
| 15.21 | aspartic acid | 1663 | 1.04 | 1.29 × 10‒8 |
| 17.34 | quinic acid | 1846 | 1.24 | 7.17 × 10‒20 |
| 17.49 | fructose | 1860 | 1.16 | 3.90 × 10‒5 |
| 17.77 | glucose | 1885 | 1.35 | 7.10 × 10‒7 |
| 18.14 | methyl galactoside | 1920 | 1.06 | 2.17 × 10‒19 |
| 19.41 | palmitic acid | 2022 | 0.81 | 2.32 × 10‒10 |
| 19.80 | myo-inositol | 2042 | 1.25 | 8.03 × 10‒13 |
| 21.30 | stearic acid | 2240 | 0.84 | 6.09 × 10‒12 |
| 24.51 | oleic acid | 2615 | 1.31 | 1.09 × 10‒14 |
| 24.57 | sucrose | 2622 | 1.21 | 8.29 × 10‒30 |

RT, retention time; RI, retention indices; VIP, variable importance in the projection.

*p*-Values were analyzed by Duncan’s test.

**Table S3.** Identification of major metabolite by UPLC-Q-TOF MS.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| RT | Compounds | Exact mass  (M+H) | MS fragment | VIP | *p*-value |
| 0.64 | arginine | 175.1181 | 70, 158, 116 | 1.27 | 6.60 × 10‒28 |
| 0.78 | stachydrine | 144.1010 | 116, 184, 70, 102, 58 | 1.15 | 6.02 × 10‒15 |
| 2.59 | phenylalanine | 166.0847 | 120, 103 | 1.39 | 2.22 × 10‒14 |
| 2.90 | tryptophan | 205.0959 | 188, 188, 144, 170 | 1.19 | 3.98 × 10‒22 |
| 2.93 | feruloyl putrescine | 265.1533 | 177, 145 | 1.81 | 2.19 × 10‒23 |
| 3.03 | luteolin-3'-7'-diglucoside | 611.1608 | 163, 593, 575, 325 | 0.90 | 1.41 × 10‒8 |
| 3.16 | saponarin | 595.1664 | 577, 475 | 1.33 | 1.91 × 10‒4 |
| 3.21 | apigenin-7-rutinoside-4’-glucoside | 741.2250 | 595, 433, 271, 377, 653 | 0.96 | 3.15 × 10‒4 |
| 3.48 | apioside | 565.1550 | 433, 415, 313, 521 | 1.31 | 2.36 × 10‒2 |
| 3.68 | zapoterin | 471.2016 | 425, 95 | 1.19 | 1.55 × 10‒6 |
| 3.72 | apigenin-7-rutinoside | 579.1719 | 271, 433, 519 | 1.77 | 7.64 × 10‒15 |
| 3.75 | narirutin | 581.1875 | 273, 419, 119 | 0.96 | 1.19 × 10‒15 |
| 3.88 | hesperidin | 611.1973 | 303, 449, 177 | 0.93 | 4.86 × 10‒18 |
| 4.09 | xylogranatin K | 515.2287 | 496, 409 | 1.50 | 5.87 × 10‒10 |
| 4.37 | didymin | 595.2021 | 287, 433, 559 | 1.19 | 3.53 × 10‒12 |
| 4.58 | cyclonatsudamine A | 728.3989 | 615, 587, 502, 474 | 0.95 | 2.81 × 10‒7 |
| 4.67 | natsudaidain derivatives  (natsudaidain 3-(4-O-3-hydroxy-3-methylglutaroylglucoside)) | 725.2313 | 419 | 1.05 | 2.97 × 10‒13 |
| 4.73 | monohydroxy tetramethoxyflavone | 359.1125 | 184 | 0.88 | 5.36 × 10‒8 |
| 5.06 | isosinensetin | 373.1276 | 343, 358 | 1.08 | 4.13 × 10‒28 |
| 5.33 | sinensetin | 373.1269 | 343, 358 | 1.09 | 4.13 × 10‒25 |
| 5.63 | nobiletin | 403.1379 | 373, 355 | 0.94 | 1.04 × 10‒25 |
| 5.66 | tetramethoxyflavone | 343.1163 | 313, 282, 299, 281 | 1.08 | 9.13 × 10‒23 |
| 5.83 | heptamethoxyflavone | 433.1489 | 403, 385, 418 | 0.97 | 4.90 × 10‒34 |
| 5.88 | monohydroxy tetramethoxyflavone | 359.1123 | 184, 326 | 1.03 | 6.07 × 10‒16 |
| 5.89 | phytosphingosine | 318.3003 | 184, 282 | 1.12 | 5.03 × 10‒16 |
| 5.93 | natsudaidain | 419.1335 | 184, 389, 371 | 1.17 | 5.29 × 10‒38 |
| 5.96 | tangeretin | 373.1275 | 343, 358 | 0.92 | 1.17 × 10‒29 |
| 6.17 | monohydroxy pentamethoxyflavone-1 | 389.1235 | 359 | 1.00 | 7.52 × 10‒9 |
| 6.21 | heptamethoxyflavone | 403.1398 | 184, 373, 355 | 1.13 | 1.96 × 10‒22 |
| 6.34 | monohydroxy pentamethoxyflavone-2 | 389.1237 | 359, 374, 356, 341 | 1.09 | 3.43 × 10‒29 |
| 6.38 | 5-hydroxy-3,6,7,8,3',4'-hexamethoxyflavone | 419.1335 | 184, 389, 371 | 1.08 | 6.06 × 10‒26 |
| 6.90 | LPE(C18:2) | 478.2943 | 155, 337, 98, 460 | 1.46 | 2.14 × 10‒10 |
| 6.92 | LPC(C18:2) | 520.3410 | 337, 478, 104 | 1.16 | 1.39 × 10‒4 |
| 7.24 | LPE(C16:0) | 454.2945 | 184, 104, 125 | 1.58 | 1.12 × 10‒18 |
| 7.27 | LPC(C16:0) | 496.3406 | 184, 104, 125 | 1.49 | 2.20 × 10‒12 |
| 7.39 | LPE(C18:1) | 480.3086 | 155, 337, 98, 460 | 1.40 | 4.30 × 10‒12 |
| 7.41 | LPC(C18:1) | 522.3572 | 339, 341, 313, 104, 504 | 1.28 | 2.99 × 10‒9 |
| 8.63 | pheophorbide A | 593.2772 | 184 | 0.89 | 2.61 × 10‒7 |
| 9.98 | cholesteryl acetate | 429.3728 | 165, 205, 164, 219 | 1.23 | 6.61 × 10‒5 |

RT, retention time; VIP, variable importance in the projection; LPE, lysophosphatidylethanolamine; LPC, lysophosphatidylcholine; *p*-Values were analyzed by Duncan’s test.

**Table S4.** Identification of major metabolite by HPLC.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | RT | Compounds | | λmax (nm) | VIP | *p*-value |
| Organic acid | 3.1 | oxalic acid | |  | 1.39 | 7.11 × 10‒7 |
| 3.5 | tartaric acid | | | 1.12 | 1.68 × 10‒21 |
| 4.4 | malic acid |  | | 1.59 | 1.73 × 10‒37 |
| 4.8 | ascorbic acid | | | 1.04 | 2.64 × 10‒29 |
| 5.4 | lactic acid | |  | 1.01 | 6.13 × 10‒5 |
| 5.7 | acetic acid | |  | 1.45 | 1.68 × 10‒13 |
| 7.7 | maleic acid | |  | 1.01 | 3.94 × 10‒25 |
| 7.8 | citric acid | |  | 1.30 | 5.90 × 10‒39 |
| 8.8 | succinic acid | | | 1.35 | 1.22 × 10‒19 |
| Carotenoids | 9.1 | violaxanthin | | 421, 448 | 0.77 | 2.05 × 10‒7 |
| 11.2 | neoxanthin | | 436, 464 | 0.70 | 2.35 × 10‒7 |
| 13.4 | lutein | | 400, 422 | 0.92 | 8.33 × 10‒8 |
| 14.1 | zeaxanthin | | 422 | 0.84 | 7.98 × 10‒5 |
| 25.3 | β-cryptoxanthin | | 451, 477 | 1.09 | 4.83 × 10‒8 |
| 35.6 | α-carotene | | 446, 474 | 0.87 | 4.38 × 10‒5 |
| 38.1 | β-carotene | | 436, 464 | 1.00 | 3.98 × 10‒14 |
| 39.3 | 9-cis-β-carotene | | 439, 469 | 0.84 | 1.79 × 10‒4 |

RT, retention time; VIP, variable importance in the projection.

*p*-Values were analyzed by Duncan’s test.