

Fig. S1: Comparing reward strength of *Rhodiola* root and fructose

Shown are associative memory scores measured as the Performance Indices of larvae trained with either 0.1 mg/ml *Rhodiola* root or 2 mol/l fructose (= 360 mg/ml, FRU) as the reward (sketch to the right, red cloud: odor *n*-amyl acetate, black circles: Petri dishes filled with agarose supplemented with *Rhodiola* or FRU, white circles: plain agarose Petri dishes). The Performance Indices of larvae trained with 0.1 mg/ml *Rhodiola* or FRU did not significantly differ from each other (U-test, $P > 0.05$, $U = 191.5$, $N = 21, 20$). ns: $P > 0.05$ in a U-test. Other details as in Fig. 1. Data are documented in *Data file S2 Behavior data.xlsx*. Preference scores underlying the Performance Indices are documented in Fig. S9.

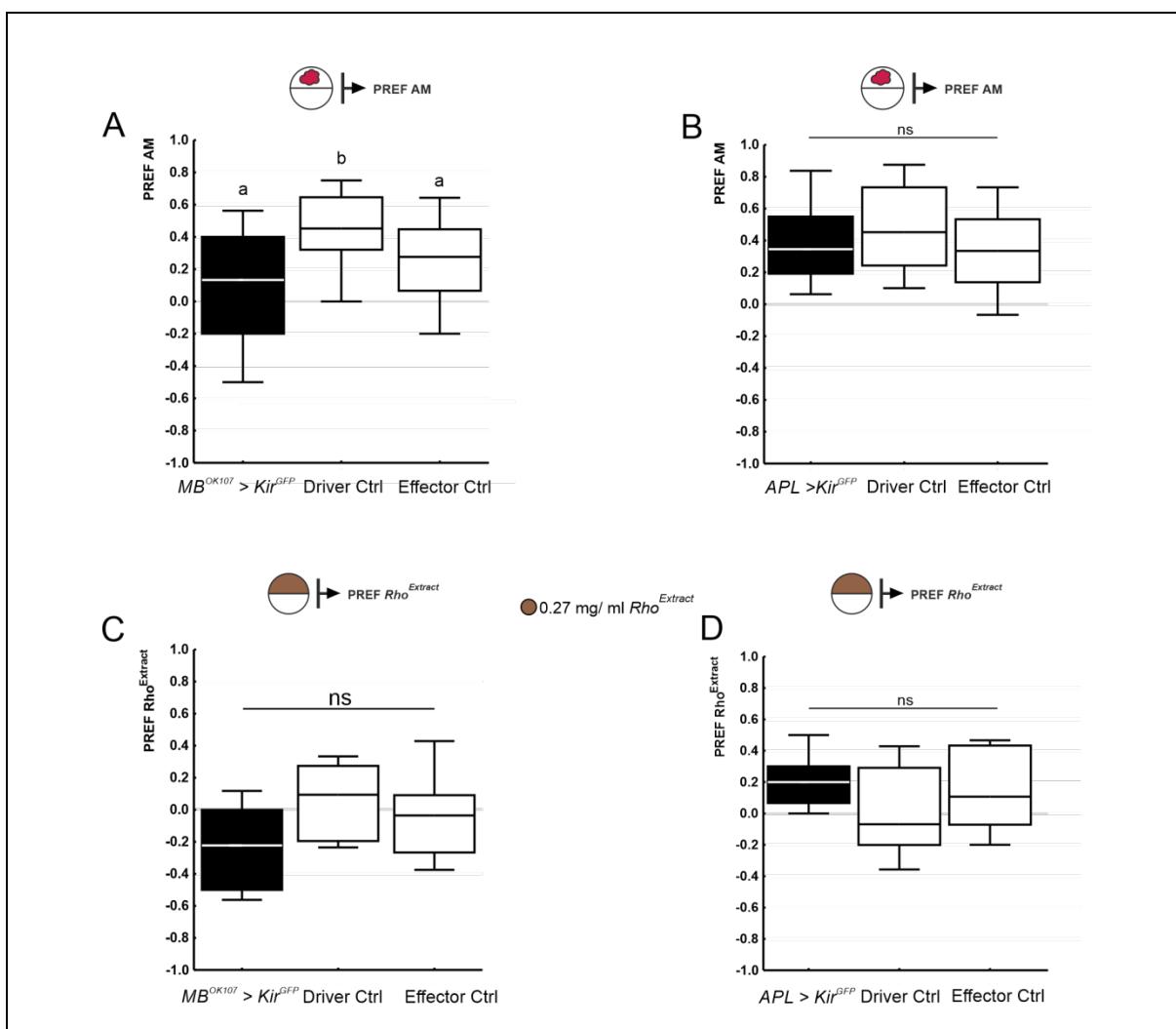
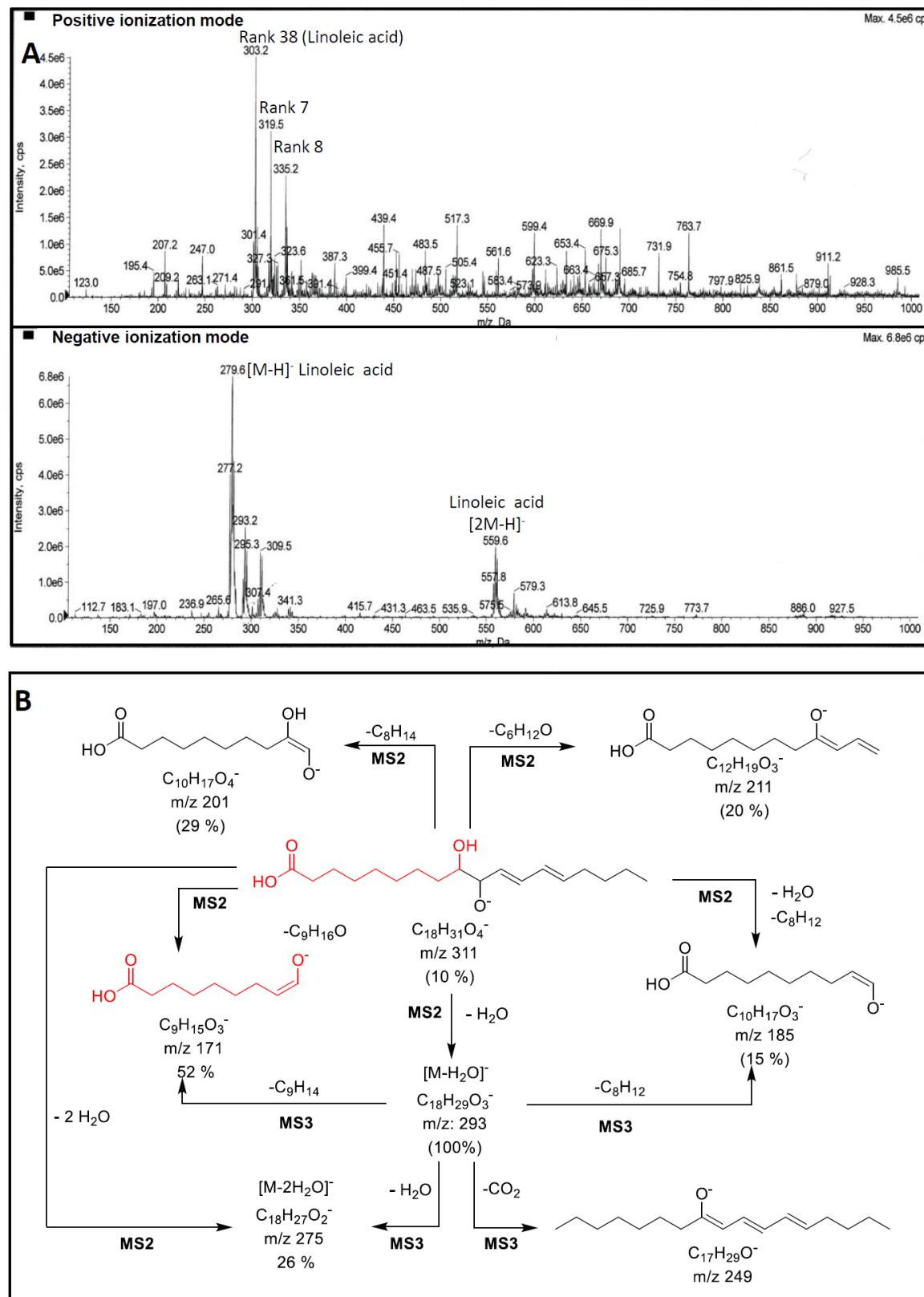


Fig. S2: Silencing of mushroom body neurons does not affect task-relevant sensory-motor faculties

Shown are the preference scores of experimentally naïve larvae in the sketched preference paradigms for the odor *n*-amyl acetate (AM; red cloud) (A, B), as well as for the *Rho*^{Extract} (brown hemicircle: *Rho*^{Extract}-supplemented agarose) (C, D), for the experimental groups $MB^{OK107} > Kir^{GFP}$ (A and C) and $APL > Kir^{GFP}$ (B and D) with their respective genetic controls. In neither case is the experimental group significantly different from both controls. *n*-amyl acetate: (A) H-test, $P < 0.05$, $H=14.2$, $df=2$, $N=28, 28, 28$; U-tests, $MB^{OK107} > Kir^{GFP}$ vs. Driver Ctrl: $P < 0.05/2$, $U=176.5$; $MB^{OK107} > Kir^{GFP}$ vs. Effector Ctrl: $P > 0.05/2$, $U=300.5$; (B) H-test, $P > 0.05$, $H=2.3$, $df=2$, $N=20, 20, 20$. *Rhodiola*: (C) H-test, $P > 0.05$, $H=3.4$, $df=2$, $N=6, 12, 14$; (D) H-test, $P > 0.05$, $H=2.3$, $df=2$, $N=12, 12, 12$. ns: $P > 0.05$ in a Kruskal-Wallis test. 'b' indicates a significant difference from the experimental group ('a') in Bonferroni-corrected U-tests ($P < 0.05/2$) preceded by a Kruskal-Wallis test ($P < 0.05$). Other details as in Fig. 1. Data are documented in *Data file S2 Behavior data.xlsx*.

**Fig. S3: ESI-MS data of *Rhodiola* fatty acids**

A) ESI-MS spectrum of the fatty acid fraction isolated from *Rhodiola* documenting the occurrence of oxygenated derivatives. B) Negative MS/MS fragmentation pattern of the hydroxylated fatty acid derivative hit 8 is in accordance with the structure proposal 9,10-dihydroxy-11,13-octadecadienic acid.

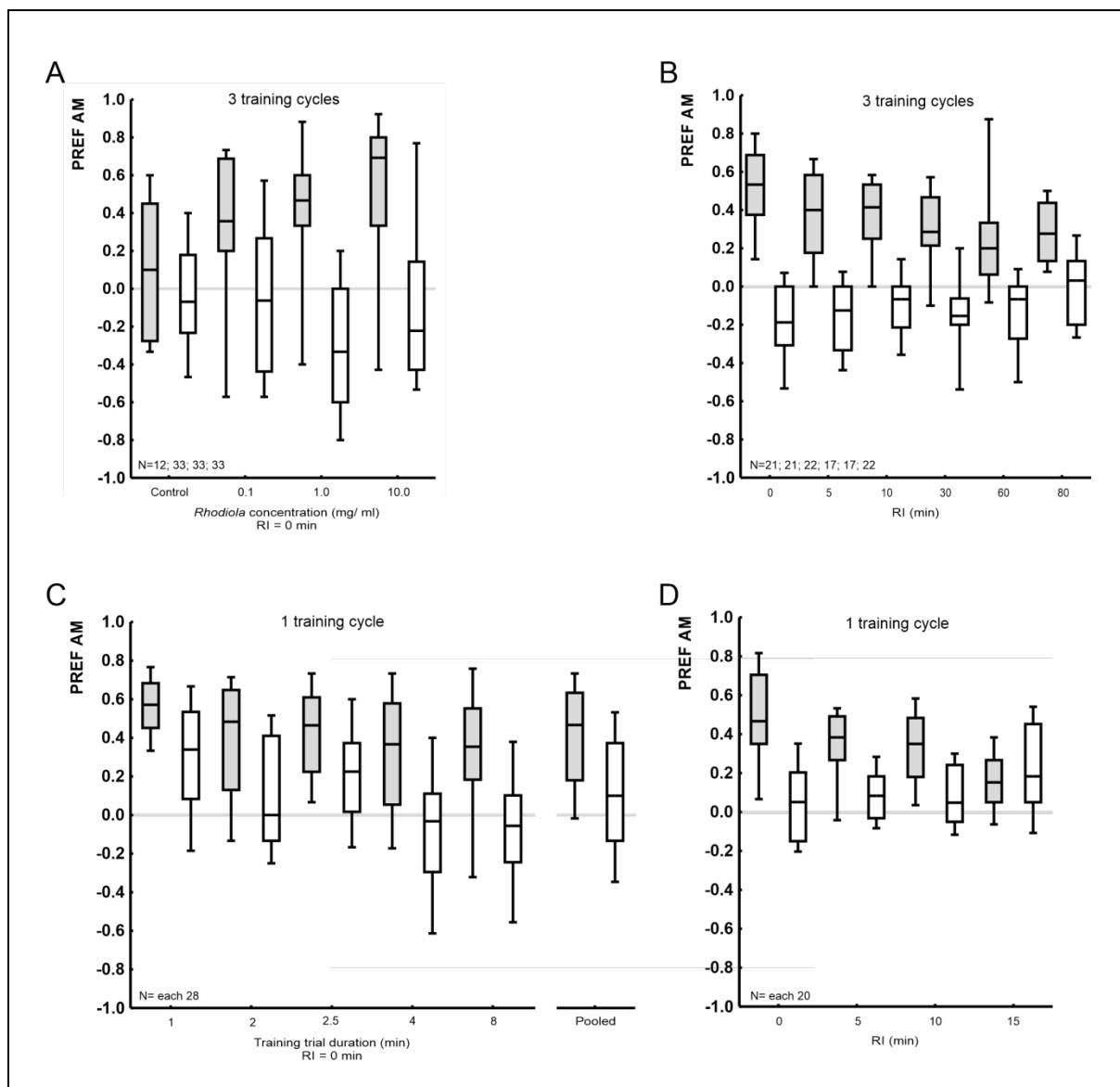


Fig. S4: Preference scores underlying the Performance Indices from Figure 1.

Visualization of the *n*-amyl acetate (AM) preference scores (PREF AM) underlying the Performance Indices from Figure 1. Preference scores after paired (grey boxes) and unpaired (white boxes) training are shown separately. The scores in A-D correspond to Figure 1C-F. Box plots show the median as the middle line, the 25/75% quantiles as box boundaries, and the 10/90% quantiles as whiskers. Sample sizes are indicated within the figure. Data are documented in *Data file S2 Behavior data.xlsx*.

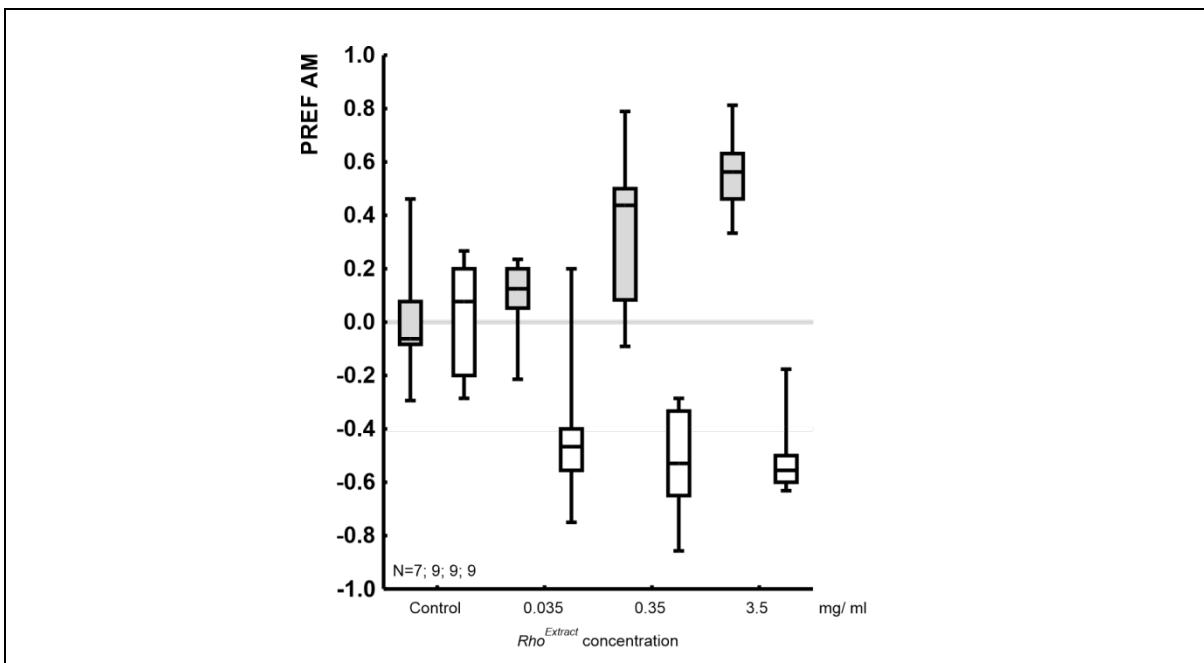


Fig. S5: Preference scores underlying the Performance Indices from Figure 2.

Visualization of the *n*-amyl acetate (AM) preference scores (PREF AM) underlying the Performance Indices from Figure 2D. Preference scores after paired (grey boxes) and unpaired (white boxes) training are shown separately. Box plots show the median as the middle line, the 25/75% quantiles as box boundaries, and the 10/90% quantiles as whiskers. Sample sizes are indicated within the figure. Data are documented in *Data file S2 Behavior data.xlsx*.

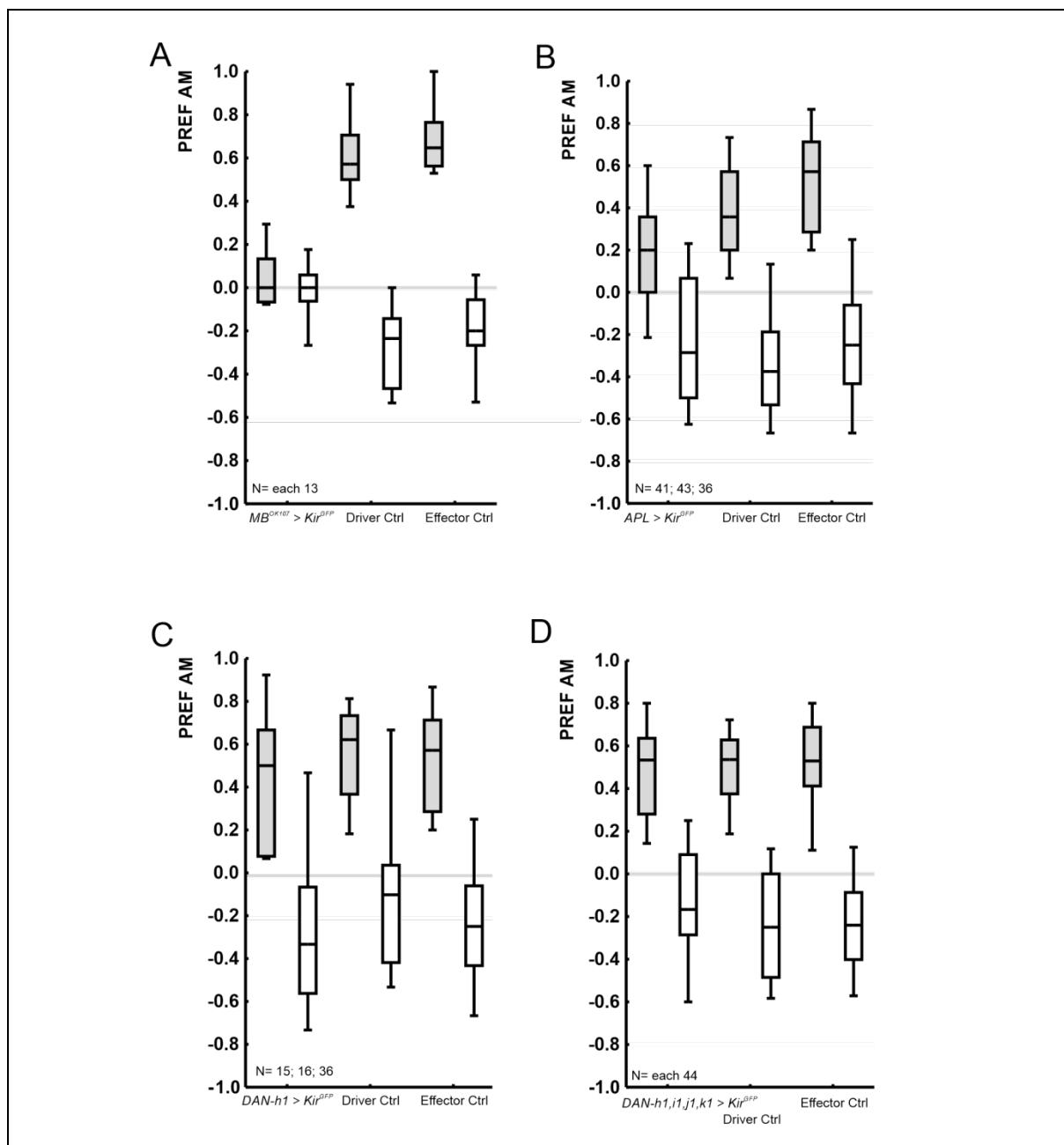


Fig. S6: Preference scores underlying the Performance Indices from Figure 3.

Visualization of the *n*-amyl acetate (AM) preference scores (PREF AM) underlying the Performance Indices from Figure 3. Preference scores after paired (grey boxes) and unpaired (white boxes) training are shown separately. The scores in A, B, C, D correspond to Figure 3C, E, G, I. Box plots show the median as the middle line, the 25/75% quantiles as box boundaries, and the 10/90% quantiles as whiskers. Sample sizes are indicated within the figure. Data are documented in *Data file S2 Behavior data.xlsx*.

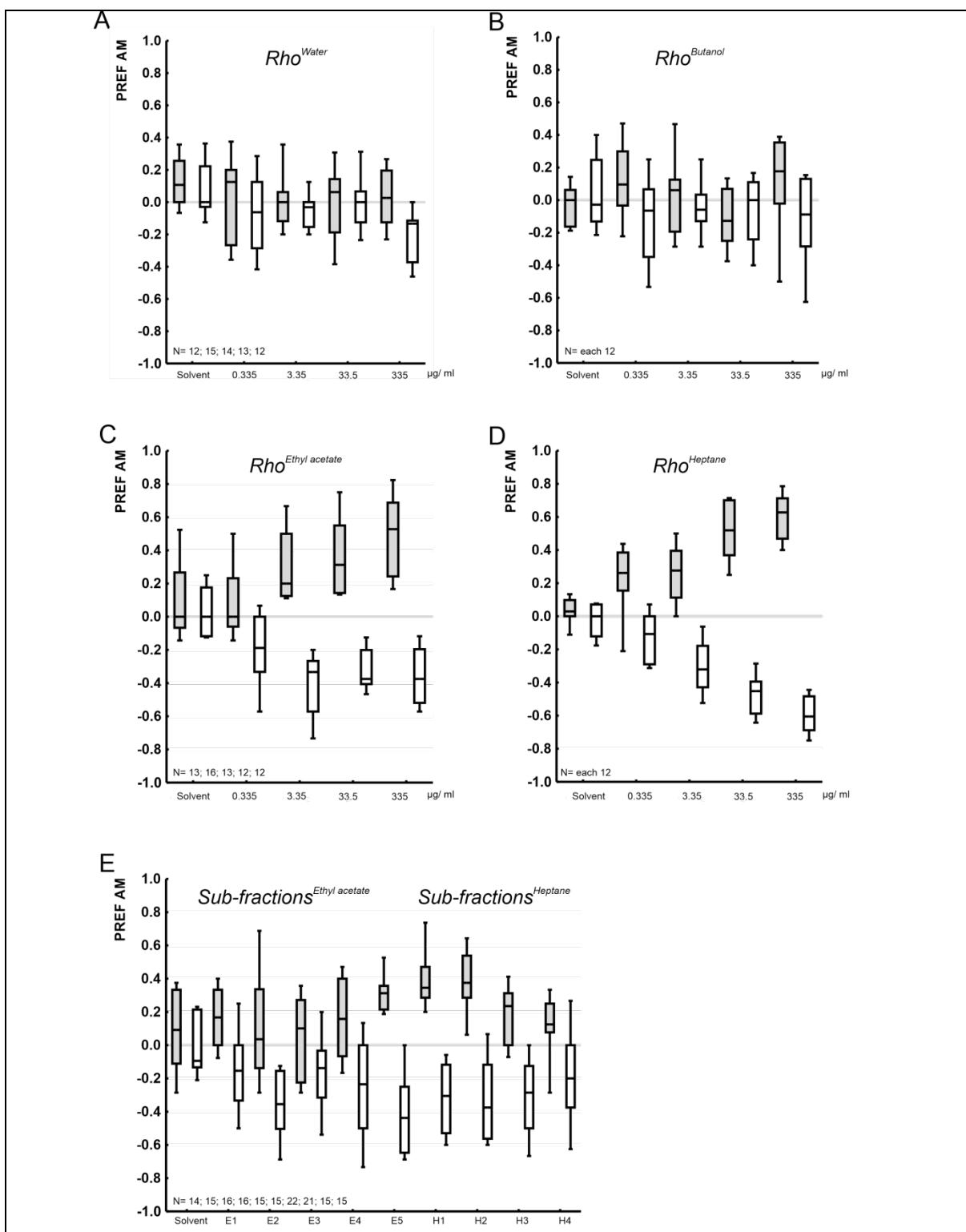
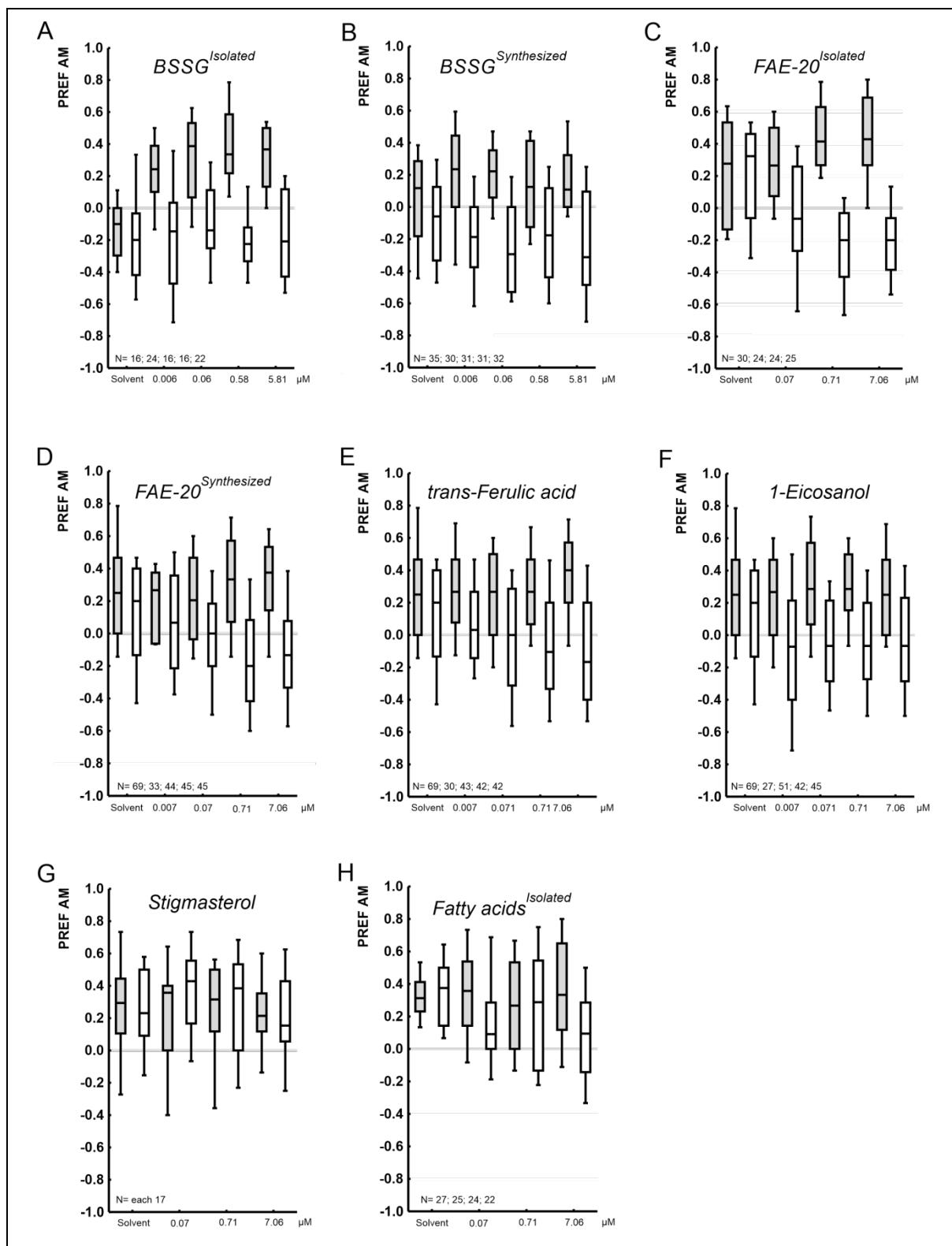


Fig. S7: Preference scores underlying the Performance Indices from Figure 4.

Visualization of the *n*-amyl acetate (AM) preference scores (PREF AM) underlying the Performance Indices from Figure 4. Preference scores after paired (grey boxes) and unpaired (white boxes) training are shown separately. The scores in A-E correspond to Figure 4C-G. Box plots show the median as the middle line, the 25/75% quantiles as box boundaries, and the 10/90% quantiles as whiskers. Sample sizes are indicated within the figure. Data are documented in *Data file S2 Behavior data.xlsx*.

**Fig. S8: Preference scores underlying the Performance Indices from Figure 5.**

Visualization of the *n*-amyl acetate (AM) preference scores (PREF AM) underlying the Performance Indices from Figure 5. Preference scores after paired (grey boxes) and unpaired (white boxes) training are shown separately. The scores in A-H correspond to Figure 5A-H. Box plots show the median as the middle line, the 25/75% quantiles as box boundaries, and the 10/90% quantiles as whiskers. Sample sizes are indicated within the figure. Data are documented in *Data file S2 Behavior data.xlsx*.

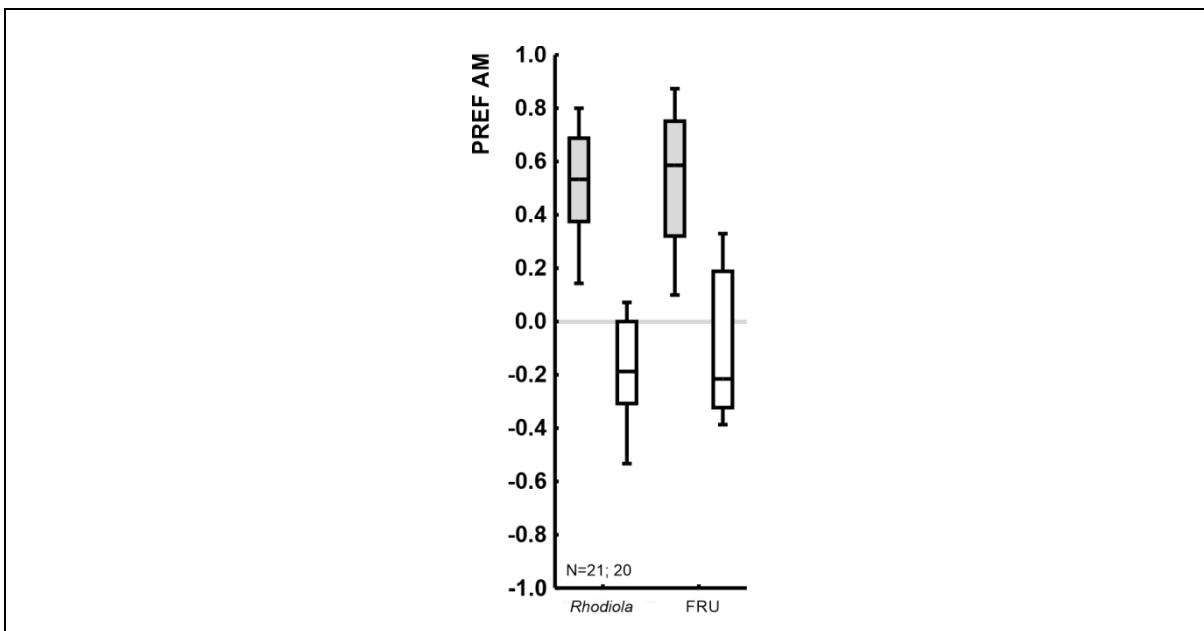


Fig. S9: Preference scores underlying the Performance Indices from Figure S1.

Visualization of the *n*-amyl acetate (AM) preference scores (PREF AM) underlying the Performance Indices from Figure S1. Preference scores after paired (grey boxes) and unpaired (white boxes) training are shown separately. Box plots show the median as the middle line, the 25/75% quantiles as box boundaries, and the 10/90% quantiles as whiskers. Sample sizes are indicated within the figure. Data are documented in *Data file S2 Behavior data.xlsx*.

Table S1. HR-ESI-MS signals (*m/z* features) correlating to the rewarding effect of *Rhodiola* fractions

Rank no.	FTICR-HR <i>m/z</i>	Spearman coefficient	Formula	MW	RDB	Calculated	Proposal
1	485.36057	0.764	C ₂₉ H ₅₀ O ₄ Na ⁺	462	4.5	485.36013	-
2	365.26635	0.664	C ₂₀ H ₃₈ O ₄ Na ⁺	342	1.5	365.26623	oxygenated fatty acid
3	497.36086	0.662	C ₃₀ H ₅₀ O ₄ Na ⁺	474	5.5	497.36013	ferulic acid eicosyl ester (FAE-20)
4	629.40341	0.624	C ₃₅ H ₅₈ O ₈ Na ⁺	606	6.5	629.40239	triterpene glycoside
5	393.29800	0.605	C ₂₂ H ₄₂ O ₄ Na ⁺	370	1.5	393.29753	oxygenated fatty acid
6	639.49637	0.605	C ₃₉ H ₆₈ O ₅ Na ⁺	616	5.5	639.49590	diglyceride
7	319.22432	0.595	C ₁₈ H ₃₂ O ₃ Na ⁺	296	2.5	319.22437	oxygenated fatty acid
8	335.21937	0.593	C ₁₈ H ₃₂ O ₄ Na ⁺	312	2.5	335.21928	oxygenated fatty acid
9	613.40841	0.588	C ₃₅ H ₅₈ O ₇ Na ⁺	590	6.5	613.40747	triterpene glycoside
10	359.14678	0.571	C ₁₈ H ₂₄ O ₆ Na ⁺	336	6.5	359.14651	-
11	345.13114	0.561	C ₁₇ H ₂₂ O ₆ Na ⁺	322	6.5	345.13086	-
12	435.17819	0.558	C ₂₄ H ₂₈ O ₆ Na ⁺	412	10.5	435.17781	-
13	144.47699	0.550	-				-
14	377.26626	0.536	C ₂₁ H ₃₈ O ₄ Na ⁺	354	2.5	377.26623	oxygenated fatty acid or monoglyceride
15	363.25069	0.530	C ₂₀ H ₃₆ O ₄ Na ⁺	340	2.5	363.25058	oxygenated fatty acid or diterpene
16	501.35597	0.525	C ₂₉ H ₅₀ O ₅ Na ⁺	478	4.5	501.35504	cholesterol derivative
17	555.36611	0.524	C ₃₂ H ₅₂ O ₆ Na ⁺	522	6.5	555.36561	triterpene acetate
18	315.15673	0.517	C ₁₇ H ₂₄ O ₄ Na ⁺	292	5.5	315.15668	sesquiterpene derivative
19	347.25551	0.517	C ₂₀ H ₃₆ O ₃ Na ⁺	324	2.5	347.25567	oxygenated fatty acid or diterpene
20	333.20380	0.511	C ₁₈ H ₃₀ O ₄ Na ⁺	310	3.5	333.20363	oxygenated fatty acid
21	393.26131	0.510	C ₂₁ H ₃₈ O ₅ Na ⁺	370	2.5	393.26114	oxygenated fatty acid or monoglyceride
22	409.25589	0.510	C ₂₁ H ₃₈ O ₆ Na ⁺	386	2.5	409.25606	monoglyceride
23	336.22327	0.507	C ₁₇ [¹³ CH ₃ O ₄ Na ⁺	312	2.5	336.22318	isotope peak of rank 8
24	379.24582	0.499	C ₂₀ H ₃₆ O ₅ Na ⁺	356	2.5	379.24549	oxygenated fatty acid or diterpene
25	348.25886	0.499	C ₁₉ [¹³ CH ₃ O ₃ Na ⁺	324	2.5	348.25960	isotope peak of rank 19
26	527.33480	0.497	C ₃₀ H ₄₈ O ₆ Na ⁺	504	6.5	527.33431	triterpene
27	317.20903	0.496	C ₁₈ H ₃₀ O ₃ Na ⁺	294	3.5	317.20871	oxygenated fatty acid
28	513.35563	0.491	C ₃₀ H ₅₀ O ₅ Na ⁺	490	5.5	513.35504	triterpene
29	615.49705	0.485	C ₃₉ H ₆₇ O ₅ ⁺ or C ₃₇ H ₆₈ O ₅ Na ⁺	614 592	6.5 3.5	615.49830 615.49589	diglyceride
30	457.29310	0.484	C ₂₆ H ₄₂ O ₅ Na ⁺	424	5.5	457.29244	pregnane derivative
31	345.24000	0.477	C ₂₀ H ₃₄ O ₃ ⁺	344	3.5	345.24002	oxygenated fatty acid or diterpene
32	413.37835	0.477	?				-
33	515.37170	0.476	C ₃₀ H ₅₂ O ₅ Na ⁺	492	4.5	515.37124	
34	378.26994	0.470	C ₂₀ [¹³ CH ₃ O ₄ Na ⁺	354	2.5	378.26958	isotope peak of rank 14
35	423.28708	0.465	C ₂₆ H ₄₀ O ₃ Na ⁺	400	6.5	423.28696	
36	437.26693	0.465	C ₂₆ H ₃₈ O ₄ Na ⁺	414	7.5	437.26623	
37	440.28543	0.465	C ₂₅ [¹³ CH ₄₀ O ₄ Na ⁺ or C ₂₀ H ₄₂ NO ₉ ⁺	416 422	6.5 0.5	440.28523 440.28541	isotope peak or NH ₄ -adduct

38	303.22935	0.464	$C_{18}H_{32}O_2Na^+$	280	2.5	303.22945	linoleic acid
39	375.12062	0.464	$C_{18}H_{24}O_6K^+$	336	6.5	375.12045	
40	441.37218	0.464	$C_{30}H_{49}O_2^+$ or $C_{28}H_{50}O_2Na^+$	440 418	6.5 3.5	441.37271 441.37030	-
41	469.36568	0.464	$C_{29}H_{50}O_3Na^+$	446	4.5	469.36521	
42	525.31925	0.464	$C_{32}H_{45}O_6^+$ $C_{30}H_{46}O_6Na^+$	524 502	10.5 7.5	525.32134	
43	529.35031	0.464	$C_{30}H_{50}O_6Na^+$	506	5.5	529.34996	
44	531.36736	0.464	$C_{32}H_{51}O_6^+$ or $C_{30}H_{52}O_6Na^+$	530 508	7.5 4.5	531.36801 531.36561	
45	545.34356	0.464	$C_{30}H_{50}O_7Na^+$	522	5.5	545.34311	
46	581.41817	0.464	$C_{35}H_{58}O_5Na^+$	558	6.5	581.41764	sitosterol glycoside – H_2O
47	597.41268	0.464	$C_{35}H_{58}O_6Na^+$	574	6.5	597.41256	-
48	616.49825	0.464	?				-
49	177.05445	0.464	$C_{10}H_9O_3^+$	176	6.5	177.05462	-
50	744.51450	0.464	?				-
51	771.54486	0.464	?				-

Table S2. Analytical data

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Table S3. Behavior data

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