

Supplementary Information (SI) for RSC Advances.  
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## Supporting Information

### Application of Rose–Mulberry Fruits Composite Fermented to Enhance Antioxidant Capacity, Flavor, and Sensory Characteristics of Mulberry Wine

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Table 1S The relative contents of volatile compounds in different types of wine

| No.    | RT<br>(min) | Compound                                                                                          | CAS          | Odor<br>description                   | Relative contents/% |           |                       |
|--------|-------------|---------------------------------------------------------------------------------------------------|--------------|---------------------------------------|---------------------|-----------|-----------------------|
|        |             |                                                                                                   |              |                                       | Mulberry wine       | Rose wine | Rose-mulberry<br>wine |
| Esters |             |                                                                                                   |              |                                       |                     |           |                       |
| A1     | 4.5049      | Isoamyl acetate                                                                                   | 019329-89-6  | banana, apple                         | 0.000               | 0.000     | 0.325                 |
| A2     | 7.3150      | Ethyl hexanoate                                                                                   | 000123-66-0  | apple peel, fruit                     | 6.437               | 7.814     | 7.076                 |
| A3     | 8.8885      | Ethyl dl-2-hydroxycaproate                                                                        | 006946-90-3  | —                                     | 0.000               | 0.175     | 0.000                 |
| A4     | 9.2919      | Acetic acid, trifluoro-, 3,7-dimethyloctyl ester                                                  | 028745-07-5  | —                                     | 0.000               | 0.246     | 0.000                 |
| A5     | 9.2669      | Isoamyl lactate                                                                                   | 19329-89-6   | —                                     | 0.257               | 0.000     | 0.000                 |
| A6     | 9.8364      | Arsenous acid tris(trimethylsilyl) ester                                                          | 055429-29-3  | —                                     | 0.000               | 0.114     | 0.000                 |
| A7     | 10.0301     | Ethyl heptanoate                                                                                  | 000106-30-9  | fruit                                 | 0.483               | 1.197     | 1.109                 |
| A8     | 12.0523     | Ethyl benzoate                                                                                    | 000093-89-0  | camomile,<br>flower, celery,<br>fruit | 1.506               | 0.514     | 0.385                 |
| A9     | 12.3084     | Diethyl butanedioate                                                                              | 000123-25-1  | wine, fruit                           | 24.091              | 7.884     | 8.966                 |
| A10    | 12.8376     | Ethyl octanoate                                                                                   | 000106-32-1  | fruit, fat                            | 21.644              | 34.605    | 38.752                |
| A11    | 14.4235     | Ethyl phenylacetate                                                                               | 000101-97-3  | fruit, sweet                          | 0.811               | 2.756     | 1.062                 |
| A12    | 14.8237     | Succinic acid, 2-methylbenzyl pentadecyl ester                                                    | 1000309-20-6 | —                                     | 0.268               | 0.000     | 0.000                 |
| A13    | 15.9047     | Nonanoic acid ethyl ester                                                                         | 000123-29-5  | rose, fruity                          | 0.392               | 0.103     | 0.224                 |
| A14    | 16.7380     | 3,7-Dimethyl-oct-6-enoic acid, ethyl ester                                                        | 1000192-30-7 | —                                     | 0.000               | 0.527     | 0.000                 |
| A15    | 17.9256     | Ethyl 9-decenoate                                                                                 | 067233-91-4  | —                                     | 0.000               | 0.358     | 0.000                 |
| A16    | 16.7419     | (S)-(-)-Citronellilic acid, methyl ester                                                          | 1000333-55-1 | —                                     | 0.000               | 0.000     | 0.521                 |
| A17    | 17.1077     | n-Caprylic acid isobutyl ester                                                                    | 005461-06-3  | —                                     | 0.000               | 0.000     | 0.033                 |
| A18    | 17.1904     | Ethyl 3-phenylpropionate                                                                          | 002021-28-5  | flower                                | 0.536               | 0.000     | 0.000                 |
| A19    | 17.6959     | Butyl benzoate                                                                                    | 000136-60-7  | balsamic                              | 0.170               | 0.000     | 0.000                 |
| A20    | 17.9190     | Sulfurous acid, 2-methyl-4-methoxybutyl hexyl ester                                               | 1000309-20-6 | —                                     | 0.215               | 0.000     | 0.000                 |
| A21    | 17.9283     | Ethyl 9-decenoate                                                                                 | 067233-91-4  | milky                                 | 0.000               | 0.000     | 0.486                 |
| A22    | 18.0904     | Ethyl decanoate                                                                                   | 000110-38-3  | grape                                 | 8.334               | 12.067    | 13.901                |
| A23    | 18.6981     | Butanedioic acid, ethyl 3-methylbutyl ester                                                       | 028024-16-0  | —                                     | 0.000               | 0.183     | 0.174                 |
| A24    | 18.9744     | Octanoic acid, 3-methylbutyl ester                                                                | 002035-99-6  | —                                     | 0.295               | 0.092     | 0.111                 |
| A25    | 21.1757     | Ethyl dodecanoate                                                                                 | 000106-33-2  | leaf                                  | 1.127               | 1.501     | 0.852                 |
| A26    | 23.6563     | Ethyl undecanoate                                                                                 | 000627-90-7  | cognac, coconut                       | 0.000               | 0.000     | 0.137                 |
| A27    | 24.6174     | 1H-Indole-2-carboxylic acid, 6-(4-ethoxyphenyl)-3-methyl-4-oxo-4,5,6,7-tetrahydro-,isobutyl ester | 1000316-17-3 | —                                     | 0.000               | 0.000     | 0.095                 |
| A28    | 23.5936     | Ethyl tetradecanoate                                                                              | 000124-06-1  | ether                                 | 0.375               | 0.538     | 0.000                 |
| A29    | 24.6147     | 3-Oxobutan-2-yl trimethylsilyl phthalate                                                          | 1000373-49-5 | —                                     | 0.107               | 0.000     | 0.000                 |

|                    |         |                                                                                    |              |                              |        |        |        |
|--------------------|---------|------------------------------------------------------------------------------------|--------------|------------------------------|--------|--------|--------|
| A30                | 25.7399 | Ethyl hexadecanoate                                                                | 000628-97-7  | wax                          | 0.410  | 0.542  | 0.137  |
| Alcohols           |         |                                                                                    |              |                              |        |        |        |
| B1                 | 8.0911  | 2-Ethyl-1-hexanol                                                                  | 000104-76-7  | rose, green                  | 0.822  | 0.000  | 0.000  |
| B2                 | 8.9034  | 2,7-Dimethyl-4,5-octanediol                                                        | 1000153-20-8 | —                            | 0.474  | 0.000  | 0.000  |
| B3                 | 8.9025  | 2,3,4-Trimethyl-pentan-3-ol                                                        | 003054-92-0  | —                            | 0.000  | 0.000  | 0.052  |
| B4                 | 10.4619 | 2-Phenylethyl alcohol                                                              | 000060-12-8  | honey, spice,<br>rose, lilac | 21.606 | 12.328 | 11.800 |
| B5                 | 12.6326 | Terpineol                                                                          | 1000411-59-6 | —                            | 0.000  | 0.840  | 0.475  |
| B6                 | 13.8158 | Citronellol                                                                        | 000106-22-9  | rose                         | 0.000  | 2.295  | 2.265  |
| B7                 | 14.7918 | L-alpha-terpineol                                                                  | 010482-56-1  | citrus, woody,<br>lemon      | 0.000  | 0.912  | 0.748  |
| B8                 | 19.5543 | 3,4-Dihydroxybenzyl<br>alcohol, tris(trimethylsilyl)-                              | 068595-79-9  | —                            | 0.046  | 0.000  | 0.000  |
| B9                 | 22.9252 | 4-Hydroxybenzyl alcohol, 2TBDS<br>derivative                                       | 1000364-43-9 | —                            | 0.000  | 0.000  | 0.044  |
| Acids              |         |                                                                                    |              |                              |        |        |        |
| C1                 | 14.6819 | Phosphonoacetic Acid, 3TMS derivative                                              | 053044-27-2  | —                            | 0.364  | 0.000  | 0.000  |
| C2                 | 15.0595 | 5-Methylsalicylic acid, 2TMS derivative                                            | 1000153-59-4 | —                            | 0.243  | 0.000  | 0.000  |
| C3                 | 22.1028 | 2,5-Dihydroxybenzoic acid, 3TMS<br>derivative                                      | 003618-20-0  | —                            | 1.061  | 0.220  | 0.000  |
| C4                 | 22.1069 | 3,4-Dihydroxymandelic acid, 4TMS<br>derivative                                     | 037148-65-5  | —                            | 0.000  | 0.000  | 0.405  |
| Long-chain alkanes |         |                                                                                    |              |                              |        |        |        |
| D1                 | 4.5242  | 1-[(2-<br>Hydroxyphenyl)thioxomethyl]pyrrolidine                                   | 1000100-20-2 | —                            | 0.326  | 0.000  | 0.000  |
| D2                 | 6.6095  | Cycloheptane                                                                       | 000291-64-5  | —                            | 0.000  | 0.252  | 0.291  |
| D3                 | 6.9357  | Ethoxy(trimethyl)silane                                                            | 001825-62-3  | —                            | 0.687  | 0.000  | 0.000  |
| D4                 | 7.0255  | Ethoxydi(tert-butyl)silane                                                         | 144890-04-0  | —                            | 0.000  | 0.000  | 0.809  |
| D5                 | 11.5882 | Decamethyl cyclopentasiloxane                                                      | 000541-02-6  | —                            | 1.471  | 0.099  | 0.078  |
| D6                 | 13.3205 | 7,7-Dimethyl-2-<br>methylenebicyclo[2.2.1]heptane                                  | 000471-84-1  | —                            | 0.000  | 0.129  | 0.000  |
| D7                 | 14.6892 | Silane, methylvinyl(2,4-dimethylpent-3-<br>yloxy)(methylvinyl)dodecyloxysilyloxy)- | 1000417-01-0 | —                            | 0.000  | 0.000  | 0.093  |
| D8                 | 16.6904 | Dodecamethylcyclohexasiloxane                                                      | 000540-97-6  | —                            | 0.721  | 0.090  | 0.102  |
| D9                 | 18.2784 | 16-Methyl-heptadecane-1,2-diol,<br>trimethylsilyl ether                            | 1000336-70-6 | —                            | 0.158  | 0.000  | 0.000  |
| D10                | 19.8213 | Tetradecamethylcycloheptasiloxane                                                  | 000107-50-6  | —                            | 0.298  | 0.159  | 0.132  |
| D11                | 20.5934 | 1,1,1,5,7,7,7-Heptamethyl-3,3-<br>bis(trimethylsiloxy)tetrasiloxane                | 038147-00-1  | —                            | 0.000  | 0.021  | 0.000  |
| D12                | 21.3375 | 1-(1-pyrrolidinyl)cyclohexanecarbonitrile                                          | 022912-25-0  | —                            | 0.000  | 0.122  | 0.000  |
| D13                | 22.0581 | Tributylchlorosilane                                                               | 000995-45-9  | —                            | 0.000  | 0.036  | 0.000  |
| D14                | 22.4879 | Tetradecane                                                                        | 000629-59-4  | alkane                       | 0.000  | 0.032  | 0.000  |
| D15                | 22.5569 | 2,6,10,14-Tetramethylpentadecane                                                   | 001921-70-6  | —                            | 0.072  | 0.085  | 0.000  |
| D16                | 22.9201 | 2,2,4,4,5,5,7,7-Octamethyl-3,6-dioxa-<br>2,4,5,7-tetrasilaoctane                   | 004342-25-0  | —                            | 0.066  | 0.000  | 0.000  |
| D17                | 23.7388 | 2,6,10,14-Tetramethylhexadecane                                                    | 000638-36-8  | —                            | 0.683  | 0.000  | 0.235  |
| D18                | 23.737  | Eicosane                                                                           | 000112-95-8  | alkane                       | 0.000  | 0.646  | 0.000  |
| D19                | 23.9289 | Octadecamethylcyclononasiloxane                                                    | 000556-71-8  | —                            | 1.273  | 0.275  | 0.630  |
| D20                | 24.6169 | 2-Methyl-eicosane                                                                  | 001560-84-5  | —                            | 0.000  | 0.037  | 0.000  |
| D21                | 25.5394 | Eicosamethylcyclodecasiloxane                                                      | 018772-36-6  | —                            | 0.426  | 0.057  | 0.105  |
| Olefins            |         |                                                                                    |              |                              |        |        |        |
| E1                 | 8.1242  | D-Limonene                                                                         | 005989-27-5  | citrus, mint                 | 0.000  | 0.118  | 0.149  |
| E2                 | 14.2327 | 1-Methyl-3-(1-<br>methylethenyl)cyclohexene(+.-.)                                  | 000499-03-6  | —                            | 0.000  | 0.969  | 0.472  |
| E3                 | 14.9106 | (+)-2-Carene                                                                       | 1000149-94-6 | woody                        | 0.000  | 2.763  | 0.000  |
| E4                 | 15.0433 | 1-Methyl-4-(1-<br>methylethylidene)cyclohexene                                     | 000586-62-9  | pine, plastic                | 0.000  | 0.301  | 1.422  |
| E5                 | 17.2299 | 2,6-Dimethylocta-2,6-diene                                                         | 002792-39-4  | —                            | 0.000  | 0.255  | 0.664  |
| E6                 | 20.0294 | 1,1,4,7-Tetramethyl-1a,2,3,4,6,7,7a,7b-<br>octahydro-1H-cyclopropa[e]azulene       | 405112-35-8  | —                            | 0.000  | 0.047  | 0.000  |
| E7                 | 20.2814 | Calamenene                                                                         | 000483-77-2  | herb, spice                  | 0.000  | 0.029  | 0.000  |
| E8                 | 20.5048 | Cis-(-)-2,4a,5,6,9a-Hexahydro-3,5,5,9-<br>tetramethyl(1H)benzocycloheptene         | 1000104-20-1 | —                            | 0.000  | 0.057  | 0.000  |
| Aldehydes          |         |                                                                                    |              |                              |        |        |        |

|                |         |                                                                                                              |              |                         |         |         |         |
|----------------|---------|--------------------------------------------------------------------------------------------------------------|--------------|-------------------------|---------|---------|---------|
| F1             | 4.5156  | Furfural                                                                                                     | 00098-01-1   | bread, almond,<br>sweet | 0.000   | 0.250   | 0.000   |
| F2             | 6.6457  | Benzaldehyde                                                                                                 | 000100-52-7  | almond, burnt<br>sugar  | 0.313   | 0.000   | 0.000   |
| F3             | 10.1616 | Nonanal                                                                                                      | 000124-19-6  | fat, citrus, green      | 0.324   | 0.000   | 0.000   |
| F4             | 19.1832 | 4,5,5-Trimethylbicyclo[2.1.1]hexane-6-carbaldehyde                                                           | 006040-45-5  | —                       | 0.000   | 0.000   | 0.073   |
| F5             | 19.3945 | Isoneral                                                                                                     | 1000414-18-0 | —                       | 0.000   | 0.085   | 0.000   |
| F6             | 19.3971 | 3,7-Dimethyl-3,6-octadienal                                                                                  | 55722-59-3   | —                       | 0.000   | 0.000   | 0.057   |
| <b>Ketones</b> |         |                                                                                                              |              |                         |         |         |         |
| G1             | 15.0546 | 2,6-Dihydroxyacetophenone, 2TMS derivative                                                                   | 1000153-59-4 | —                       | 0.000   | 0.000   | 0.268   |
| G2             | 15.6793 | 2-{4-nitrophenyl}-6,7,8,9-tetrahydrothieno[3',2':4,5]pyrimido[1,2-a]azepin-11(5H)-one                        | 312529-71-8  | —                       | 0.123   | 0.000   | 0.000   |
| G3             | 15.8308 | 1-Methyl-3,6-diazahomoadamantan-9-one                                                                        | 123387-98-4  | —                       | 0.000   | 0.086   | 0.000   |
| G4             | 15.839  | 2-Undecanone                                                                                                 | 000112-12-9  | orange, fresh,<br>green | 0.000   | 0.000   | 0.040   |
| G5             | 19.1793 | 3,4,5-Trimethyl-2-cyclopenten-1-one                                                                          | 055683-21-1  | —                       | 0.000   | 0.078   | 0.000   |
| G6             | 21.8633 | 1-Acetyl-6-methyl-3-piperidinone                                                                             | 054751-97-2  | —                       | 0.000   | 0.082   | 0.000   |
| <b>Phenols</b> |         |                                                                                                              |              |                         |         |         |         |
| H1             | 18.2821 | Methyl eugenol                                                                                               | 000093-15-2  | clove, spice            | 0.000   | 1.037   | 0.421   |
| H2             | 20.0774 | Butylated Hydroxytoluene                                                                                     | 000128-37-0  | —                       | 0.000   | 0.039   | 0.000   |
| <b>Ethers</b>  |         |                                                                                                              |              |                         |         |         |         |
| I1             | 7.1203  | 2-Ethoxyethanol, TBDMS derivative                                                                            | 1000352-13-6 | —                       | 0.000   | 0.000   | 0.235   |
| I2             | 15.6788 | Geranyl ethyl ether 1                                                                                        | 1000285-27-5 | —                       | 0.000   | 0.593   | 0.635   |
| I3             | 19.5588 | 3-Amino-2-phenazinol ditms                                                                                   | 1000332-15-5 | —                       | 0.000   | 0.000   | 0.028   |
| <b>Others</b>  |         |                                                                                                              |              |                         |         |         |         |
| J1             | 4.5741  | 5-Methyl-2-phenyl-1H-indole                                                                                  | 013228-36-9  | —                       | 0.390   | 0.000   | 0.000   |
| J2             | 9.8638  | 2-Ethylacridine                                                                                              | 055751-83-2  | —                       | 0.172   | 0.000   | 0.000   |
| J3             | 10.3414 | (2S,4R)-4-Methyl-2-(2-methylprop-1-en-1-yl)tetrahydro-2H-pyran                                               | 003033-23-6  | sweet, rose             | 0.000   | 2.505   | 2.115   |
| J4             | 11.5749 | 4-Methyl-2-(2-methylprop-1-enyl)-3,6-dihydro-2H-pyran                                                        | 001786-08-9  | oil, flower             | 0.000   | 0.736   | 0.739   |
| J5             | 17.2857 | 3,4-Dihydro-1H-2-benzopyran-3-imine                                                                          | 038866-67-0  | —                       | 0.198   | 0.000   | 0.000   |
| J6             | 18.3452 | 2-(1-Adamantyl)-N-(2-adamantyl)acetamide                                                                     | 329204-06-0  | —                       | 0.227   | 0.000   | 0.000   |
| J7             | 20.0436 | 2H-3,9a-Methano-1-benzoxepin, octahydro-2,2,5a,9-tetramethyl-, [3R-(3.alpha.,5a.alpha.,9.alpha.,9a.alpha.)]- | 005956-09-2  | —                       | 0.000   | 0.000   | 0.075   |
| J8             | 21.4485 | p-Anisaldehyde 4-[1-adamantyl]-3-thiosemicarbazone                                                           | 058567-32-1  | —                       | 0.000   | 0.074   | 0.000   |
| J9             | 22.3601 | 1,6-Dimethyl-4-propan-2-ynaphthalene                                                                         | 000483-78-3  | —                       | 0.000   | 0.049   | 0.000   |
| Total          |         |                                                                                                              |              |                         | 100.002 | 100.004 | 100.003 |

Note: Odor descriptions are sourced from the flavornet database (<http://www.flavornet.org>), "—" means that the odor description of the substance was not found. RT means retention time.