

附表 1 4 种不同退化程度高寒草甸土壤样本各比较组 TOP20 差异代谢物表达量差异变化

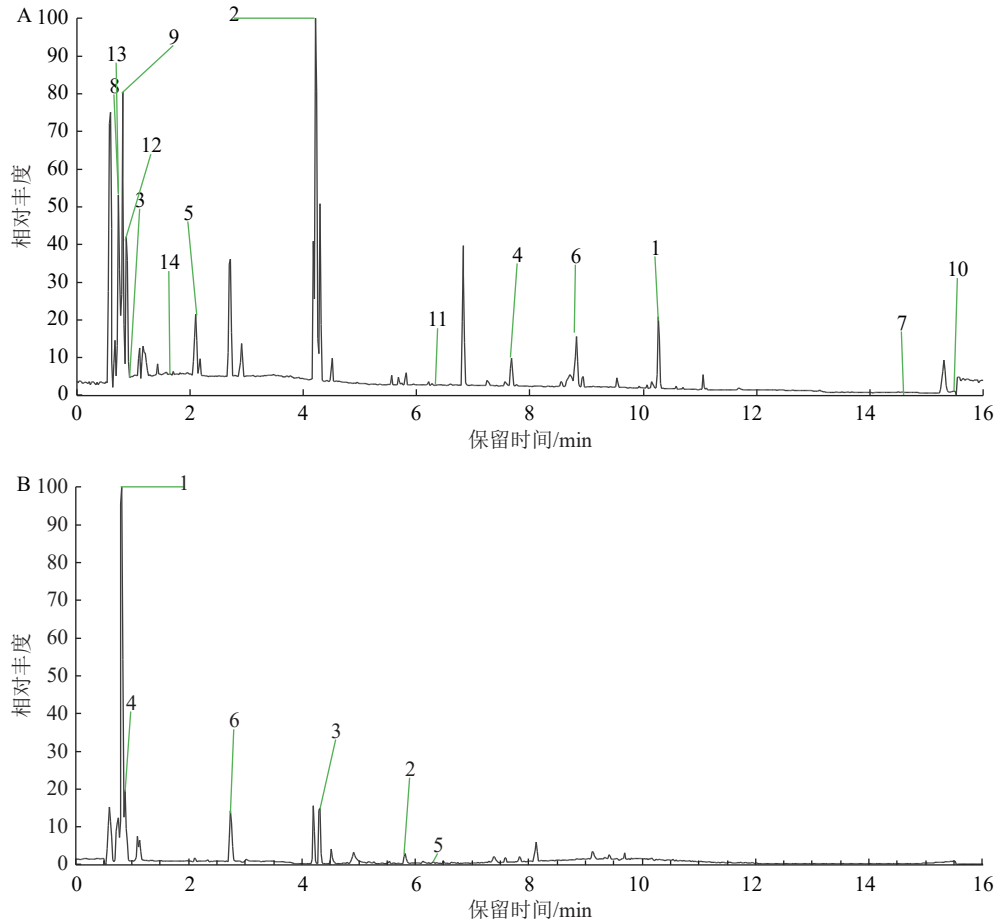
Supplementary table 1 Differential changes in TOP20 differential metabolites expression across comparison groups in soil samples of 4 different degraded alpine meadows

分组	编号	代谢物名称	分类	log ₂ (FC) / +(-)	显著差异代谢物数		
					总数	下调	上调
NDM /LDM	9.17_508.2753m/z	去莫辛desmosine	羧酸及其衍生物carboxylic acids and derivatives	+4.50			
	4.30_259.1300m/z	γ-谷氨酰异亮氨酸gamma-glutamylisoleucine	羧酸及其衍生物carboxylic acids and derivatives	-0.87			
	7.81_422.2383m/z	氟桂利嗪flunarizine	苯及取代衍生物benzene and substituted derivatives	+2.46			
	10.85_852.4195m/z	CDP-DG(a-13:0/a-13:0)	甘油磷脂glycerophospholipids	+8.19			
	10.07_421.3172m/z	Nb-棕榈酰色胺Nb-palmitoyltryptamine	吲哚及其衍生物indoles and derivatives	+1.70	441	212	229
	15.35_133.0528n	吲哚oxindole	吲哚及其衍生物indoles and derivatives	+0.87			
	0.74_162.1124m/z	左旋肉碱L-carnitine	有机氮化合物organonitrogen compounds	+0.71			
	0.87_666.2219n	水苏糖stachyose	有机氧化合物organoxygen compounds	+0.47			
NDM /LDM	2.12_268.1038m/z	腺苷adenosine	嘌呤核苷类purine nucleosides	+0.63			
	4.23_200.0473m/z	3-[(5-甲基-2-咪喃基)甲基]-1H-吡咯	吡咯类pyrroles	+1.06			
	8.80_274.2739m/z	C16鞘氨醇C16 sphinganine	鞘脂类sphingolipids	+0.71			
	4.30_259.1300m/z	γ-谷氨酰异亮氨酸gamma-glutamylisoleucine	羧酸及其衍生物carboxylic acids and derivatives	-1.27			
NDM/MDM	0.74_147.0533n	L-谷氨酸L-glutamate	羧酸及其衍生物carboxylic acids and derivatives	+0.77			
	2.73_246.1213n	γ-谷氨酰缬氨酸gamma-glutamylvaline	羧酸及其衍生物carboxylic acids and derivatives	+1.55			
	0.81_171.0894n	N-丁酰基-L-高丝氨酸内酯N-butanoyl-l-homoserine lactone	脂肪酰基类fatty acyls	+0.87			
	15.50_698.5868n	DG(18:4(6Z,9Z,12Z,15Z)/24:1(15Z)/0:0)	甘油脂类glycerolipids	-1.21	363	175	188
	0.74_162.1124m/z	左旋肉碱L-carnitine	有机氮化合物organonitrogen compounds	+1.23			
	4.45_498.2696m/z	4-丙酰基-HT2毒素4-propanoyl-HT2 toxin	戊二烯醇脂质prenol lipids	+16.36			
	2.12_268.1038m/z	腺苷adenosine	嘌呤核苷类purine nucleosides	+0.55			
	0.85_276.1189m/z	5-甲基尿嘧啶ribothymidine	嘧啶核苷pyrimidine nucleosides	-1.22			
	9.17_508.2753m/z	去莫辛desmosine	羧酸及其衍生物carboxylic acids and derivatives	+5.66			
	7.67_350.2171m/z	色氨酰赖氨酸tryptophyl-Lysine	羧酸及其衍生物carboxylic acids and derivatives	+1.23			
NDM/SDM	7.81_422.2383m/z	氟桂利嗪flunarizine	苯及取代衍生物benzene and substituted derivatives	+4.25	578	64	514
	4.73_404.2430m/z	17-苯基-18,19,20-三正前列腺素E2 17-phenyl-18,19,20-trinor-prostaglandin E2	脂肪酰基类fatty acyls	+15.49			

附表 1 (续)

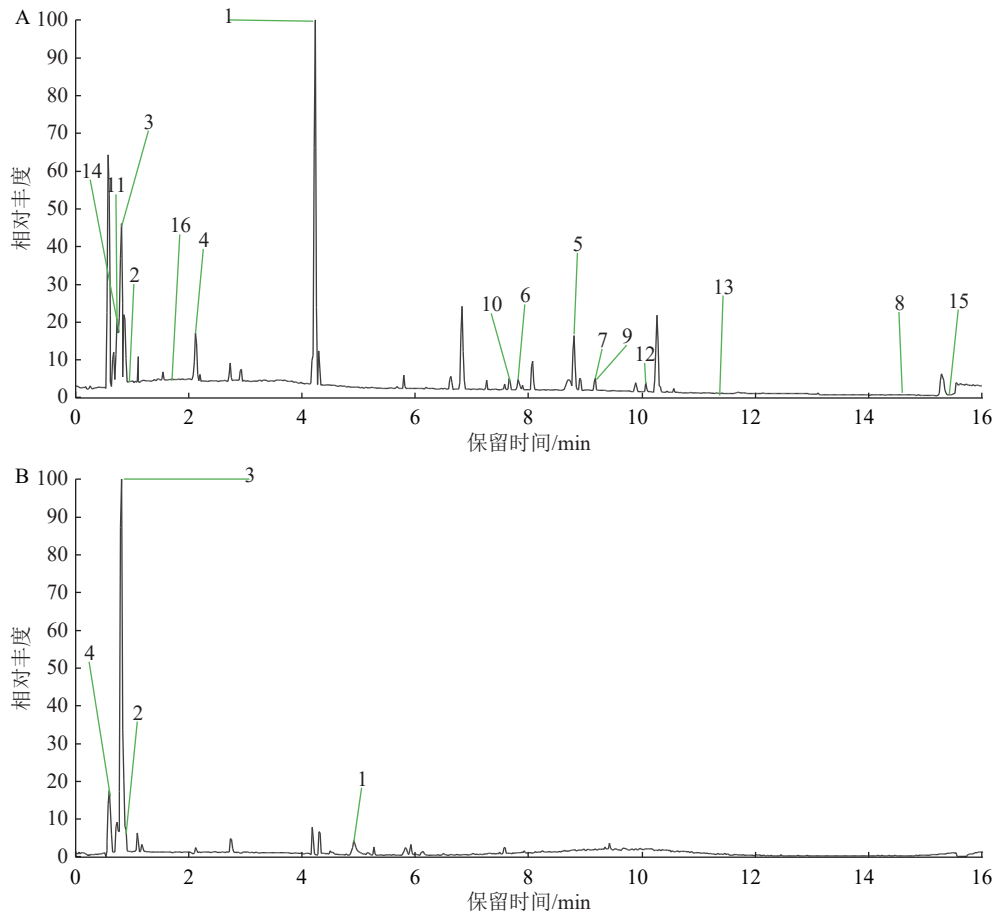
Supplementary table 1 Continued

分组	编号	代谢物名称	分类	log ₂ (FC) / +(-)	显著差异代谢物数		
					总数	下调	上调
NDM/SDM	4.51_500.2852m/z	11-β-羟基雄甾酮-3-葡萄糖苷酸 11-beta-hydroxyandrosterone-3-glucuronide	吲哚及其衍生物indoles and derivatives	+12.62	578	64	514
	5.85_447.1892n	氢吗啡酮-3-葡萄糖苷 hydromorphone-3-glucoside	吗啡多morphinans	+23.88			
	5.18_480.2954m/z	视黄醇β-葡萄糖醛酸苷retinyl beta-glucuronide	戊二烯醇脂质prenol lipids	+15.10			
	4.23_200.0473m/z	3-[(5-甲基-2-咪唑基)甲基]-1H-吡咯 3-[(5-methyl-2-furanyl)methyl]-1H-pyrrole	吡咯类pyrroles	+0.71			
	4.29_482.2747m/z	脱氢异雄甾酮-3-葡萄糖醛酸苷 dehydroisoandrosterone 3-glucuronide	类固醇和类固醇衍生物steroids and steroid derivatives	+14.09			
	10.26_460.2692m/z	海葱皂苷元scillirosidin	甾醇脂类sterol lipids	+0.72			
	7.21_602.2953m/z	4E,15Z-胆红素IXa 4E,15Z-Bilirubin IXa	四吡咯及其衍生物tetrapyrroles and derivatives	+16.40			
LDM/MDM	0.79_198.0889m/z	普瑞巴林pregabalin	羧酸及其衍生物carboxylic acids and derivatives	-0.92	223	91	132
	7.81_422.2383m/z	氟桂利嗪flunarizine	苯及取代衍生物benzene and substituted derivatives	+0.52			
	4.29_482.2747m/z	脱氢异雄甾酮-3-葡萄糖醛酸苷 dehydroisoandrosterone 3-glucuronide	类固醇和类固醇衍生物steroids and steroid derivatives	+41.81			
	10.85_852.4195m/z	CDP-DG(a-13:0/a-13:0) CDP-DG(a-13:0/a-13:0)	甘油磷脂glycerophospholipids	+0.35			
	0.74_162.1124m/z	左旋肉碱L-carnitine	有机氮化合物organonitrogen compounds	+0.52			
	9.00_508.2752m/z	异黄酮素Isodesmosine	羧酸及其衍生物carboxylic acids and derivatives	+2.01			
	7.63_422.2383m/z	1-二甲基砷酰基-(2Z,5Z,8Z,11Z,14Z,17Z)-二十二碳六烯 1-dimethylarsinoyl-(2Z,5Z,8Z,11Z,14Z,17Z)-heneicosahexaene	脂肪酰基类fatty acyls	+1.62			
LDM/SDM	4.51_500.2852m/z	11-β-羟基雄甾酮-3-葡萄糖苷酸 11-beta-hydroxyandrosterone-3-glucuronide	吲哚及其衍生物indoles and derivatives	+17.18	571	71	500
	4.45_498.2696m/z	4-丙酰基-HT2毒素4-propanoyl-HT2 toxin	戊二烯醇脂质prenol lipids	+42.61			
	7.21_602.2953m/z	4E,15Z-胆红素IXa 4E,15Z-bilirubin IXa	四吡咯及其衍生物tetrapyrroles and derivatives	+14.96			
	5.12_633.1827m/z	聚酮类化合物matteuorientate C	聚酮类化合物polyketides	+5.55			
	4.23_200.0473m/z	3-[(5-甲基-2-咪唑基)甲基]-1H-吡咯 3-[(5-methyl-2-furanyl)methyl]-1H-pyrrole	吡咯类pyrroles	-0.45			
MDM/SDM	4.23_200.0473m/z	3-[(5-甲基-2-咪唑基)甲基]-1H-吡咯 3-[(5-methyl-2-furanyl)methyl]-1H-pyrrole	吡咯类pyrroles	-0.45	527	48	479



A: 1.海葱皂苷元; 2. 3-[(5-甲基-2-咪喃基)甲基]-1H-吡咯; 3. 拉坦前列素乳糖醇; 4. 色氨酸赖氨酸; 5. 腺苷; 6. C16鞘氨醇; 7. 甲胺; 8. L-谷氨酸; 9. N-丁酰基-L-高丝氨酸内酯; 10. DG(18:4(6Z,9Z,12Z,15Z)/24:1(15Z)/0:0); 11. 5-[4-(5-{3-[3-(3,5-二羟基苯基)-6-羟基-2-(4-羟基苯基)-2,3-二氢-1-苄基-4-基]环氧乙烷-2-基}-2-(4-羟基苯基)-2,3-二氢-1-苯并咪喃-3-基)-6-羟基-2-苯基-2,3-二氢-1-苯并咪喃-3-基]苯-1,3-二醇; 12. 5-甲基尿嘧啶; 13. 左旋肉碱; 14. (3 β ,6 β)-咪喃咪喃-3,6-二醇-6-乙酸酯。B: 1.5'-丁酰基腺苷; 2. 7,4',5'-三羟基-5,2'-氧代-4-苯基香豆素; 3. γ -谷氨酰异亮氨酸; 4. 水苏糖; 5. 6-[4-(2-{3-[3-(3,5-二羟基苯基)-6-羟基-2-(4-羟基苯基)-2,3-二氢-1-苄基-4-基]-2-苯基-2,3-二氢-1-苯并咪喃-5-基}乙烯基)-6-羟基-2-(4-羟基苯基)-2,3-二氢-1-苯并咪喃-3-基]苯-1,2,4-三醇; 6. γ -谷氨酰缬氨酸。

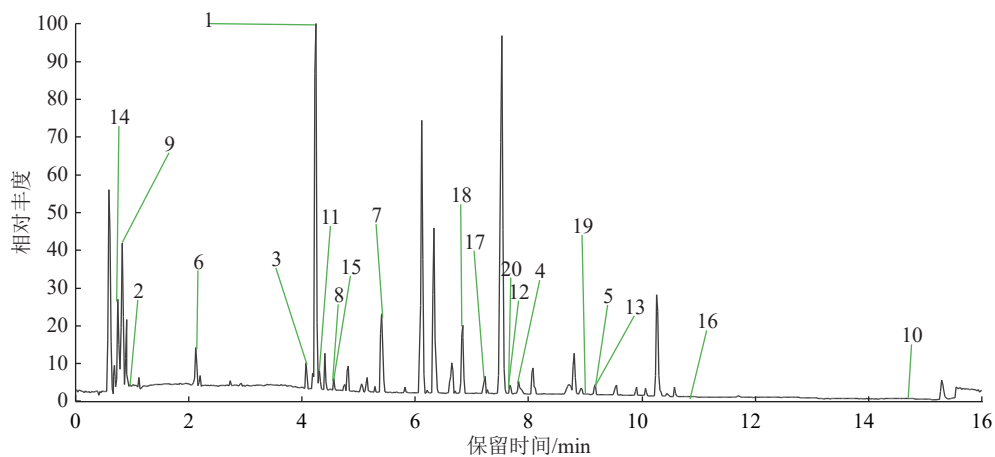
附图 1 未退化草甸土壤样本表达量前 20 差异代谢物的正离子模式 (A) 和负离子模式 (B) 色谱图
Supplementary figure 1 Chromatogram of metabolites with the TOP 20 differentially expression in soil sample of NDM in positive (A) and negative (B) ion modes



A. 1. 3-[(5-甲基-2-咪喃基)甲基]-1H-吡咯; 2. 拉坦前列素乳糖醇; 3. N-丁酰基-L-高丝氨酸内酯; 4. 腺苷; 5. C16鞘氨醇; 6. 氟桂利嗪; 7. 去莫辛; 8. 甲萘胺; 9. valerosidatum; 10. 色氨酸赖氨酸; 11. 普瑞巴林; 12. Nb-棕榈酰色胺; 13. CDP-DG(a-13:0/a-13:0); 14. 左旋肉碱; 15. 吡啶; 16. (3 β ,6 β)-咪喃咪喃-3,6-二醇6-乙酸酯。B: 1. 7,4',5'-三羟基-5,2'-氧化-4-苯基香豆素; 2. 水苏糖; 3. 5'-丁酰基膦苷; 4. 1-O-(2-乙酰氨基-2-脱氧- α -D-吡喃葡萄糖基)-1D-肌醇3-磷酸。

附图2 轻度退化草甸土壤样本表达量前20差异代谢物的正离子模式(A)和负离子模式(B)色谱图

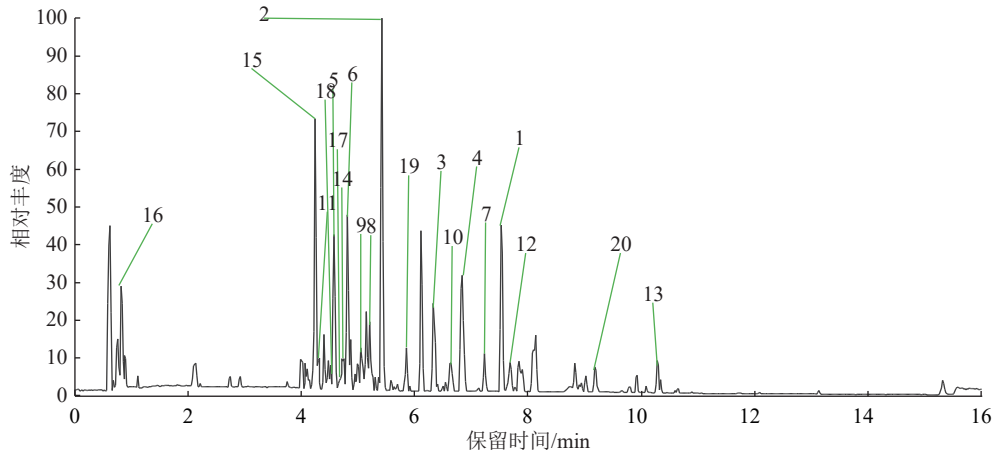
Supplementary figure 2 Chromatogram of metabolites with the TOP 20 differentially expression in soil sample of LDM in positive (A) and negative (B) ion modes)



1. 3-[(5-甲基-2-咪喃基)甲基]-1H-吡咯; 2. 拉坦前列素乳糖醇; 3. 二氢左旋布洛尔葡萄糖苷酸; 4. 氟桂利嗪; 5. 去莫辛; 6. 腺苷; 7. 螺拉明A; 8. 4-丙酰基-HT2毒素; 9. N-丁酰基-L-高丝氨酸内酯; 10. 甲磺胺; 11. 脱氢异雄甾酮-3-葡萄糖醛酸苷; 12. 色氨酸赖氨酸; 13. valerosidatum; 14. 左旋肉碱; 15. 11- β 羟基雄甾酮-3-葡萄糖苷酸; 16. CDP-DG(A-13:0/A-13:0); 17. 4E,15Z-胆红素IXa; 18. 翠雀碱; 19. 异黄酮素; 20. 1-二甲基砷酰基-(2Z,5Z,8Z,11Z,14Z,17Z)-二十二碳六烯。

附图3 中度退化草甸土壤样本表达量前20差异代谢物的正离子模式色谱

Supplementary figure 3 Chromatogram of metabolites with the TOP 20 differentially expression in soil sample of MDM in the positive ion mode



- 1.乌头碱; 2.螺旋霉素A; 3. 8',10'-二羟基二氢麦角胺; 4. 翠雀碱; 5. 松果灵; 6. 布福他林; 7. 4E,15Z-胆红素IXa;
 8. 视黄醇 β -葡萄糖醛酸苷; 9. 3 β ,5 β -四氢炔诺酮葡萄糖苷酸; 10. Kni 102; 11. 脱氢异雄甾酮-3-葡萄糖醛酸苷;
 12. 氟桂利嗪; 13. 海葱皂苷元; 14. 17-苯基-18,19,20-三正前列腺素E2; 15. 3-[(5-甲基-2-呋喃基)甲基]-1H-吡咯;
 16. 5'-丁酰基腺苷; 17. 3 β ,5 α -四氢炔诺酮葡萄糖苷酸; 18. 11- β -羟基雄甾酮-3-葡萄糖醛酸苷; 19. 氢吗啡酮-3-葡萄糖苷;
 20. 去莫辛。

附图4 未退化土壤样本表达量前20差异代谢物的正离子模式色谱图

Supplementary figure 4 Chromatogram of metabolites with the TOP 20 differentially expression in soil sample of SDM in the positive ion mode