***Supplementary Material***

**Table S1.** Significant different metabolites of low-temperature sausage in 0 days and 2 days

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Metabolites | Classification | VIP | FC | P value |
| **Formylkynurenine** | **Organic oxygen compounds** | **13.30**  | **6.97**  | **0.0148**  |
| **4-Guanidinobutyric acid** | **Organic acids and derivatives** | **6.79**  | **5.47**  | **<0.01** |
| L-alpha-Aspartyl-L-phenylalanine | Organic acids and derivatives | 6.19  | 0.21  | <0.01 |
| Methylgallic acid-O-sulphate | Benzenoids | 6.08  | 3.93  | 0.0332  |
| **Guanosine cyclic monophosphate**  | **Nucleosides, nucleotides, and analogues** | **5.49**  | **4.00**  | **<0.01** |
| 8-[(Aminomethyl)sulfanyl]-6-sulfanyloctanoic acid | Lipids and lipid-like molecules | 4.47  | 0.28  | 0.0396  |
| **3-Hydroxy-5, 8-tetradecadiencarnitine** | **Organic acids and derivatives** | **3.85**  | **2.56**  | **0.0262**  |
| PC(18:3(9Z,12Z,15Z)/18:2(9Z,12Z)) | Lipids and lipid-like molecules | 3.60  | 0.43  | <0.01 |
| Isophorone | Organooxygen compounds | 3.50  | 0.41  | <0.01 |
| 5-guanidino-2-oxopentanoic acid | Organic acids and derivatives | 3.30  | 2.35  | <0.01 |
| 5-Methoxyindoleacetic acid | Organoheterocyclic compounds | 3.13  | 2.26  | <0.01 |
| LTF4 | Lipids and lipid-like molecules | 2.96  | 0.46  | 0.0277 |
| Valeric acid | Lipids and lipid-like molecules | 2.87  | 1.79  | <0.01 |
| **3-Hydroxy-cis-5-tetradecenoylcarnitine** | **Organic acids and derivatives** | **2.84**  | **1.99**  | **0.0297**  |
| Cumene | Benzenoids | 2.79  | 0.53  | 0.0357  |
| fenvalerate | Lipids and lipid-like molecules | 2.68  | 1.80  | <0.01 |
| 1-stearoyl-2-oleoyl-sn-glycero-3-phosphoserine | Lipids and lipid-like molecules | 2.67  | 0.52  | <0.01 |
| Jujuboside B | Lipids and lipid-like molecules | 2.66  | 1.78  | <0.01 |
| TBHQ | Benzenoids | 2.65  | 0.49  | <0.01 |
| Naphthalen-2-amine | Benzenoids | 2.52  | 0.52  | 0.0273  |
| 4-methylthio-2-oxobutanoic acid | Lipids and lipid-like molecules | 2.42  | 1.76  | <0.01 |
| trans-Anethole | Benzenoids | 2.32  | 0.55  | <0.01 |
| Pyruvic acid  | Organic acids and derivatives | 2.29  | 0.58  | 0.0104  |
| DL-2,6-Diaminopimelic acid | Organic acids and derivatives | 2.27  | 0.60  | 0.0121  |
| Vitamin C | Organoheterocyclic compounds | 2.27  | 0.59  | <0.01 |
| Ubiquinone Q4 | Lipids and lipid-like molecules | 2.22  | 0.63  | 0.0119  |
| **Capryloylglycine** | **Organic acids and derivatives** | **2.16**  | **1.59**  | **<0.01** |
| Ascorbic acid  | Organoheterocyclic compounds | 2.14  | 0.64  | <0.01 |
| Biphenyl | Benzenoids | 2.10  | 1.66  | 0.0201  |
| 2,6-Dimethoxyquinone | Organic oxygen compounds | 2.09  | 1.54  | 0.0146  |
| 2-methylcitric acid | Organic acids and derivatives | 2.08  | 0.61  | <0.01 |
| 2-Thienylacetic acid | Organoheterocyclic compounds | 2.06  | 0.57  | 0.0327  |

**Table S2.** Significant different metabolites of low-temperature sausage in 0 days and 4 days

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Metabolites | Classification | VIP | FC | P value |
| L-Hexanoylcarnitine | Lipids and lipid-like molecules | 4.94  | 59.33  | <0.01 |
| **Leu-enkephalin** | **Organic acids and derivatives** | **4.45**  | **36.33**  | **<0.01** |
| **3-Hydroxy-cis-5-tetradecenoylcarnitine** | **Organic acids and derivatives** | **4.22**  | **408.41**  | **<0.01** |
| **Guanosine cyclic monophosphate** | **Nucleosides, nucleotides, and analogues** | **4.21**  | **28.06**  | **<0.01** |
| **Nicotinamide** | **Organoheterocyclic compounds** | **4.10**  | **0.04**  | **<0.01** |
| **3-Hydroxy-5, 8-tetradecadiencarnitine** | **Organic acids and derivatives** | **3.96**  | **279.33**  | **<0.01** |
| **Formylkynurenine** | **Organic oxygen compounds** | **3.90**  | **5.22**  | **0.0202** |
| O-3-methylglutarylcarnitine | Organooxygen compounds | 3.71  | 164.92  | <0.01 |
| Monocrotaline | Organoheterocyclic compounds | 3.68  | 20.46  | <0.01 |
| Retinyl beta-glucuronide | Lipids and lipid-like molecules | 3.58  | 267.43  | <0.01 |
| Cynarine | Organooxygen compounds | 3.57  | 22.05  | <0.01 |
| **DL-Serine**  | **Organic acids and derivatives** | **3.53**  | **17.65**  | <0.01 |
| **Capryloylglycine** | **Organic acids and derivatives** | **3.52**  | **151.05**  | <0.01 |
| **Tyramine**  | **Benzenoids** | **3.51**  | **182.01**  | <0.01 |
| Ganglioside GD2 (d18:1/25:0) | Lipids and lipid-like molecules | 3.37  | 13.53  | <0.01 |
| trans-2-Dodecenoylcarnitine | Organic acids and derivatives | 3.23  | 126.46  | <0.01 |
| Leukotriene B4 Ethanolamide | Organic nitrogen compounds | 3.20  | 16.40  | <0.01 |
| N-Undecanoylglycine | Organic acids and derivatives | 3.07  | 13.58  | <0.01 |
| Ganglioside GM1 (18:1/12:0) | Lipids and lipid-like molecules | 3.06  | 18.12  | <0.01 |
| 3, 5-Tetradecadiencarnitine | Lipids and lipid-like molecules | 3.06  | 106.02  | <0.01 |
| Prednicarbate | Lipids and lipid-like molecules | 2.97  | 84.06  | <0.01 |
| **arg-his** | Organic acids and derivatives | 2.86  | 60.51  | <0.01 |
| Hydroxyhexanoycarnitine | Organic acids and derivatives | 2.85  | 66.80  | <0.01 |
| Leukotriene E3 | Lipids and lipid-like molecules | 2.77  | 9.75  | <0.01 |
| **Cytosine** | **Organoheterocyclic compounds** | **2.75**  | **10.41**  | **<0.01** |
| 5-Hydroxyindole-3-acetic acid | Organoheterocyclic compounds | 2.74  | 11.53  | <0.01 |
| Tiglylcarnitine | Lipids and lipid-like molecules | 2.72  | 9.67  | <0.01 |
| D-Urobilin | Organoheterocyclic compounds | 2.69  | 47.01  | <0.01 |
| **4-Guanidinobutyric acid** | **Organic acids and derivatives** | **2.67**  | **8.02**  | **<0.01** |
| ophthalmic acid | Organic acids and derivatives | 2.64  | 8.78  | <0.01 |
| Methylgallic acid-O-sulphate | Benzenoids | 2.60  | 5.65  | <0.01 |
| 9-Decenoylcarnitine | Organic acids and derivatives | 2.58  | 46.31  | <0.01 |
| Rutacridone epoxide | Organoheterocyclic compounds | 2.56  | 8.64  | <0.01 |
| Cyclododecanone | Organic acids and derivatives | 2.55  | 41.28  | <0.01 |
| Ganglioside GM1 (18:1/9Z-18:1) | Lipids and lipid-like molecules | 2.55  | 7.59  | <0.01 |
| Tuftsin | Organic acids and derivatives | 2.54  | 34.76  | <0.01 |
| **Tyr-Phe** | Organic acids and derivatives | 2.51  | 38.37  | <0.01 |
| Butenylcarnitine | Organic acids and derivatives | 2.48  | 38.24  | <0.01 |
| Mitiglinide | Phenylpropanoids and polyketides | 2.46  | 8.00  | <0.01 |
| 7alpha-Hydroxy-3-oxochol-4-en-24-oic acid | Lipids and lipid-like molecules | 2.40  | 33.56  | <0.01 |
| **lys-leu** | Organic acids and derivatives | 2.37  | 24.59  | <0.01 |
| **L-(-)-Serine**  | **Organic acids and derivatives** | **2.37**  | **0.15**  | **<0.01** |

**Table S2. (continued)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Metabolites | Classification | VIP | FC | P value |
| Ganglioside GM1 (18:1/18:0) | Lipids and lipid-like molecules | 2.34  | 6.57  | <0.01 |
| linatine | Organic acids and derivatives | 2.31  | 6.79  | <0.01 |
| Biocytin | Organic acids and derivatives | 2.28  | 6.97  | <0.01 |
| 1beta-Hydroxycholic acid | Lipids and lipid-like molecules | 2.21  | 30.07  | <0.01 |
| Nandrolone phenpropionate | Lipids and lipid-like molecules | 2.17  | 23.95  | <0.01 |
| met-thr | Organic acids and derivatives | 2.12  | 5.41  | <0.01 |
| Citrulline | Organic acids and derivatives | 2.10  | 23.33  | <0.01 |
| N-[(3a,5b,7b)-7-hydroxy-24-oxo-3-(sulfooxy)cholan-24-yl]-Glycine | Lipids and lipid-like molecules | 2.09  | 23.38  | <0.01 |
| Macrocin | Lipids and lipid-like molecules | 2.04  | 5.00  | <0.01 |

**Table S3.** Significant different metabolites of low-temperature sausage in 0 days and 6 days

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Metabolites | Classification | VIP | FC | P value |
| **Leu-enkephalin** | **Organic acids and derivatives** | **4.10**  | **117.09**  | **<0.01** |
| **3-Hydroxy-cis-5-tetradecenoylcarnitine** | **Organic acids and derivatives** | **3.66**  | **958.15**  | **<0.01** |
| **Nicotinamide** | **Organoheterocyclic compounds** | **3.65**  | **0.01**  | **<0.01** |
| L-Hexanoylcarnitine | Lipids and lipid-like molecules | 3.36  | 57.20  | <0.01 |
| **3-Hydroxy-5, 8-tetradecadiencarnitine** | **Organic acids and derivatives** | **3.36**  | **517.15**  | **<0.01** |
| Ganglioside GM1 (18:1/12:0) | Lipids and lipid-like molecules | 3.35  | 62.17  | <0.01 |
| Retinyl beta-glucuronide | Lipids and lipid-like molecules | 3.27  | 620.76  | <0.01 |
| **Pyridinoline** | **Organic acids and derivatives** | **3.22**  | **69.66**  | **<0.01** |
| **Tyramine** | **Benzenoids** | **3.11**  | **391.99**  | **<0.01** |
| **Guanosine cyclic monophosphate** | **Nucleosides, nucleotides, and analogues** | **3.09**  | **34.32**  | **<0.01** |
| Leukotriene B4 Ethanolamide | Organic nitrogen compounds | 2.95  | 31.80  | <0.01 |
| trans-2-Dodecenoylcarnitine | Organic acids and derivatives | 2.88  | 231.82  | <0.01 |
| Cynarine | Organooxygen compounds | 2.85  | 32.28  | <0.01 |
| O-3-methylglutarylcarnitine | Lipids and lipid-like molecules | 2.78  | 225.55  | <0.01 |
| **Capryloylglycine** | **Organic acids and derivatives** | **2.77**  | **196.87**  | **<0.01** |
| 3, 5-Tetradecadiencarnitine | Organic acids and derivatives | 2.76  | 187.84  | <0.01 |
| Monocrotaline | Organoheterocyclic compounds | 2.65  | 27.44  | <0.01 |
| Tuftsin | Organic acids and derivatives | 2.62  | 144.74  | <0.01 |
| **arg-his** | Organic acids and derivatives | 2.57  | 122.18  | <0.01 |
| D-Urobilin | Organoheterocyclic compounds | 2.55  | 115.99  | <0.01 |
| **Cytosine** | **Organoheterocyclic compounds** | **2.54**  | **20.11**  | **<0.01** |
| **Formylkynurenine** | **Organic oxygen compounds** | **2.53**  | **4.13**  | **0.0264** |
| Ganglioside GD2 (d18:1/25:0) | Lipids and lipid-like molecules | 2.51  | 17.44  | <0.01 |
| **Tyr-Phe** | Organic acids and derivatives | 2.48  | 109.19  | <0.01 |
| 5-Hydroxyindole-3-acetic acid | Organoheterocyclic compounds | 2.45  | 17.27  | <0.01 |
| N-[(3a,5b,7b)-7-hydroxy-24-oxo-3-(sulfooxy)cholan-24-yl]-Glycine | Lipids and lipid-like molecules | 2.41  | 105.05  | <0.01 |
| Mitiglinide | Phenylpropanoids and polyketides | 2.38  | 16.74  | <0.01 |
| Hydroxyhexanoycarnitine | Organic acids and derivatives | 2.38  | 98.54  | <0.01 |
| Leukotriene E3 | Lipids and lipid-like molecules | 2.35  | 15.15  | <0.01 |
| **DL-Serine** | **Organic acids and derivatives** | **2.34**  | **15.87**  | **<0.01** |
| N-Undecanoylglycine | Organic acids and derivatives | 2.31  | 15.31  | <0.01 |
| **lys-leu** | Organic acids and derivatives | 2.31  | 79.94  | <0.01 |
| 9-Decenoylcarnitine | Organic acids and derivatives | 2.30  | 77.26  | <0.01 |
| Rutacridone epoxide | Organoheterocyclic compounds | 2.25  | 13.18  | <0.01 |
| **pro-met** | Organic acids and derivatives | 2.23  | 14.87  | <0.01 |
| Ganglioside GM1 (18:1/18:0) | Lipids and lipid-like molecules | 2.22  | 13.48  | <0.01 |
| Prednicarbate | Lipids and lipid-like molecules | 2.22  | 101.18  | <0.01 |
| 7alpha-Hydroxy-3-oxochol-4-en-24-oic acid | Lipids and lipid-like molecules | 2.19  | 58.56  | <0.01 |
| **L-(-)-Serine** | **Organic acids and derivatives** | **2.18**  | **0.08**  | **<0.01** |
| **Lys-phe** | Organic acids and derivatives | 2.17  | 13.39  | <0.01 |
| Glaucarubin | Lipids and lipid-like molecules | 2.14  | 14.56  | <0.01 |
| Tiglylcarnitine | Lipids and lipid-like molecules | 2.14  | 12.07  | <0.01 |

**Table S3. (continued)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Metabolites | Classification | VIP | FC | P value |
| ophthalmic acid | Organic acids and derivatives | 2.08  | 11.32  | <0.01 |
| PGF2a ethanolamide | Lipids and lipid-like molecules | 2.07  | 11.09  | <0.01 |
| 1beta-Hydroxycholic acid | Lipids and lipid-like molecules | 2.06  | 55.40  | <0.01 |
| N-Acetylvanilalanine | Organic acids and derivatives | 2.06  | 52.27  | <0.01 |
| Butenylcarnitine | Organic acids and derivatives | 2.06  | 50.57  | <0.01 |
| Cyclododecanone | Organooxygen compounds | 2.06  | 48.68  | <0.01 |
| Arg-Trp | Organic acids and derivatives | 2.05  | 12.01  | <0.01 |
| Leucyltryptophan | Organic acids and derivatives | 2.03  | 46.50  | <0.01 |
| decanoylcarnitine | Lipids and lipid-like molecules | 2.00  | 54.46  | <0.01 |

**Table S4.** Significant different metabolites of low-temperature sausage in 0 days and 8 days

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Metabolites | Classification | VIP | FC | P value |
| **Leu-enkephalin** | **Organic acids and derivatives** | **3.56**  | **163.77**  | **<0.01** |
| Retinyl beta-glucuronide | Lipids and lipid-like molecules | 3.47  | 2201.00  | <0.01 |
| **3-Hydroxy-cis-5-tetradecenoylcarnitine** | **Organic acids and derivatives** | **3.34**  | **1225.37**  | **<0.01** |
| **Pyridinoline** | **Organic acids and derivatives** | **3.30**  | **112.47**  | **<0.01** |
| **Nicotinamide** | **Organoheterocyclic compounds** | **3.15**  | **0.01**  | **<0.01** |
| **3-Hydroxy-5, 8-tetradecadiencarnitine** | **Organic acids and derivatives** | **2.99**  | **583.09**  | **<0.01** |
| O-3-methylglutarylcarnitine | Lipids and lipid-like molecules | 2.85  | 445.07  | <0.01 |
| **Tyramine** | **Benzenoids** | **2.84**  | **458.06**  | **<0.01** |
| Ganglioside GM1 (18:1/12:0) | Lipids and lipid-like molecules | 2.75  | 52.60  | <0.01 |
| Monocrotaline | Organoheterocyclic compounds | 2.73  | 51.54  | <0.01 |
| Leukotriene B4 Ethanolamide | Organic nitrogen compounds | 2.64  | 46.32  | <0.01 |
| Cynarine | Organooxygen compounds | 2.61  | 50.72  | <0.01 |
| trans-2-Dodecenoylcarnitine | Organic acids and derivatives | 2.57  | 253.77  | <0.01 |
| **Cytosine** | **Organoheterocyclic compounds** | **2.51**  | **40.44**  | **<0.01** |
| L-Hexanoylcarnitine | Lipids and lipid-like molecules | 2.49  | 36.23  | <0.01 |
| 3, 5-Tetradecadiencarnitine | Organic acids and derivatives | 2.44  | 192.13  | <0.01 |
| **arg-his** | Organic acids and derivatives | 2.34  | 138.82  | <0.01 |
| N-[(3a,5b,7b)-7-hydroxy-24-oxo-3-(sulfooxy)cholan-24-yl]-Glycine | Lipids and lipid-like molecules | 2.33  | 148.33  | <0.01 |
| **Capryloylglycine** | **Organic acids and derivatives** | **2.31**  | **138.37**  | **<0.01** |
| **5-Hydroxyindole-3-acetic acid** | **Organoheterocyclic compounds** | **2.31**  | **26.62**  | **<0.01** |
| Hydroxyhexanoycarnitine | Organic acids and derivatives | 2.25  | 124.57  | <0.01 |
| **Tyr-Phe** | Organic acids and derivatives | 2.23  | 114.44  | <0.01 |
| N6-Acetyl-L-lysine | Organic acids and derivatives | 2.22  | 25.56  | <0.01 |
| **pro-met** | Organic acids and derivatives | 2.21  | 23.03  | <0.01 |
| D-Urobilin | Organoheterocyclic compounds | 2.21  | 109.73  | <0.01 |
| Glaucarubin | Lipids and lipid-like molecules | 2.21  | 23.21  | <0.01 |
| **Formylkynurenine** | **Organic oxygen compounds** | **2.17**  | **5.66**  | **0.0198**  |
| Tuftsin | Organic acids and derivatives | 2.16  | 104.27  | <0.01 |
| Leucyltryptophan | Organic acids and derivatives | 2.15  | 99.29  | <0.01 |
| **lys-leu** | Organic acids and derivatives | 2.14  | 90.39  | <0.01 |
| **L-(-)-Serine** | **Organic acids and derivatives** | **2.14**  | **0.05**  | **<0.01** |
| **Lys-phe** | Organic acids and derivatives | 2.09  | 19.59  | <0.01 |
| 7alpha-Hydroxy-3-oxochol-4-en-24-oic acid | Lipids and lipid-like molecules | 2.09  | 85.40  | <0.01 |
| N-Acetylvanilalanine | Organic acids and derivatives | 2.04  | 83.03  | <0.01 |
| decanoylcarnitine | Lipids and lipid-like molecules | 2.04  | 84.90  | <0.01 |
| 2-ETHYL-4,5-DIMETHYLOXAZOLE | Organoheterocyclic compounds | 2.04  | 88.95  | <0.01 |
| Mitiglinide | Phenylpropanoids and polyketides | 2.03  | 18.35  | <0.01 |

**Table S5.** Significant different metabolites of low-temperature sausage in 0 days and 10 days

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Metabolites | Classification | VIP | FC | P value |
| **Pyridinoline** | **Organic acids and derivatives** | **3.47**  | **184.93**  | **<0.01** |
| **Leu-enkephalin** | **Organic acids and derivatives** | **3.42**  | **168.22**  | **<0.01** |
| **Nicotinamide** | **Organoheterocyclic compounds** | **3.22**  | **0.01**  | **<0.01** |
| **3-Hydroxy-cis-5-tetradecenoylcarnitine** | **Organic acids and derivatives** | **3.15**  | **1039.99**  | **<0.01** |
| Retinyl beta-glucuronide | Lipids and lipid-like molecules | 3.10  | 915.24  | <0.01 |
| Monocrotaline | Organoheterocyclic compounds | 2.97  | 89.60  | <0.01 |
| O-3-methylglutarylcarnitine | Lipids and lipid-like molecules | 2.88  | 536.37  | <0.01 |
| **3-Hydroxy-5, 8-tetradecadiencarnitine** | **Organic acids and derivatives** | **2.83**  | **491.61**  | **<0.01** |
| Ganglioside GM1 (18:1/12:0) | Lipids and lipid-like molecules | 2.79  | 73.43  | <0.01 |
| **Tyramine** | **Benzenoids** | **2.74**  | **406.78**  | **<0.01** |
| Cynarine | Organooxygen compounds | 2.71  | 61.63  | <0.01 |
| Leukotriene B4 Ethanolamide | Organic nitrogen compounds | 2.59  | 58.92  | <0.01 |
| trans-2-Dodecenoylcarnitine | Organic acids and derivatives | 2.48  | 255.64  | <0.01 |
| **lys-leu** | Organic acids and derivatives | 2.42  | 186.79  | <0.01 |
| Glaucarubin | Lipids and lipid-like molecules | 2.41  | 38.25  | <0.01 |
| 3, 5-Tetradecadiencarnitine | Organic acids and derivatives | 2.41  | 218.47  | <0.01 |
| **Cytosine** | **Organoheterocyclic compounds** | **2.39**  | **36.16**  | **<0.01** |
| N-[(3a,5b,7b)-7-hydroxy-24-oxo-3-(sulfooxy)cholan-24-yl]-Glycine | Lipids and lipid-like molecules | 2.36  | 175.42  | <0.01 |
| Leucyltryptophan | Organic acids and derivatives | 2.35  | 167.35  | <0.01 |
| N6-Acetyl-L-lysine | Organic acids and derivatives | 2.30  | 32.58  | <0.01 |
| **arg-his** | Organic acids and derivatives | 2.27  | 136.21  | <0.01 |
| **Capryloylglycine** | **Organic acids and derivatives** | **2.22**  | **128.55**  | **<0.01** |
| **Trp-Trp** | Organic acids and derivatives | 2.21  | 28.30  | <0.01 |
| **pro-met** | Organic acids and derivatives | 2.21  | 28.67  | <0.01 |
| 5-Hydroxyindole-3-acetic acid | Organoheterocyclic compounds | 2.21  | 27.46  | <0.01 |
| Tuftsin | Organic acids and derivatives | 2.20  | 124.97  | <0.01 |
| D-Urobilin | Organoheterocyclic compounds | 2.16  | 113.04  | <0.01 |
| Hydroxyhexanoycarnitine | Organic acids and derivatives | 2.16  | 113.53  | <0.01 |
| **Tyr-Phe** | Organic acids and derivatives | 2.14  | 109.19  | <0.01 |
| **Lys-phe** | Organic acids and derivatives | 2.12  | 24.17  | <0.01 |
| **L-(-)-Serine** | **Organic acids and derivatives** | **2.12**  | **0.04**  | **<0.01** |
| L-Hexanoylcarnitine | Lipids and lipid-like molecules | 2.10  | 23.54  | <0.01 |
| 2-ETHYL-4,5-DIMETHYLOXAZOLE | Organoheterocyclic compounds | 2.05  | 89.45  | <0.01 |
| N-Acetylvanilalanine | Organic acids and derivatives | 2.05  | 87.19  | <0.01 |
| Pyruvic acid | Organic acids and derivatives | 2.04  | 0.05  | <0.01 |
| Valeric acid | Lipids and lipid-like molecules | 2.02  | 84.28  | <0.01 |
| PGF2a ethanolamide | Lipids and lipid-like molecules | 2.00  | 21.63  | <0.01 |
| decanoylcarnitine | Lipids and lipid-like molecules | 2.00  | 86.26  | <0.01 |

**Table S6.** Significant different metabolites of low-temperature sausage in 0 days and 12 days

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Metabolites | Classification | VIP | FC | P value |
| **3-Hydroxy-cis-5-tetradecenoylcarnitine** | **Organic acids and derivatives** | **3.30**  | **1514.49**  | **<0.01** |
| **Leu-enkephalin** | **Organic acids and derivatives** | **3.11**  | **165.06**  | **<0.01** |
| Retinyl beta-glucuronide | Lipids and lipid-like molecules | 2.88  | 592.55  | <0.01 |
| **Pyridinoline** | **Organic acids and derivatives** | **2.87**  | **157.17**  | **<0.01** |
| **3-Hydroxy-5, 8-tetradecadiencarnitine** | **Organic acids and derivatives** | **2.84**  | **506.48**  | **<0.01** |
| **Nicotinamide** | **Organoheterocyclic compounds** | **2.83**  | **0.01**  | **<0.01** |
| O-3-methylglutarylcarnitine | Lipids and lipid-like molecules | 2.82  | 547.35  | <0.01 |
| Monocrotaline | Organoheterocyclic compounds | 2.78  | 78.19  | <0.01 |
| **Tyramine** | **Benzenoids** | **2.70**  | **412.54**  | **<0.01** |
| Leukotriene B4 Ethanolamide | Organic nitrogen compounds | 2.56  | 56.67  | <0.01 |
| Ganglioside GM1 (18:1/12:0) | Lipids and lipid-like molecules | 2.56  | 73.02  | <0.01 |
| trans-2-Dodecenoylcarnitine | Organic acids and derivatives | 2.52  | 266.48  | <0.01 |
| Leucyltryptophan | Organic acids and derivatives | 2.45  | 222.25  | <0.01 |
| **lys-leu** | Organic acids and derivatives | 2.45  | 224.38  | <0.01 |
| 3, 5-Tetradecadiencarnitine | Organic acids and derivatives | 2.44  | 221.17  | <0.01 |
| Cynarine | Organooxygen compounds | 2.44  | 44.93  | <0.01 |
| N-[(3a,5b,7b)-7-hydroxy-24-oxo-3-(sulfooxy)cholan-24-yl]-Glycine | Lipids and lipid-like molecules | 2.40  | 203.40  | <0.01 |
| Glaucarubin | Lipids and lipid-like molecules | 2.38  | 42.75  | <0.01 |
| **pro-met** | Organic acids and derivatives | 2.31  | 36.90  | <0.01 |
| Pyruvic acid | Organic acids and derivatives | 2.28  | 0.03  | <0.01 |
| **Trp-Trp** | Organic acids and derivatives | 2.27  | 42.82  | <0.01 |
| Vitamin C | Organoheterocyclic compounds | 2.26  | 0.03  | <0.01 |
| **Tyr-Phe** | Organic acids and derivatives | 2.25  | 142.28  | <0.01 |
| **arg-his** | Organic acids and derivatives | 2.23  | 130.46  | <0.01 |
| **Cytosine** | **Organoheterocyclic compounds** | **2.21**  | **32.28**  | **<0.01** |
| 3-Succinoylpyridine | Organic acids and derivatives | 2.18  | 29.03  | <0.01 |
| **Lys-phe** | Organic acids and derivatives | 2.15  | 28.70  | <0.01 |
| Tuftsin | Organic acids and derivatives | 2.14  | 116.40  | <0.01 |
| 5-aminoimidazole ribotide | Organic oxygen compounds | 2.13  | 0.06  | <0.01 |
| **Capryloylglycine** | **Organic acids and derivatives** | **2.06**  | **96.94**  | **<0.01** |
| D-Urobilin | Organoheterocyclic compounds | 2.06  | 98.96  | <0.01 |
| **N6-Acetyl-L-lysine** | **Organic acids and derivatives** | **2.05**  | **24.33**  | **<0.01** |
| Adenosine 5'-monophosphate | Nucleosides, nucleotides, and analogues | 2.04  | 0.05  | <0.01 |
| Glycyrrhizin | Lipids and lipid-like molecules | 2.03  | 0.05  | <0.01 |
| **L-(-)-Serine** | **Organic acids and derivatives** | **2.02**  | **0.04**  | **<0.01** |
| PGF2a ethanolamide | Lipids and lipid-like molecules | 2.01  | 23.63  | <0.01 |

**Table S7**. The relative abundance of bacterial species (top 10 species) at different stages of storage

|  |  |
| --- | --- |
| **Bacterial species** | **Storage time (days)** |
| **0** | **2** | **4** | **6** | **8** | **10** | **12** |
| *Bacillus velezensis* | 0.10 ± 0.02c | 0.91 ± 0.84c | 38.96 ± 10.13ab | 30.5 ± 4.98b | 44.15 ± 5.05a | 32.88 ± 12.68b | 35.37 ± 11.36ab |
| *Paenibacillus polymyxa* | 0a | 0a | 0a | 0.01 ± 0.01a | 0.03 ± 0.01a | 0.06 ± 0.08a | 5.32 ± 11.81a |
| *Phaseolus vulgaris* | 15.86 ± 2.36b | 18.67 ± 4.4a | 2.72 ± 1.60b | 2.30 ± 1.34b | 0.51 ± 0.53b | 0.32 ± 0.24b | 0.52 ± 0.37b |
| *Gleditsia sinensis* | 9.52 ± 7.20a | 1.75 ± 1.78b | 1.05 ± 1.14b | 6.08 ± 6.79ab | 2.92 ± 2.08b | 4.89 ± 5.80ab | 4.56 ± 0.48ab |
| *Anoxybacillus sp* | 1.76 ± 0.41b | 3.25 ± 1.59a | 0.25 ± 0.07c | 0.20 ± 0.11c | 0.03 ± 0.03c | 0.01 ± 0.01c | 0.03 ± 0.03c |
| ***Bacillus anthracis*** | **0b** | **0.13 ± 0.27b** | **0.11 ± 0.16b** | **0.32 ± 0.56b** | **2.75 ± 2.57a** | **0.04 ± 0.06b** | **0.02 ± 0.02b** |
| *Bacillus aryabhattai* | 0a | 0.02 ± 0.01a | 0.84 ± 1.51a | 0.35 ± 0.32a | 0.19 ± 0.17a | 0.06 ± 0.05a | 0.33 ± 0.30a |
| *Bacillus circulans* | 0b | 0.00 ± 0.01b | 0.73 ± 1.36ab | 0.62 ± 1.01ab | 0.67 ± 0.44ab | 1.65 ± 0.96a | 1.40 ± 0.92a |
| *Psychrobacter alimentarius* | 0.03 ± 0.02b | 0.22 ± 0.41b | 0.01 ± 0.03b | 0.02 ± 0.03b | 0.07 ± 0.14b | 0.07 ± 0.10b | 1.07 ± 1.46a |
| *Acinetobacter johnsonii* | 1.68 ± 0.37a | 1.81 ± 0.49a | 0.16 ± 0.09b | 0.16 ± 0.10b | 0.09 ± 0.03b | 0.08 ± 0.06b | 0.14 ± 0.04b |
| Others | 71.04 ± 7.08a | 73.25 ± 4.52a | 55.17 ± 11.59 b | 59.44 ± 7.43b | 48.6 ± 6.74b | 59.93 ± 8.98b | 51.24 ± 10.17b |

Values are presented in the table as the mean ± standard deviation.

Means within the different superscript on a row indicate significant differences (*p* < 0.05).