***Supplementary Material***

**1 Supplemetary Tables**

Tables listing wavenumber positions (cm-1) as well as standard deviations (each band position was calculated as an average of five measurements) of the three characteristic Raman bands of detected carotenoid pigments. The tables contain all the data, as was collected using four instruments analysing eight microorganisms, each of them prepared in four different types of samples. An x denotes a band was not detected.

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| --- | --- | --- | --- | --- | --- | --- |
| ***Halobacterium* *salinarum*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 999 | 0.07 | 1150 | 0.16 | 1505.2 | 0.08 |
| Lyophilized cells | 999 | 0.19 | 1149.5 | 0.1 | 1505.1 | 0.35 |
| Methanol-acetone extracts | 1000.0 | 0.1 | 1148.3 | 0.1 | 1506.3 | 0.3 |
| Bligh & Dyer extracts | 999.7 | 0.43 | 1148.7 | 0.57 | 1506.0 | 0.31 |

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| ***Haloarcula marismortui*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 1000.1 | 0.17 | 1150.1 | 0.08 | 1505.8 | 0.23 |
| Lyophilized cells | 999.4 | 0.19 | 1149.5 | 0.1 | 1505.1 | 0.35 |
| Methanol-acetone extracts | 1000.1 | 0.5 | 1148.3 | 0.1 | 1506.4 | 0.2 |
| Bligh & Dyer extracts | 999.8 | 0.26 | 1149.6 | 0.15 | 1507.2 | 0.22 |

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| ***Halorubrum sodomense*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 999.1 | 0.14 | 1149.9 | 0.08 | 1505.2 | 0.14 |
| Lyophilized cells | 1000 | 1.1 | 1150.5 | 0.99 | 1506.1 | 1.07 |
| Methanol-acetone extracts | 999.7 | 0.2 | 1148.1 | 0.1 | 1505.9 | 0.2 |
| Bligh & Dyer extracts | 1000 | 0.38 | 1149.5 | 0.16 | 1506.7 | 0.42 |

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| ***Salinibacter ruber*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 1000.8 | 0.3 | 1152.7 | 0.07 | 1509.6 | 0.14 |
| Lyophilized cells | 1001.0 | 0.27 | 1153.7 | 0.14 | 1510.5 | 0.12 |
| Methanol-acetone extracts | 1002.6 | 0.7 | 1151.3 | 0.1 | 1510.9 | 0.1 |
| Bligh & Dyer extracts | 1000.8 | 0.30 | 1152.0 | 0.23 | 1510.4 | 0.15 |

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| ***Ectothiorhodosphira marismortui*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 1001.2 | 0.15 | 1149.8 | 0.09 | 1508.7 | 0.33 |
| Lyophilized cells | x | x | x | x | x | x |
| Methanol-acetone extracts | x | x | x | x | x | x |
| Bligh & Dyer extracts | 1000.7 | 0.13 | 1150.7 | 0.26 | 1508.4 | 0.14 |

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| --- | --- | --- | --- | --- | --- | --- |
| ***Dunaliella parva*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 1004.1 | 1.02 | 1154.8 | 0.32 | 1522 | 0.32 |
| Lyophilized cells | 1004.4 | 1.3 | 1154.9 | 0.47 | 1521.6 | 0.19 |
| Methanol-acetone extracts | x | x | x | x | x | x |
| Bligh & Dyer extracts | x | x | x | x | x | x |

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| ***Micrococcus luteus*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 1003.6 | 0.7 | 1155.2 | 0.12 | 1526 | 0.34 |
| Lyophilized cells | 1005.3 | 0.8 | 1154.9 | 0.24 | 1526.8 | 0.27 |
| Methanol-acetone extracts | x | x | x | x | x | x |
| Bligh & Dyer extracts | 1001.3 | 0.13 | 1151.8 | 0.34 | 1512.1 | 0.25 |

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| ***Corynebacterium glutamicum*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 1004.8 | 0.38 | 1156.1 | 0.15 | 1523 | 0.5 |
| Lyophilized cells | 1006.3 | 0.59 | 1156 | 0.27 | 1523.1 | 0.88 |
| Methanol-acetone extracts | x | x | x | x | x | x |
| Bligh & Dyer extracts | x | x | x | x | 1522? | x |

**Tables for RaPort (532 nm)**

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| ***Halobacterium* *salinarum*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 998.0 | 0.23 | 1149.7 | 0.05 | 1506.2 | 0.07 |
| Lyophilized cells | 999.0 | 0.77 | 1150.3 | 0.04 | 1507.5 | 0.3 |
| Methanol-acetone extracts | 998.7 | 0.7 | 1147.4 | 0.1 | 1506.5 | 0.2 |
| Bligh & Dyer extracts | 998.4 | 0.48 | 1148.7 | 0.05 | 1507.0 | 0.13 |

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| --- | --- | --- | --- | --- | --- | --- |
| ***Haloarcula marismortui*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 998.8 | 0.58 | 1149.7 | 0.05 | 1506.4 | 0.05 |
| Lyophilized cells | 998.4 | 0.56 | 1149.8 | 0.05 | 1508.0 | 0.13 |
| Methanol-acetone extracts | 999.0 | 0.3 | 1147.2 | 0.0 | 1506.4 | 0.3 |
| Bligh & Dyer extracts | 998.6 | 0.05 | 1148.7 | 0.04 | 1507.0 | 0.07 |

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| --- | --- | --- | --- | --- | --- | --- |
| ***Halorubrum sodomense*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 997.8 | 0.15 | 1149.7 | 0.00 | 1506.2 | 0.04 |
| Lyophilized cells | 999.3 | 0.35 | 1149.9 | 0.05 | 1507.4 | 0.27 |
| Methanol-acetone extracts | 999.7 | 0.2 | 1148.8 | 0.1 | 1507.4 | 0.1 |
| Bligh & Dyer extracts | 998.2 | 0.42 | 1148.6 | 0.00 | 1506.9 | 0.05 |

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| --- | --- | --- | --- | --- | --- | --- |
| ***Salinibacter ruber*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 1000.3 | 0.12 | 1152.3 | 0.06 | 1510.3 | 0.07 |
| Lyophilized cells | 1001.0 | 0.78 | 1152.5 | 0.05 | 1510.6 | 0.04 |
| Methanol-acetone extracts | 1002.0 | 0.3 | 1151.3 | 0.2 | 1510.9 | 0.4 |
| Bligh & Dyer extracts | 1000.3 | 0.27 | 1151.5 | 0.08 | 1509.7 | 0.05 |

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| --- | --- | --- | --- | --- | --- | --- |
| ***Ectothiorhodosphira marismortui*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 999.8 | 0.1 | 1149.4 | 0.32 | 1508.7 | 0.19 |
| Lyophilized cells | 997.8 | 1.13 | 1149.8 | 0.1 | 1508.6 | 0.43 |
| Methanol-acetone extracts | x | x | x | x | x | x |
| Bligh & Dyer extracts | 997.6 | 0.46 | 1149.5 | 0.08 | 1507.8 | 0.39 |

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| --- | --- | --- | --- | --- | --- | --- |
| ***Dunaliella parva*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 1000.9 | 1.06 | 1153.3 | 0.14 | 1520.4 | 0.47 |
| Lyophilized cells | 1001.5 | 0.91 | 1152.8 | 0.48 | 1519.8 | 0.79 |
| Methanol-acetone extracts | x | x | x | x | x | x |
| Bligh & Dyer extracts | x | x | x | x | x | x |

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| ***Micrococcus luteus*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 1000.4 | 0.00 | 1156.1 | 0.43 | 1524.8 | 1.83 |
| Lyophilized cells | 1001.1 | 1.55 | 1154.0 | 0.73 | 1522.8 | 0.56 |
| Methanol-acetone extracts | x | x | x | x | x | x |
| Bligh & Dyer extracts | 1001.2 | 0.74 | 1151.1 | 0.58 | 1510.3 | 0.62 |

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| ***Corynebacterium glutamicum*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | x | x | x | x | x | x |
| Lyophilized cells | – | – | 1153.1 | 0.25 | 1521.6 | 0.59 |
| Methanol-acetone extracts | x | x | x | x | x | x |
| Bligh & Dyer extracts | x | x | x | x | x | x |

**Tables for First Guard (532 nm)**

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| --- | --- | --- | --- | --- | --- | --- |
| ***Halobacterium* *salinarum*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 998.7 | 0.34 | 1149.4 | 0.21 | 1506.6 | 0.48 |
| Lyophilized cells | 1000.2 | 0.86 | 1151.5 | 0.12 | 1508.5 | 0.63 |
| Methanol-acetone extracts | – | – | 1150.6 | 0,3 | 1506,3 | 0,37 |
| Bligh & Dyer extracts | – | – | 1149.7 | 0.46 | 1508.7 | 0.38 |

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| ***Haloarcula marismortui*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 998.0 | 0.25 | 1149.2 | 0.08 | 1506.2 | 0.32 |
| Lyophilized cells | 999.7 | 2.04 | 1151.1 | 0.33 | 1507.8 | 0.52 |
| Methanol-acetone extracts | – | – | 1149,2 | 0,08 | 1506,6 | 0,1 |
| Bligh & Dyer extracts | – | – | 1149.5 | 0.53 | 1510.2 | 0.52 |

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| ***Halorubrum sodomense*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 997.9 | 0.22 | 1149.3 | 0.07 | 1505.8 | 0.19 |
| Lyophilized cells | 1000.6 | 0.44 | 1151.5 | 0.05 | 1508.0 | 0.64 |
| Methanol-acetone extracts | – | – | 1149,1 | 0,23 | 1502,2 | 0,43 |
| Bligh & Dyer extracts | 1001.3 | 0.44 | 1149.1 | 0.05 | 1508.7 | 0.37 |

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| ***Salinibacter ruber*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 1000.7 | 0.19 | 1153.8 | 0.07 | 1512.2 | 0.15 |
| Lyophilized cells | 1001.1 | 0.28 | 1154.6 | 0.44 | 1512.5 | 0.12 |
| Methanol-acetone extracts | – | – | 1150,6 | 0,06 | 1507,9 | 0,1 |
| Bligh & Dyer extracts | – | – | 1152.5 | 0.52 | 1512.5 | 0.17 |

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| --- | --- | --- | --- | --- | --- | --- |
| ***Ectothiorhodosphira marismortui*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | x | x | x | x | x | x |
| Lyophilized cells | x | x | x | x | x | x |
| Methanol-acetone extracts | x | x | x | x | x | x |
| Bligh & Dyer extracts | x | x | x | x | x | x |

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| --- | --- | --- | --- | --- | --- | --- |
| ***Dunaliella parva*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | x | x | x | x | x | x |
| Lyophilized cells | x | x | x | x | x | x |
| Methanol-acetone extracts | x | x | x | x | x | x |
| Bligh & Dyer extracts | x | x | x | x | x | x |

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| ***Micrococcus luteus*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | x | x | x | x | x | x |
| Lyophilized cells | x | x | x | x | x | x |
| Methanol-acetone extracts | x | x | x | x | x | x |
| Bligh & Dyer extracts | x | x | x | x | x | x |

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| --- | --- | --- | --- | --- | --- | --- |
| ***Corynebacterium glutamicum*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | x | x | x | x | x | x |
| Lyophilized cells | x | x | x | x | x | x |
| Methanol-acetone extracts | x | x | x | x | x | x |
| Bligh & Dyer extracts | x | x | x | x | x | x |

**Tables for Inspector Raman (785 nm)**

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| --- | --- | --- | --- | --- | --- | --- |
| ***Halobacterium* *salinarum*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 1002.8 | 0.64 | 1151.9 | 0.43 | 1506 | 0.30 |
| Lyophilized cells | 1002 | 0 | 1153 | 0 | 1508 | 0 |
| Methanol-acetone extracts | 1000.3 | 0.44 | 1151.0 | 0.08 | 1506.2 | 0.19 |
| Bligh & Dyer extracts | 1001.4 | 0.68 | 1151.7 | 0.17 | 1508.3 | 0.54 |

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| --- | --- | --- | --- | --- | --- | --- |
| ***Haloarcula marismortui*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 1002.2 | 0.95 | 1152.3 | 0.71 | 1509.0 | 0.47 |
| Lyophilized cells | 1001.2 | 0.44 | 1150.9 | 0.45 | 1508.3 | 0.55 |
| Methanol-acetone extracts | 1002.5 | 0.48 | 1152.7 | 0.19 | 1509.3 | 0.36 |
| Bligh & Dyer extracts | 1001.2 | 0.68 | 1151.4 | 0.41 | 1508 | 0.59 |

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| --- | --- | --- | --- | --- | --- | --- |
| ***Halorubrum sodomense*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 1000.9 | 0.33 | 1151.4 | 0.16 | 1507.8 | 0.32 |
| Lyophilized cells | 1002.6 | 0.29 | 1153.2 | 0.38 | 1510.2 | 0.77 |
| Methanol-acetone extracts | 1001.2 | 0.39 | 1151.3 | 0.22 | 1507.0 | 0.72 |
| Bligh & Dyer extracts | 1003 | 0.16 | 1150.2 | 0.24 | 1505.1 | 0.09 |

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| --- | --- | --- | --- | --- | --- | --- |
| ***Salinibacter ruber*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 1002.6 | 0.59 | 1154.5 | 0.25 | 1512.7 | 0.37 |
| Lyophilized cells | 1001.9 | 0.38 | 1154.8 | 0.27 | 1513 | 0.42 |
| Methanol-acetone extracts | 1001.3 | 0.58 | 1153.5 | 0.06 | 1510.7 | 0.21 |
| Bligh & Dyer extracts | 1001.7 | 0.41 | 1154.2 | 0.13 | 1512.3 | 0.30 |

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| --- | --- | --- | --- | --- | --- | --- |
| ***Ectothiorhodosphira marismortui*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | x | x | x | x | x | x |
| Lyophilized cells | x | x | x | x | x | x |
| Methanol-acetone extracts | x | x | x | x | x | x |
| Bligh & Dyer extracts | x | x | x | x | x | x |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Dunaliella parva*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | – | – | 1156.1 | 0.33 | 1524.7 | 0.34 |
| Lyophilized cells | 1001.2 | 0.2 | 1156 | 1.86 | 1525.6 | 1.08 |
| Methanol-acetone extracts | 1007.3 | 0.65 | 1156.7 | 0.31 | 1522.9 | 0.19 |
| Bligh & Dyer extracts | – | – | 1156.5 | 0.24 | 1525.2 | 0.3 |

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| --- | --- | --- | --- | --- | --- | --- |
| ***Micrococcus luteus*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | 1004.0 | 0.84 | 1157.3 | 0.49 | 1527.7 | 0.42 |
| Lyophilized cells | 1004.9 | 1.2 | 1157.5 | 0.24 | 1528.8 | 0.35 |
| Methanol-acetone extracts | x | x | x | x | x | x |
| Bligh & Dyer extracts | 1005.6 | 0.46 | 1157.3 | 0.18 | 1528.1 | 0.35 |

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| --- | --- | --- | --- | --- | --- | --- |
| ***Corynebacterium glutamicum*** | **ρ(C–CH3)** | **sd1** | **ν2(C–C)** | **sd2** | **ν1(C=C)** | **sd3** |
| Wet pellets | x | x | x | x | x | x |
| Lyophilized cells | 1003.4 | 0.77 | 1157.1 | 0.19 | 1527.8 | 0.33 |
| Methanol-acetone extracts | x | x | x | x | x | x |
| Bligh & Dyer extracts | 1005.6 | 0.74 | 1156.6 | 0.37 | 1526.5 | 0.39 |

**Tables for Bravo (PSSERS 785/853 nm)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Organism**  **(major carotenoid)** | **Raman bands positions from this study (cm-1)** | **Raman bands positions from literature (cm-1)** | **Reference** |
| ***Halobacterium* *salinarum* (bacterioruberin)** | 1505, 1150, 999 | 1505, 1150, 1000 | Jehlička et al., 2013a |
| ***Haloarcula marismortui***  **(bacterioruberin)** | 1506, 1150, 999 | 1509, 1155, 1002 | Oren et al., 2018 |
| ***Halorubrum sodomense***  **(bacterioruberin)** | 1506, 1150, 1000 | 1506, 1152, 1001 | Jehlička et al., 2013a |
| ***Salinibacter ruber***  **(salinixanthin)** | 1511, 1154, 1001 | 1512, 1155, 1003 | Jehlička et al., 2013a |
| ***Ectothiorhodosphira marismortui\****  **(spirilloxanthin)** | 1509, 1150, 1001 | 1510, 1151, 1004 | Jehlička and Oren, 2013 |
| ***Dunaliella parva***  **(β–carotene)** | 1522, 1155, 1004 | 1525, 1157, 1005 | Jehlička et al., 2014a |
| ***Micrococcus luteus***  **(sarcinaxanthin)** | 1527, 1156, 1005 | 1529, 1156, 1005 | Jehlička et al., 2014a |
| ***Corynebacterium glutamicum***  **(decaprenoxanthin)** | 1523, 1156, 1006 | 1522, 1157, 1005 | Jehlička (unpublished materials) |
| **\*** values taken from the wet pellets sample type | | |  |

**Comparison of Raman band positions for major carotenoids detected in this study (instrument RaPort 532 nm, sample type lyophilized cultures) and references in literature**