Supplementary Material

# Supplementary Tables

**Supplement Table 1.** Fatty acid changes of SO, PO, OO and LO at different heating temperatures.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Fatty acid | | Concentration(%) | | | | | |
| unheated | 100oC | 120oC | 150oC | 180oC | 200oC |
| SO | C16:0 | 4.73±0.05a | 4.74±0.01a | 5.10±0.06b | 5.42±0.11c | 5.80±0.16d | 6.06±0.08e |
| C18:2 | 69.28±0.01c | 69.27±0.64c | 68.39±0.16bc | 67.35±0.52b | 66.23±0.57a | 65.50±0.27a |
| C18:3 | 7.97±0.06c | 7.97±0.20c | 7.87±0.25bc | 7.84±0.09bc | 7.53±0.01ab | 7.22±0.04a |
| C18:1 | 14.53±0.01a | 14.50±0.35a | 14.85±0.08ab | 15.27±0.13b | 15.97±0.32c | 16.43±0.21c |
| C18:0 | 3.49±0.01a | 3.53±0.10ab | 3.80±0.11b | 4.12±0.20c | 4.48±0.09d | 4.79±0.07e |
| SFA | 8.22±0.06a | 8.27±0.08a | 8.90±0.16b | 9.54±0.31c | 10.28±0.25d | 10.86±0.02e |
| MUFA | 14.53±0.01a | 14.50±0.35a | 14.85±0.08ab | 15.27±0.13b | 15.97±0.32c | 16.43±0.21c |
| PUFA | 77.26±0.05e | 77.23±0.44e | 76.26±0.09d | 75.19±0.44c | 73.76±0.57b | 72.72±0.23a |
| PO | C14:0 | 0.79±0.01a | 0.78±0.01a | 0.83±0.02ab | 0.86±0.01b | 0.92±0.04c | 1.02±0.01d |
| C16:0 | 35.25±0.07a | 35.24±0.11a | 35.59±0.04b | 36.15±0.18c | 36.72±0.18d | 36.18±0.03e |
| C18:2 | 17.53±0.01e | 17.51±0.08e | 16.50±0.21d | 15.20±0.07c | 13.88±0.04b | 12.98±0.31a |
| C18:1 | 42.29±0.05a | 42.29±0.07a | 42.76±0.25b | 43.33±0.08c | 43.88±0.11d | 44.06±0.34d |
| C18:0 | 4.16±0.01a | 4.19±0.11ab | 4.34±0.05bc | 4.47±0.03cd | 4.61±0.17d | 4.77±0.04e |
| SFA | 30.19±0.06a | 30.21±0.01a | 30.75±0.06b | 31.47±0.16c | 32.24±0.06d | 32.96±0.03e |
| MUFA | 47.29±0.05a | 47.29±0.07a | 47.76±0.25b | 48.33±0.08c | 48.88±0.11d | 49.06±0.34d |
| PUFA | 22.53±0.01e | 22.51±0.08e | 21.50±0.21d | 20.20±0.07c | 18.88±0.04b | 17.98±0.31a |
| OO | C16:1 | 0.72±0.04a | 0.72±0.03a | 0.80±0.02ab | 0.85±0.02bc | 0.89±0.02c | 0.90±0.05c |
| C16:0 | 6.40±0.01a | 6.40±0.01a | 7.17±0.19b | 7.83±0.18c | 7.89±0.08c | 8.35±0.29d |
| C18:2 | 11.71±0.13c | 11.70±0.18c | 11.20±0.38c | 10.41±1.29b | 9.89±0.24b | 8.88±0.19a |
| C18:1 | 78.44±0.23bc | 78.45±0.12bc | 78.03±0.12a | 78.06±0.10ab | 78.35±0.16ab | 78.78±0.13c |
| C18:0 | 2.74±0.07a | 2.74±0.07a | 2.81±0.06a | 2.87±0.06ab | 3.00±0.01bc | 3.11±0.02c |
| SFA | 9.14±0.06a | 9.14±0.09a | 9.98±0.24b | 10.69±0.23c | 10.88±0.10c | 11.46±0.28d |
| MUFA | 79.16±0.18b | 79.17±0.09b | 78.82±0.14a | 78.91±0.13ab | 79.22±0.14b | 79.67±0.08c |
| PUFA | 11.71±0.13c | 11.70±0.18c | 11.20±0.38c | 10.41±0.36b | 9.89±0.24b | 8.88±0.19a |
| LD | C14:0 | 0.75±0.08a | 0.74±0.16a | 0.73±0.08a | 1.01±0.05ab | 1.21±0.11bc | 1.51±0.25c |
| C16:1 | 1.65±0.03 | 1.63±0.02 | 1.62±0.01 | 1.64±0.01 | 1.62±0.03 | 1.60±0.02 |
| C16:0 | 11.96±0.30a | 12.07±0.22a | 12.80±0.09b | 13.38±0.17b | 14.36±0.12c | 15.48±0.39d |
| C18:2 | 25.56±0.39e | 25.57±0.36e | 24.06±0.96d | 21.86±0.59c | 18.83±0.46b | 16.39±0.07a |
| C18:1 | 42.65±1.03 | 43.16±0.36 | 43.64±0.50 | 42.80±0.49 | 43.28±0.41 | 43.31±0.08 |
| C18:0 | 16.99±0.97a | 16.83±0.80a | 17.15±1.62a | 19.31±0.01b | 20.71±0.07bc | 21.71±0.31c |
| SFA | 29.69±0.76a | 29.64±0.74a | 30.68±1.44a | 33.69±0.11b | 36.27±0.08c | 38.70±0.17d |
| MUFA | 44.30±1.00 | 44.79±0.38 | 45.26±0.48 | 44.44±0.48 | 44.90±0.38 | 44.91±0.10 |
| PUFA | 25.56±0.39e | 25.57±0.36e | 24.06±0.96d | 21.86±0.59c | 18.83±0.46b | 16.39±0.07a |

Data are mean value of triplicate with SD. Different lowercase denotes significant difference (P < 0.05) in the same row.

**Supplement Table 2.** Pearson correlation coefficients between the levels of oxidation products and fatty acids during heating in SO.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | C16:0 | C18:2 | C18:3 | C18:1 | C18:0 | SFA | MUFA | PUFA |
| SO | 2-Butenal | 0.811 | -0.794 | -0.882\* | 0.925\* | 0.855 | 0.834 | 0.925\* | -0.807 |
| Pentanal | 0.748 | -0.740 | -0.845 | 0.890\* | 0.801 | 0.776 | 0.890\* | -0.755 |
| 2-Pentenal | 0.826 | -0.808 | -0.893\* | 0.934\* | 0.867 | 0.848 | 0.934\* | -0.821 |
| Hexanal | 0.751 | -0.741 | -0.846 | 0.891\* | 0.803 | 0.778 | 0.891\* | -0.756 |
| 2-Hexenal | 0.834 | -0.817 | -0.897\* | 0.940\* | 0.876 | 0.856 | 0.940\* | -0.829 |
| Heptanal | 0.746 | -0.725 | -0.827 | 0.881\* | 0.796 | 0.772 | 0.881\* | -0.740 |
| 2-Heptenal | 0.820 | -0.794 | -0.875 | 0.924\* | 0.860 | 0.841 | 0.924\* | -0.806 |
| 2,4-Heptadienal, (E,Z) | 0.841 | -0.811 | -0.880\* | 0.931\* | 0.877 | 0.860 | 0.931\* | -0.821 |
| Octanal | 0.751 | -0.724 | -0.824 | 0.878 | 0.797 | 0.775 | 0.878 | -0.738 |
| 2,4-Heptadienal, (E,E) | 0.797 | -0.765 | -0.846 | 0.904\* | 0.838 | 0.819 | 0.904\* | -0.777 |
| 2-Octenal | 0.781 | -0.756 | -0.849 | 0.900\* | 0.825 | 0.804 | 0.900\* | -0.769 |
| Nonanal | 0.736 | -0.709 | -0.815 | 0.868 | 0.783 | 0.760 | 0.868 | -0.724 |
| 2-Decenal | 0.748 | -0.721 | -0.822 | 0.876 | 0.794 | 0.772 | 0.876 | -0.735 |
| 2,4-Decadienal, (E,Z) | 0.819 | -0.791 | -0.866 | 0.920\* | 0.859 | 0.840 | 0.920\* | -0.802 |
| 2,4-Decadienal, (E,E) | 0.800 | -0.771 | -0.852 | 0.908\* | 0.842 | 0.822 | 0.908\* | -0.783 |
| 2-Undecenal | 0.802 | -0.783 | -0.875 | 0.918\* | 0.846 | 0.825 | 0.918\* | -0.797 |
| GO | 0.795 | -0.777 | -0.870 | 0.914\* | 0.839 | 0.818 | 0.914\* | -0.790 |
| MGO | 0.715 | -0.689 | -0.799 | 0.854 | 0.764 | 0.740 | 0.854 | -0.704 |
| 2,3-BD | 0.867 | -0.860 | -0.934\* | 0.964\*\* | 0.906\* | 0.888\* | 0.964\*\* | -0.872 |
| MDA | 0.929\* | -0.958\* | -0.989\*\* | 0.972\*\* | 0.952\* | 0.941\* | 0.972\*\* | -0.964\*\* |
| 4-HHE | 0.970\*\* | -0.953\* | -0.963\*\* | 0.900\* | 0.958\* | 0.965\*\* | 0.900\* | -0.948\* |
| 4-HNE | 0.915\* | -0.955\* | -0.914\* | 0.946\* | 0.935\* | 0.926\* | 0.946\* | -0.960\*\* |

\* Significance at P < 0.05. \*\* Significance at P < 0.01.

**Supplement Table 3.** Pearson correlation coefficients between the levels of oxidation products and fatty acids during heating in PO.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | C14:0 | C16:0 | C18:2 | C18:1 | C18:0 | SFA | MUFA | PUFA |
| PO | 2-Butenal | 0.949\* | 0.849 | -0.844 | 0.595 | 0.859 | 0.865 | 0.595 | -0.844 |
| Pentanal | 0.973\*\* | 0.938\* | -0.928\* | 0.765 | 0.930\* | 0.944\* | 0.765 | -0.928\* |
| 2-Pentenal | 0.922\* | 0.946\* | -0.928\* | 0.847 | 0.918\* | 0.941\* | 0.847 | -.928\* |
| Hexanal | 0.789 | 0.803 | -0.766 | 0.678 | 0.751 | 0.793 | 0.678 | -0.766 |
| 2-Hexenal | 0.955\* | 0.942\* | -0.929\* | 0.798 | 0.927\* | 0.944\* | 0.798 | -0.929\* |
| Heptanal | 0.906\* | 0.813 | -0.797 | 0.558 | 0.805 | 0.824 | 0.558 | -0.797 |
| 2-Heptenal | 0.888\* | 0.914\* | -0.920\* | 0.821 | 0.881\* | 0.908\* | 0.821 | -.892\* |
| 2,4-Heptadienal, (E,Z) | 0.846 | 0.945\* | -0.926\* | 0.948\* | 0.905\* | 0.930\* | 0.948\* | -0.926\* |
| Octanal | 0.889\* | 0.756 | -0.751 | 0.461 | 0.769 | 0.775 | 0.461 | -0.750 |
| 2,4-Heptadienal, (E,E) | 0.981\*\* | 0.924\* | -0.919\* | 0.717 | 0.926\* | 0.934\* | 0.717 | -0.919\* |
| 2-Octenal | 0.969\*\* | 0.901\* | -0.893\* | 0.685 | 0.901\* | 0.912\* | 0.685 | -0.893\* |
| Nonanal | 0.956\* | 0.927\* | -0.913\* | 0.759 | 0.913\* | 0.931\* | 0.759 | -0.913\* |
| 2-Decenal | 0.867 | 0.714 | -0.717 | 0.405 | 0.742 | 0.738 | 0.405 | -0.717 |
| 2,4-Decadienal, (E,Z) | 0.971\*\* | 0.925\* | -0.924\* | 0.731 | 0.932\* | 0.935\* | 0.731 | -0.924\* |
| 2,4-Decadienal, (E,E) | 0.974\*\* | 0.920\* | -0.919\* | 0.717 | 0.927\* | 0.931\* | 0.717 | -0.919\* |
| 2-Undecenal | 0.874 | 0.723 | -0.725 | 0.417 | 0.750 | 0.747 | 0.417 | -0.725 |
| GO | 0.986\*\* | 0.928\* | -0.940\* | 0.748 | 0.954\* | 0.944\* | 0.748 | -0.940\* |
| MGO | 0.985\*\* | 0.923\* | -0.920\* | 0.726 | 0.930\* | 0.935\* | 0.726 | -0.920\* |
| 2,3-BD | 0.949\* | 0.950\* | -0.967\*\* | 0.883\* | 0.976\*\* | 0.961\*\* | 0.883\* | -0.967\*\* |
| MDA | 0.992\*\* | 0.965\*\* | -0.963\*\* | 0.814 | 0.968\*\* | 0.973\*\* | 0.814 | -0.963\*\* |
| 4-HNE | 0.930\* | 0.992\*\* | -0.993\*\* | 0.962\* | 0.986\*\* | 0.988\*\* | 0.962\* | -0.993\*\* |

\* Significance at P < 0.05. \*\* Significance at P < 0.01.

**Supplement Table 4.** Pearson correlation coefficients between the levels of oxidation products and fatty acids during heating in OO.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | C16:1 | C16:0 | C18:2 | C18:1 | C18:0 | SFA | MUFA | PUFA |
| OO | 2-Butenal | 0.869 | 0.860 | -0.976\*\* | -0.950\* | 0.993\*\* | 0.890\* | -0.953\* | -0.976\*\* |
| Pentanal | 0.789 | 0.823 | -0.969\*\* | -0.901\* | 0.976\*\* | 0.855 | -0.906\* | -0.969\*\* |
| 2-Pentenal | 0.947\* | 0.983\*\* | -0.968\*\* | -0.971\*\* | 0.933\* | 0.990\*\* | -0.970\*\* | -0.968\*\* |
| Hexanal | 0.866 | 0.882\* | -0.993\*\* | -0.967\*\* | 0.969\*\* | 0.907\* | -0.972\*\* | -0.993\*\* |
| 2-Hexenal | -0.966\*\* | -0.969\*\* | 0.966\*\* | 0.975\*\* | -0.968\*\* | -0.982\*\* | 0.973\*\* | 0.966\*\* |
| Heptanal | 0.856 | 0.869 | -0.991\*\* | -0.959\*\* | 0.979\*\* | 0.896\* | -0.963\*\* | -0.991\*\* |
| 2-Heptenal | 0.978\*\* | 0.977\*\* | -0.970\*\* | -0.992\*\* | 0.956\* | 0.988\*\* | -0.990\*\* | -0.970\*\* |
| 2,4-Heptadienal, (E,Z) | 0.938\* | 0.944\* | -0.907\* | -0.963\*\* | 0.827 | 0.942\* | -0.962\*\* | -0.907\* |
| Octanal | 0.735 | 0.772 | -0.947\* | -0.865 | 0.959\*\* | 0.808 | -0.871 | -0.947\* |
| 2,4-Heptadienal, (E,E) | 0.811 | 0.858 | -0.983\*\* | -0.931\* | 0.947\* | 0.883\* | -0.937\* | -0.983\*\* |
| 2-Octenal | 0.885\* | 0.901\* | -0.996\*\* | -0.977\*\* | 0.966\*\* | 0.923\* | -0.981\*\* | -0.996\*\* |
| Nonanal | 0.893\* | 0.926\* | -0.998\*\* | -0.974\*\* | 0.968\*\* | 0.945\* | -0.977\*\* | -0.998\*\* |
| 2-Decenal | 0.686 | 0.740 | -0.929\* | -0.833 | 0.928\* | 0.776 | -0.841 | -0.929\* |
| 2,4-Decadienal, (E,Z) | 0.786 | 0.849 | -0.968\*\* | -0.913\* | 0.915\* | 0.871 | -0.919\* | -0.968\*\* |
| 2,4-Decadienal, (E,E) | 0.759 | 0.826 | -0.959\*\* | -0.892\* | 0.914\* | 0.850 | -0.899\* | -0.959\*\* |
| 2-Undecenal | 0.590 | 0.666 | -0.868 | -0.747 | 0.869 | 0.703 | -0.756 | -0.868 |
| GO | 0.884\* | 0.874 | -0.981\*\* | -0.964\*\* | 0.987\*\* | 0.901\* | -0.967\*\* | -0.981\*\* |
| MGO | 0.929\* | 0.916\* | -0.933\* | -0.977\*\* | 0.877 | 0.924\* | -0.978\*\* | -0.933\* |
| 2,3-BD | 0.911\* | 0.904\* | -0.937\* | -0.973\*\* | 0.874 | 0.914\* | -0.975\*\* | -0.937\* |
| MDA | 0.790 | 0.804 | -0.962\*\* | -0.900\* | 0.983\*\* | 0.840 | -0.906\* | -0.962\*\* |
| 4-HNE | 0.834 | 0.869 | -0.989\*\* | -0.937\* | 0.978\*\* | 0.896\* | -0.942\* | -0.989\*\* |

\* Significance at P < 0.05. \*\* Significance at P < 0.01.

**Supplement Table 5.** Pearson correlation coefficients between the levels of oxidation products and fatty acids during heating in LO.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | C14:0 | C16:1 | C16:0 | C18:2 | C18:1 | C18:0 | SFA | MUFA | PUFA |
| LO | 2-Butenal | 0.926\* | -0.957\* | 0.988\*\* | -0.992\*\* | -0.929\* | 0.965\*\* | 0.979\*\* | -0.934\* | -0.992\*\* |
| Pentanal | 0.934\* | -0.935\* | 0.953\* | -0.987\*\* | -0.909\* | 0.960\*\* | 0.968\*\* | -0.914\* | -0.987\*\* |
| 2-Pentenal | 0.962\*\* | -0.958\* | 0.969\*\* | -0.995\*\* | -0.973\*\* | 0.995\*\* | 0.997\*\* | -0.976\*\* | -0.995\*\* |
| Hexanal | 0.814 | -0.83 | 0.921\* | -0.926\* | -0.857 | 0.890\* | 0.902\* | -0.859 | -0.926\* |
| 2-Hexenal | 0.962\*\* | -0.943\* | 0.951\* | -0.981\*\* | -0.989\*\* | 0.998\*\* | 0.995\*\* | -0.991\*\* | -0.981\*\* |
| Heptanal | 0.907\* | -0.906\* | 0.931\* | -0.970\*\* | -0.873 | 0.933\* | 0.942\* | -0.878 | -0.970\*\* |
| 2-Heptenal | 0.971\*\* | -0.951\* | 0.949\* | -0.981\*\* | -0.989\*\* | 0.999\*\* | 0.996\*\* | -0.991\*\* | -0.981\*\* |
| 2,4-Heptadienal, (E,Z) | 0.990\*\* | -0.969\*\* | 0.942\* | -0.991\*\* | -0.960\*\* | 0.994\*\* | 0.993\*\* | -0.964\*\* | -0.991\*\* |
| Octanal | 0.766 | -0.762 | 0.833 | -0.871 | -0.745 | 0.815 | 0.826 | -0.75 | -0.871 |
| 2,4-Heptadienal, (E,E) | 0.986\*\* | -0.970\*\* | 0.949\* | -0.994\*\* | -0.955\* | 0.993\*\* | 0.993\*\* | -0.960\*\* | -0.994\*\* |
| 2-Octenal | 0.959\*\* | -0.934\* | 0.945\* | -0.982\*\* | -0.982\*\* | 0.996\*\* | 0.991\*\* | -0.984\*\* | -0.982\*\* |
| Nonanal | 0.915\* | -0.912\* | 0.949\* | -0.979\*\* | -0.914\* | 0.956\* | 0.962\*\* | -0.918\* | -0.979\*\* |
| 2-Decenal | 0.938\* | -0.937\* | 0.930\* | -0.978\*\* | -0.872 | 0.942\* | 0.950\* | -0.879\* | -0.978\*\* |
| 2,4-Decadienal, (E,Z) | 0.935\* | -0.938\* | 0.944\* | -0.984\*\* | -0.890\* | 0.951\* | 0.960\*\* | -0.896\* | -0.984\*\* |
| 2,4-Decadienal, (E,E) | 0.933\* | -0.936\* | 0.938\* | -0.980\*\* | -0.877 | 0.943\* | 0.953\* | -0.884\* | -0.980\*\* |
| 2-Undecenal | 0.912\* | -0.918\* | 0.931\* | -0.970\*\* | -0.859 | 0.928\* | 0.939\* | -0.866 | -0.970\*\* |
| GO | 0.964\*\* | -0.992\*\* | 0.982\*\* | -0.992\*\* | -0.947\* | 0.978\*\* | 0.990\*\* | -0.953\* | -0.992\*\* |
| MGO | 0.942\* | -0.951\* | 0.960\*\* | -0.991\*\* | -0.907\* | 0.961\*\* | 0.971\*\* | -0.913\* | -0.991\*\* |
| 2,3-BD | 0.944\* | -0.954\* | 0.939\* | -0.981\*\* | -0.871 | 0.941\* | 0.953\* | -0.879\* | -0.981\*\* |
| MDA | 0.919\* | -0.945\* | 0.979\*\* | -0.965\*\* | -0.983\*\* | 0.975\*\* | 0.983\*\* | -0.985\*\* | -0.965\*\* |
| HNE | 0.991\*\* | -0.973\*\* | 0.881\* | -0.944\* | -0.896\* | 0.947\* | 0.946\* | -0.903\* | -0.944\* |

\* Significance at P < 0.05. \*\* Significance at P < 0.01.

FIGURE 5**Supplement Figure 1.**

Supplement Figure 1. Pearson’s correlation heatmap showing different indices in SO (A), PO (B), OO (C), and LO (D) at different temperatures.