Table 1. Chemical composition of *M. oleifera* leaves from triple interactions

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **FCR (mg GAE g-1)** | | | | | | | | | | | | | | | | | |
|  | **summer** | | **autumn** | | **winter** | | **spring** | |  |  | **S** | | **SE** | | **NE** | |
|  | young | mature | young | mature | young | mature | young | mature |  |  | **y** | **m** | **y** | **m** | **y** | **m** |
| **S** | 70.2 ± 0.9 ab | 55.7 ± 5.0 b | 66.37 ± 3.6 b | 49.60 ± 2.0 c | 33.43 ± 2.5 b | 29.5 ± 1.1 b | 37.90 ± 2.0b | 39.69 ± 2.0a |  | **s** | aA | aB | aA | aA | aA | aA |
| **SE** | 75.6 ± 5.5 a | 74.7 ± 7.4 a | 75.96 ± 5.6 a | 80.24 ± 0.5 a | 46.71 ± 3.9 a | 41.9 ± 2.4 a | 44.23 ± 2.2a | 36.10 ± 0.4a |  | **a** | aA | aB | aA | aA | aA | aA |
| **NE** | 69.0 ± 2.7 b | 69.9 ± 2.3 a | 63.27 ± 0.6 b | 65.31 ± 6.2 b | 44.36 ± 1.2 a | 40.1 ± 1.0 a | 39.85 ± 1.5ab | 38.93 ± 1.8a |  | **w** | bA | cA | bA | bA | bA | bA |
|  |  |  |  |  |  |  |  |  |  | **sp** | bA | bA | bA | bB | bA | bA |
| **ABTS (µmol TEAC g-1)** | | | | | | | | | | | | | | | | | |
|  | **summer** | | **autumn** | | **winter** | | **spring** | |  |  | **S** | | **SE** | | **NE** | |
|  | young | mature | young | mature | young | mature | young | mature |  |  | y | m | y | m | y | m |
| **S** | 415.9 ± 2.8 a | 138.7 ± 3.3 b | 280.9 ± 44.4 a | 125.9 ± 12.8 b | 311.0 ± 7.2 b | 215.1 ± 17.7 c | 442.1 ± 18.9 a | 435.3 ± 14.1ab |  | **s** | abA | bB | bA | bA | bA | bA |
| **SE** | 258.7 ± 2.2 b | 272.0 ± 11.1 a | 239.2 ± 6.1 a | 275.9 ± 10.6 a | 433.0 ± 32.7 a | 511.6 ± 6.9 a | 421.0 ± 26.0 a | 362.8 ± 35.2 b |  | **a** | cA | bB | bA | bA | bA | bA |
| **NE** | 180.3 ± 10.6 c | 187.6 ± 0.0 b | 156.4 ± 10.0 b | 196.8 ± 12.9 b | 469.3 ± 23.7 a | 392.1 ± 169.9 b | 430.4 ± 16.4 a | 459.7 ± 26.8 a |  | **w** | bcA | bA | aA | aA | aA | aA |
|  |  |  |  |  |  |  |  |  |  | **sp** | aA | aA | aA | bA | aA | aA |
| **DPPH (µmol TEAC g-1)** | | | | | | | | | | | | | | | | | |
|  | **summer** | | **autumn** | | **winter** | | **spring** | |  |  | **S** | | **SE** | | **NE** | |
|  | young | mature | young | mature | young | mature | young | mature |  |  | y | m | y | m | y | m |
| **S** | 328.0 ± 6.7 a | 202.1 ± 20.4 b | 289.1 ± 8.0 a | 139.9 ± 5.2 c | 278.7 ± 27.9 b | 223.9 ± 13.8 b | 282.5 ± 9.1 b | 293.0 ± 23.7 a |  | **s** | aA | cB | aA | aA | bcB | aA |
| **SE** | 305.6 ± 25 a | 314.7 ± 27.1 a | 258.2 ± 21.5 b | 221.1 ± 15.1 b | 330.3 ± 16.8 a | 303.0 ± 27.1 a | 318.0 ± 5.0 a | 243.4 ± 2.5 b |  | **a** | bA | dB | bA | bB | cB | abA |
| **NE** | 268.2 ± 1.7 b | 310.7 ± 10.0 a | 238.3 ± 9.0 b | 298.8 ± 28.7 a | 321.2 ± 13.3 ab | 285.2 ± 11.2 a | 293.4 ± 5.6 ab | 277.2 ± 10.1 a |  | **w** | bA | bB | aA | aB | aA | abB |
|  |  |  |  |  |  |  |  |  |  | **sp** | bA | aA | aA | bB | abA | bA |
| **FRAP (μmol de Fe2+ g-1)** | | | | | | | | | | | | | | | | | |
|  | **summer** | | **autumn** | | **winter** | | **spring** | |  |  | **S** | | **SE** | | **NE** | |
|  | young | mature | young | mature | young | mature | young | mature |  |  | y | m | y | m | y | m |
| **S** | 1104.8 ± 11.4 a | 773.81 ± 89.2 b | 1098.1 ± 77.1 ab | 760.63 ± 70.7 c | 1198.2 ± 93.7 b | 1135.7 ± 70.1 b | 1347.1 ± 65.3 b | 1477.9 ± 115 a |  | **s** | bA | cB | bA | cA | bA | bA |
| **SE** | 1167.9 ± 115 a | 1100.9 ± 12.4 a | 1146.8 ± 74.7 a | 1259.0 ± 30.4 b | 1632.2 ± 104.7 a | 1505.9 ± 67.3 a | 1652.5 ± 86.7 a | 1428.1 ± 138.8 a |  | **a** | bA | cB | bA | bcA | cB | aA |
| **NE** | 1149.5 ± 36.2 a | 1120.5 ± 21.2 a | 964.8 ± 3.81 b | 1474.3 ± 237 a | 1480.2 ± 26.9 a | 1450.9 ± 21.1 a | 1586.5 ± 160.8 a | 1396.7 ± 76.6 a |  | **w** | abA | bA | aA | aA | aA | aA |
|  |  |  |  |  |  |  |  |  |  | **sp** | aA | aA | aA | abB | aA | aB |
| **Caffeoylquinic acid (mg g-1)** | | | | | | | | | | | | | | | | | |
|  | **summer** | | **autumn** | | **winter** | | **spring** | |  |  | **S** | | **SE** | | **NE** | |
|  | young | mature | young | mature | young | mature | young | mature |  |  | y | m | y | m | y | m |
| **S** | 7.75 ± 0.6 a | 7.13 ± 0.8 a | 10.04 ± 0.8 a | 5.33 ± 0.5 a | 7.54 ± 0.0 a | 9.00 ± 0.2 a | 5.88 ± 0.0 a | 5.19 ± 0.2 a |  | **s** | bA | bA | bB | aA | aA | abB |
| **SE** | 4.01 ± 0.2 c | 5.67 ± 0.2 b | 4.42 ± 0.2 b | 6.09 ± 0.2 a | 7.13 ± 0.4 a | 4.22 ± 0.0 b | 4.91 ± 0.2 ab | 3.18 ± 0.2 b |  | **a** | aA | cB | bB | aA | cA | cA |
| **NE** | 5.67 ± 1.0 b | 4.22 ± 0.6 c | 3.25 ± 0.2 c | 3.18 ± 0.2 b | 4.63 ± 0.0 b | 4.01 ± 0.7 b | 4.42 ± 0.6 b | 3.52 ± 0.6 b |  | **w** | cA | aA | aA | bB | bA | aA |
|  |  |  |  |  |  |  |  |  |  | **sp** | cA | cA | bA | cB | bA | bcA |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Caffeic acid (mg g-1)** | | | | | | | | | | | | | | | | | |
|  | **summer** | | **autumn** | | **winter** | | **spring** | |  |  | **S** | | **SE** | | **NE** | |
|  | young | mature | young | mature | young | mature | young | mature |  |  | y | m | y | m | y | m |
| **S** | 1.79 ± 0.1 b | 2.74 ± 0.3 b | 1.58 ± 0.1 b | 1.53 ± 0.1 b | 0.16 ± 0.0 b | 0.42 ± 0.0 b | 0.42 ± 0.0 b | 0.67 ± 0.0 b |  | **s** | aB | aA | abA | abB | aA | aA |
| **SE** | 2.48 ± 0.3 b | 2.14 ± 0.1 b | 2.65 ± 0.1 a | 2.48 ± 0.3 a | 2.05 ± 0.1 a | 1.96 ± 0.0 a | 2.22 ± 0.0 a | 1.79 ± 0.1 a |  | **a** | aA | bA | aA | aA | bA | cB |
| **NE** | 2.87 ± 0.1 a | 2.61 ± 0.5 a | 2.14 ± 0.1 b | 1.19 ± 0.2 c | 1.96 ± 0.0 a | 1.71 ± 0.4 a | 1.83 ± 0.1 b | 1.90 ± 0.1 a |  | **w** | bA | cA | cA | bA | bA | bA |
|  |  |  |  |  |  |  |  |  |  | **sp** | bA | cA | bcA | bB | bA | bA |
| **Rutin (mg g-1)** | | | | | | | | | | | | | | | | | |
|  | **summer** | | **autumn** | | **winter** | | **spring** | |  |  | **S** | | **SE** | | **NE** | |
|  | young | mature | young | mature | young | mature | young | mature |  |  | y | m | y | m | y | m |
| **S** | 11.02 ± 0.8 c | 10.70 ± 0.8 c | 10.70 ± 0.6 c | 4.25 ± 0.4 c | 5.51 ± 0.5 b | 5.67 ± 0.4 b | 9.63 ± 0.4 c | 10.93 ± 0.1 b |  | **s** | aA | aA | aA | bB | aA | aA |
| **SE** | 19.12 ± 1.7 b | 16.43 ± 1.4 b | 19.76 ± 0.1 a | 19.04 ± 2.0 a | 16.35 ± 1.3 a | 16.43 ± 1.4 a | 17.46 ± 1.2 a | 13.19 ± 0.2 a |  | **a** | aA | bB | aA | aA | cA | cB |
| **NE** | 22.21 ± 0.9 a | 20.67 ± 3.5 a | 14.77 ± 1.6 b | 8.80 ± 1.3 b | 17.38 ± 0.4 a | 15.21 ± 3.8 a | 15.09 ± 0.7 b | 14.53 ± 0.6 a |  | **w** | bA | bA | bA | bA | bA | bB |
|  |  |  |  |  |  |  |  |  |  | **sp** | aA | aA | abA | cB | bcA | bA |
| **Astragalin (mg g-1)** | | | | | | | | | | | | | | | | | |
|  | **summer** | | **autumn** | | **winter** | | **spring** | |  |  | **S** | | **SE** | | **NE** | |
|  | young | mature | young | mature | young | mature | young | mature |  |  | y | m | y | m | y | m |
| **S** | 3.47 ± 0.2 a | 6.14 ± 0.4 a | 3.91 ± 0.2 a | 5.53 ± 0.3 a | 2.79 ± 0.1 a | 2.14 ± 0.1 a | 3.43 ± 0.1 a | 2.82 ± 0.2 a |  | **s** | bB | aA | aA | bA | aA | aA |
| **SE** | 2.55 ± 0.2 c | 2.28 ± 0.2 c | 2.68 ± 0.0 b | 2.79 ± 0.1 b | 2.35 ± 0.1 b | 2.35 ± 0.2 a | 2.55 ± 0.2 b | 1.67 ± 0.0 b |  | **a** | aB | bA | aA | aA | cA | dB |
| **NE** | 2.99 ± 0.1 b | 2.79 ± 0.4 b | 2.01 ± 0.1 c | 1.36 ± 0.1 c | 2.48 ± 0.0 ab | 2.28 ± 0.0 a | 2.18 ± 0.1 b | 1.87 ± 0.2 b |  | **w** | cA | dB | aA | bA | bA | bA |
|  |  |  |  |  |  |  |  |  |  | **sp** | bA | cB | aA | cB | bcA | cB |
| **Isoquercitrin (mg g-1)** | | | | | | | | | | | | | | | | | |
|  | **summer** | | **autumn** | | **winter** | | **spring** | |  |  | **S** | | **SE** | | **NE** | |
|  | young | mature | young | mature | young | mature | young | mature |  |  | y | m | y | m | y | m |
| **S** | 10.35 ± 0.2 a | 7.31 ± 0.7 a | 8.83 ± 0.7 a | 3.30 ± 0.1 b | 14.26 ± 0.2 a | 11.09 ± 0.6 a | 15.39 ± 0.9 a | 14.85 ± 0.1a |  | **s** | bA | cB | bA | bB | bA | bB |
| **SE** | 7.65 ± 0.3 b | 6.18 ± 0.5 b | 7.03 ± 0.1 b | 6.72 ± 0.4 a | 10.98 ± 0.8 b | 10.70 ± 1.1 a | 11.43 ± 0.8 b | 6.63 ± 0.2 b |  | **a** | cA | dB | bA | bA | cA | cB |
| **NE** | 8.58 ± 0.4 b | 7.56 ± 1.6 a | 6.21 ± 0.1 b | 3.16 ± 0.4 b | 11.32 ± 0.4 b | 10.11 ± 0.6 a | 9.77 ± 0.2 c | 7.42 ± 2.6 b |  | **w** | aA | bB | aA | aA | aA | aB |
|  |  |  |  |  |  |  |  |  |  | **sp** | aA | aA | aA | bB | bA | bB |

Table 2. Environmental conditions (temperature, radiation and precipitation) of evaluated regions

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Factor | Level of factor | Average temperature (°C) | SD | Average radiation (kJ m-2) | SD | Average precipitation (mm) | SD |
| Region | South | 20.98 | 3.36 | 1114.98 | 273.41 | 57.86 | 46.09 |
| Region | Southeastern | 21.60 | 2.49 | 1391.74 | 204.94 | 49.74 | 44.02 |
| Region | Northeast | 24.22 | 2.13 | 1494.22 | 252.12 | 44.06 | 52.87 |
| Seasonality | Summer | 25.12 | 1.19 | 1570.48 | 229.35 | 67.76 | 59.29 |
| Seasonality | Autumn | 22.57 | 2.72 | 1233.12 | 286.86 | 40.27 | 35.90 |
| Seasonality | Winter | 18.84 | 2.42 | 1121.53 | 224.95 | 49.91 | 47.53 |
| Seasonality | Spring | 22.66 | 1.61 | 1417.94 | 212.60 | 45.50 | 44.74 |
| Age | Young | 22.39 | 3.10 | 1363.00 | 285.15 | 60.35 | 47.99 |
| Age | Mature | 22.13 | 2.98 | 1304.30 | 296.97 | 40.76 | 45.51 |