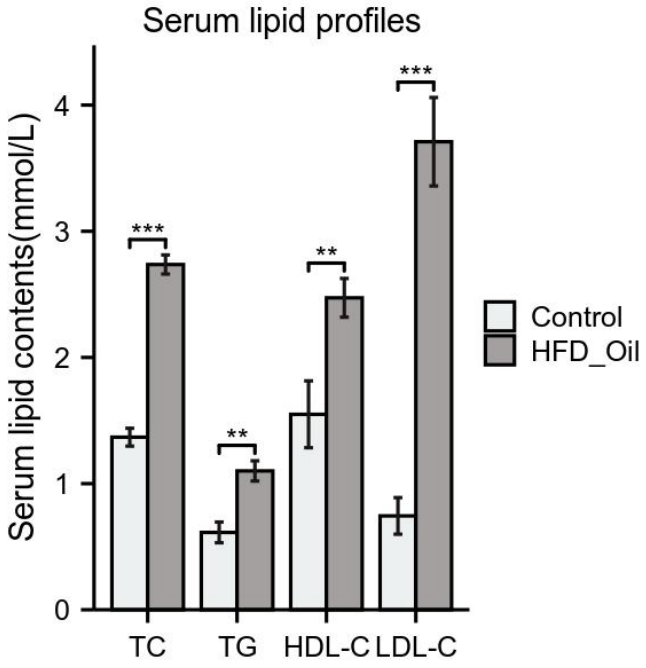

Fig.S1 Serum lipid contents after 60-day HFD exposure and without RSV treatment. (control, n=10; HFD_Oil & HFD_RSV, n=20). Statistical significance was determined by the Mann-Whitney U test. $^{**}p < 0.01$， $^{***}p < 0.001$.

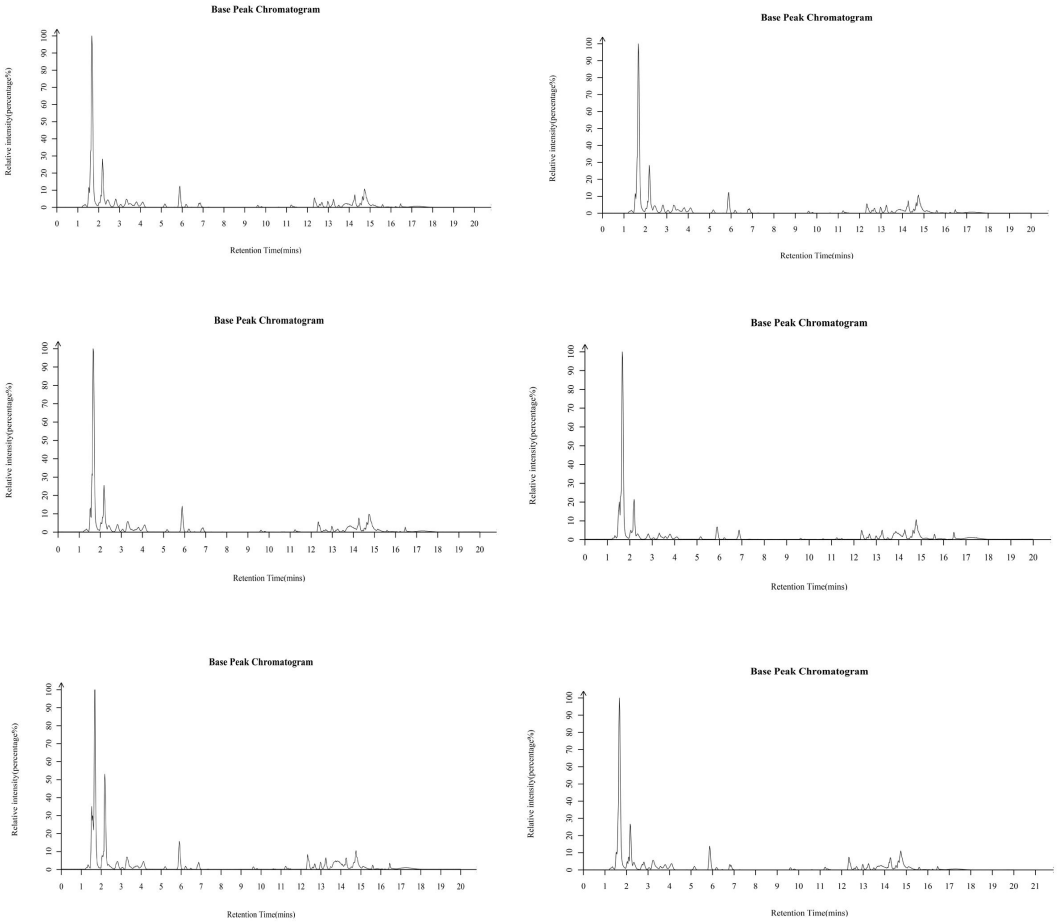

Fig.S2 Base peak chromatograms (BPC) of testis samples in various mice.

a the control mice in postive mode. b the control mice in negative mode. c HFD_Oil mice in postive mode. d HFD_ Oil mice in negative mode. e HFD_RSV mice in postive mode. f HFD_RSV mice in negative mode.

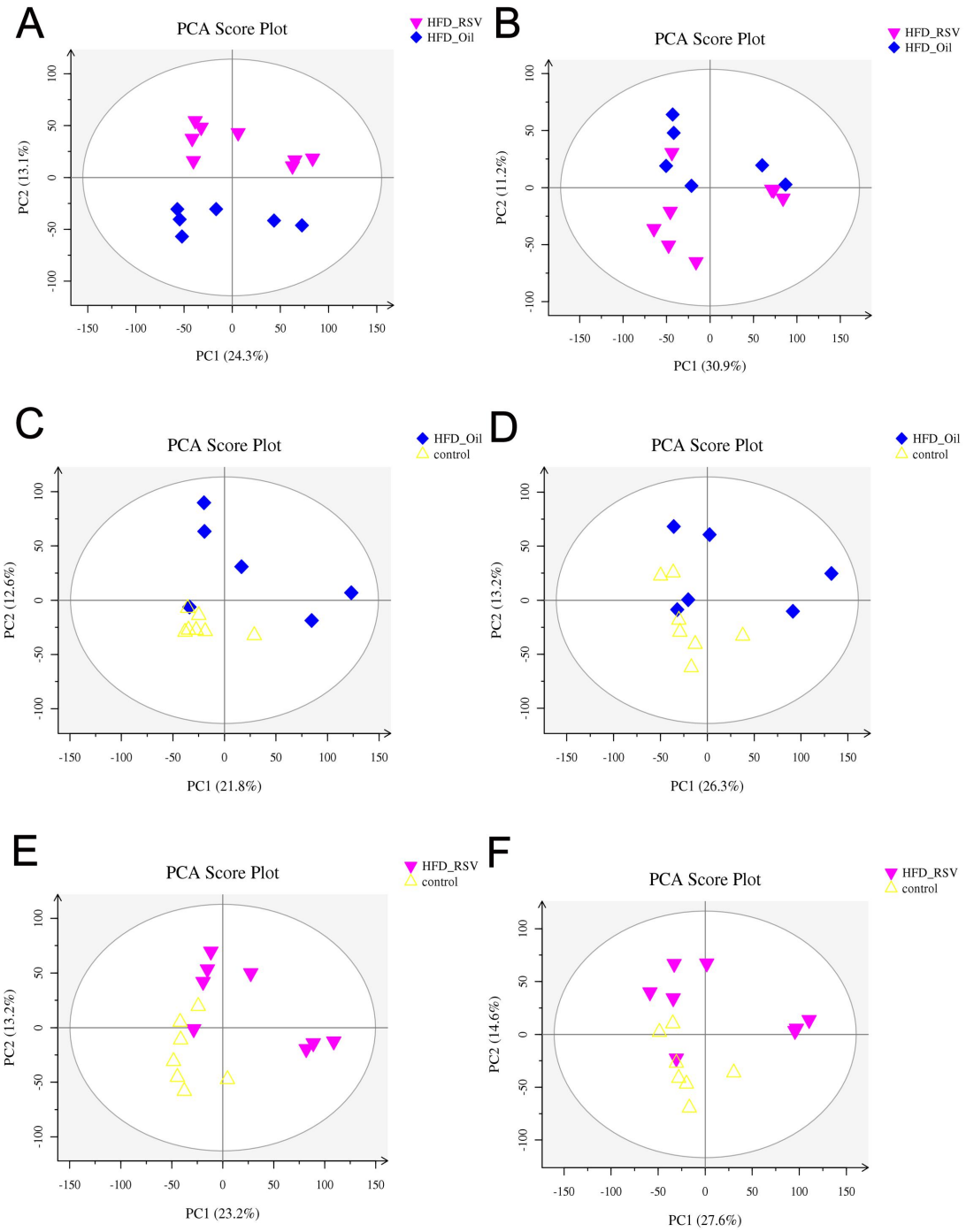

Fig.S3 Principal component analysis (PCA) score plot of testis metabolites in various groups of mice. a HFD_RSV vs HFD_Oil samples in ESI^+ mode. b HFD_RSV vs HFD_Oil samples in ESI^- mode. c HFD_Oil vs control samples in ESI^+ mode. d HFD_Oil vs control samples in ESI^- mode. e HFD_RSV vs control samples in ESI^+ mode. f HFD_RSV vs control samples in ESI^- mode.

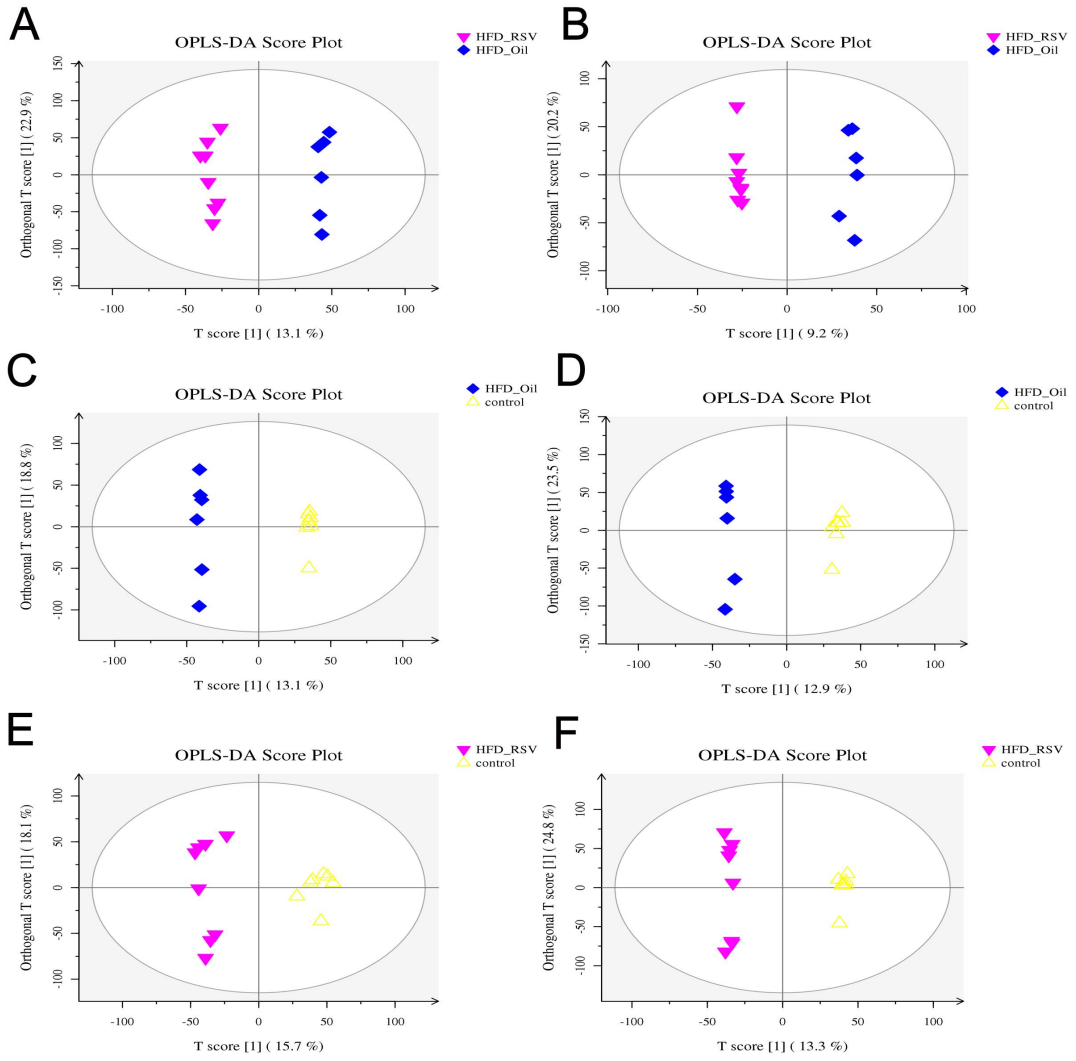

Fig.S4 Orthogonal partial least squared discriminant analysis (OPLS-DA) score plot of testis metabolites in various groups of mice. a HFD_RSV vs HFD_Oil samples in ESI^{+} mode. b HFD_RSV vs HFD_Oil samples in ESI^{-} mode. c HFD_Oil vs control samples in ESI^{+} mode. d HFD_Oil vs control samples in ESI^{-} mode. e HFD_RSV vs control samples in ESI^{+} mode. f HFD_RSV vs control samples in ESI^{-} mode.

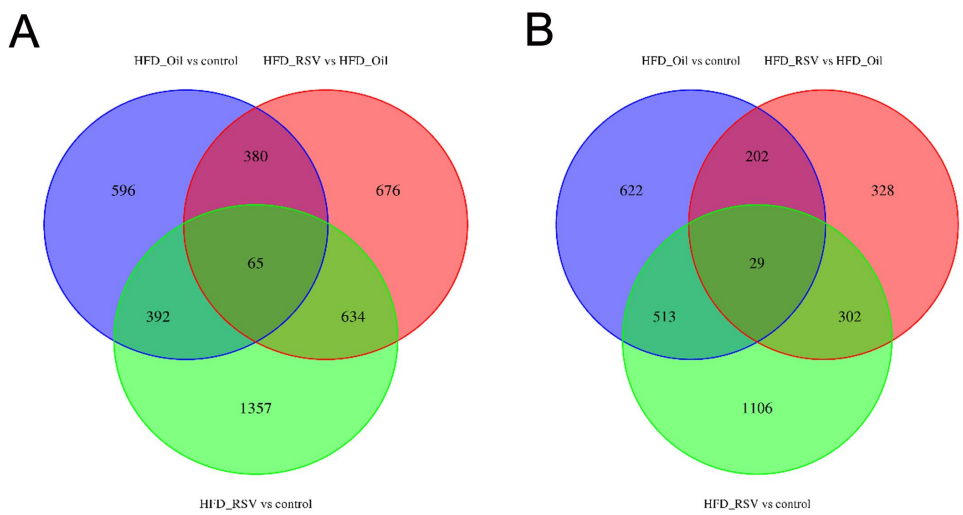

Fig.S5 Venn diagram of differential testicular metabolites in ESI^+ **(a)** and ESI^- **(b)** mode, respectively.

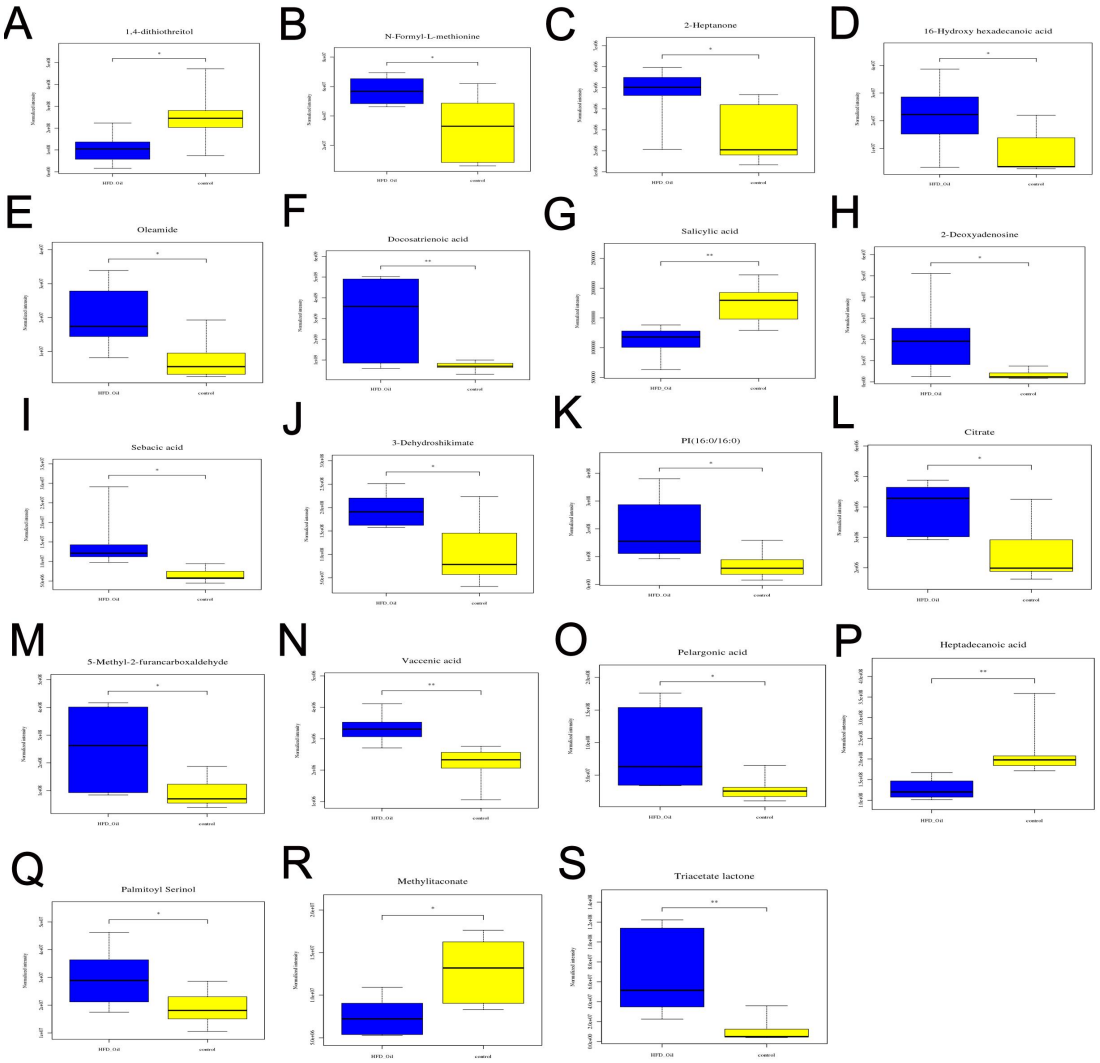

Fig.S6 The shared 19 testis metabolites in HFD_Oil vs control. * $p < 0.05$, ** $p < 0.01$

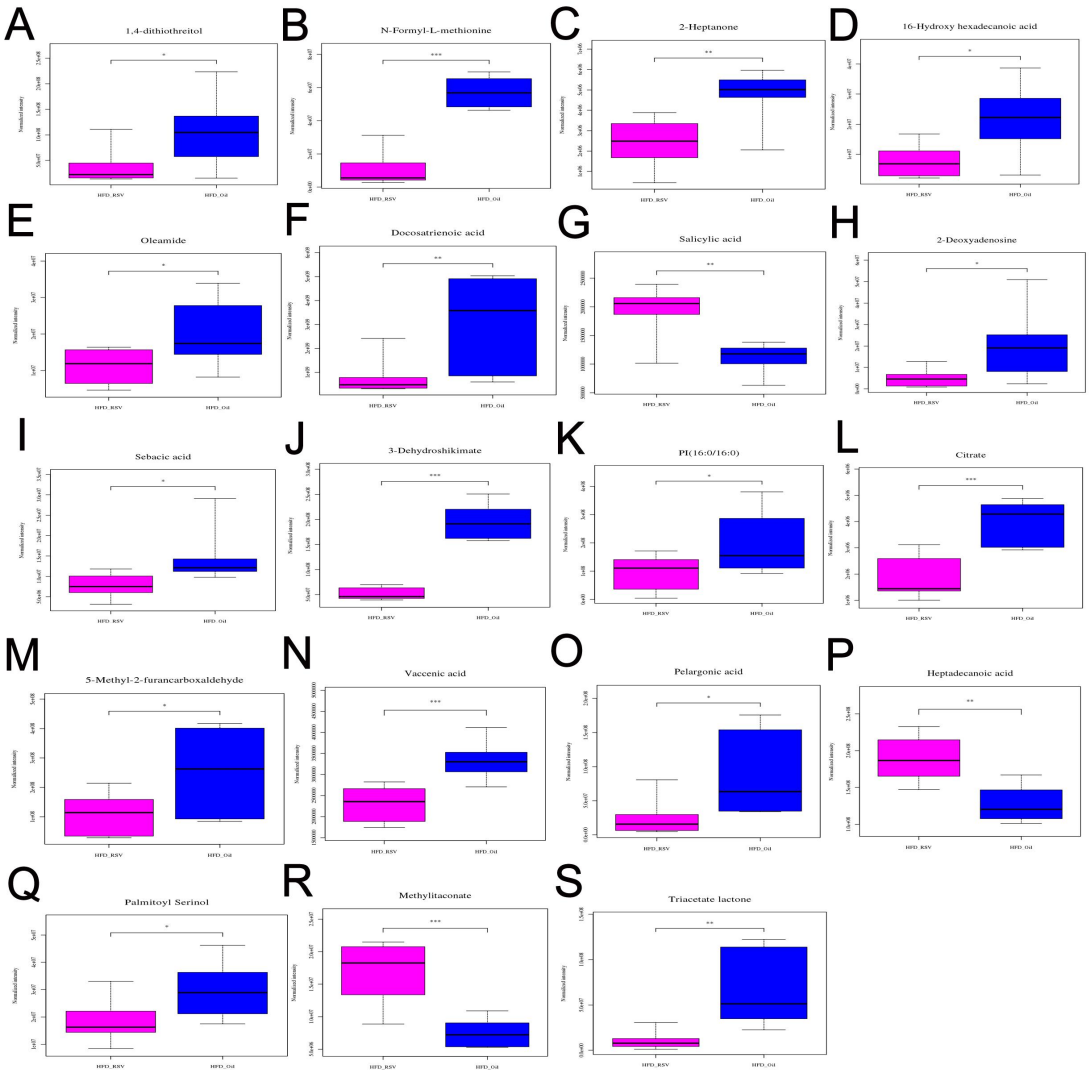

Fig.S7 The shared 19 testis metabolites in HFD_RSV vs HFD_Oil. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.005$.

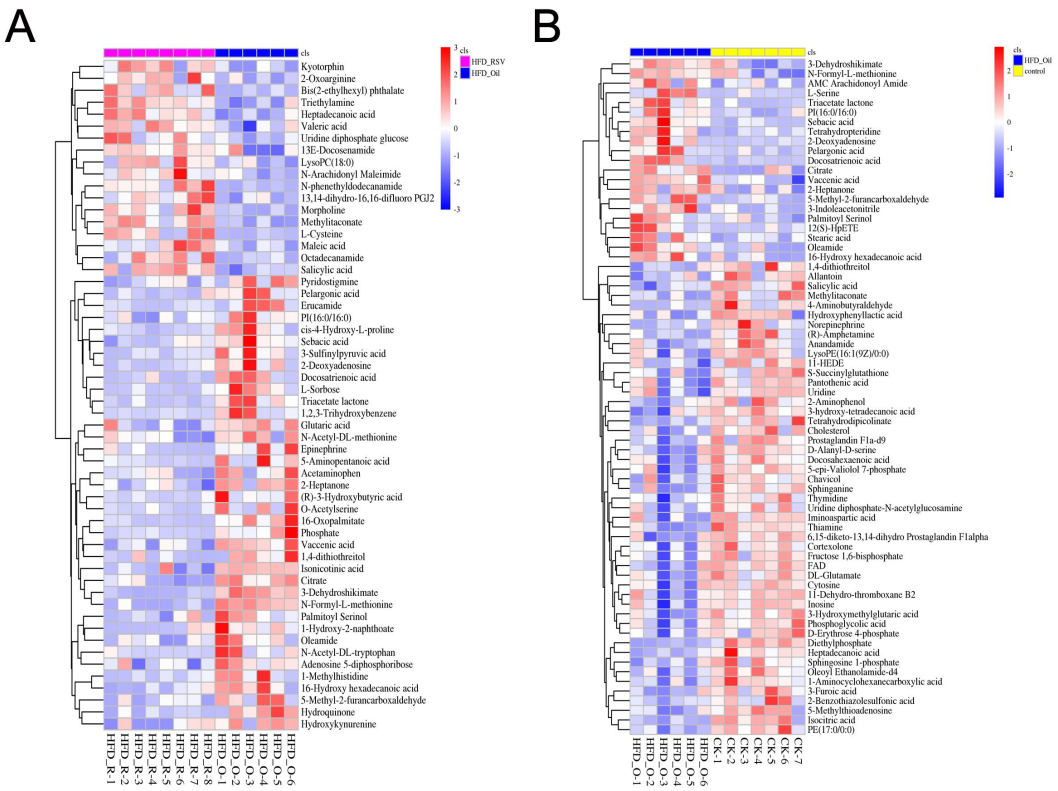

Fig.S8 Heatmap of Hierarchical cluster analysis (HCA) of differential metabolites in HFD_RSV vs HFD_Oil, HFD_Oil vs control

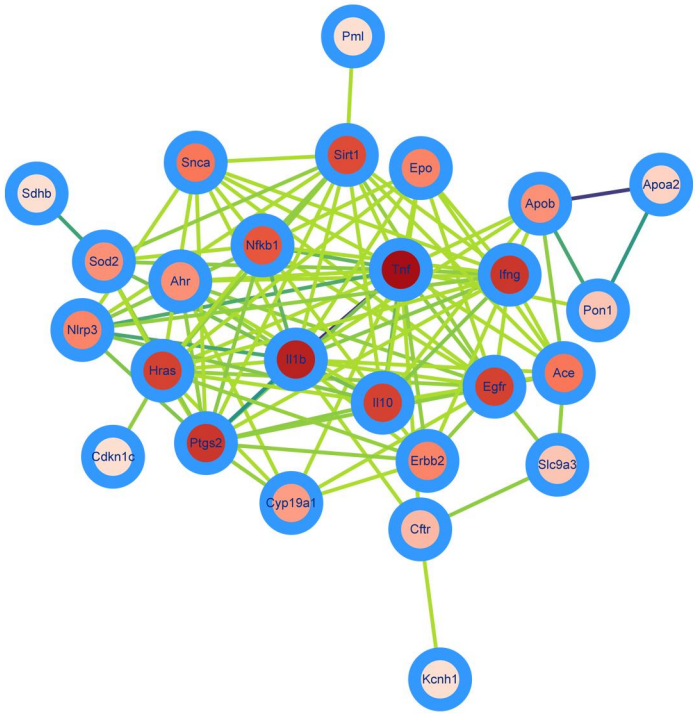

Fig.S9 PPI network for the intersected targets by STRING and Cytoscape

Nodes colors presented degree, the redder nodes reflected the higher degrees. The edges colors presented genes coexpressions, the bluer edges reflected the higher association scores.

Table S1 Theoretical Nutritional Composition of Experimental Diets

Component	Standard Diet (Control)	High-Fat Diet (HFD)
Ingredient (g/100g diet)		
Standard rodent chow powder	100	68
Food-grade lard	0	30
Cholesterol	0	2
Energy Contribution		
Fat (% of total energy)	12	60
Protein (% of total energy)	~28*	~16*
Carbohydrate (% of total energy)	~60*	~24*
Key Additive		
Cholesterol (% by weight)	0	2

Notes: 1. The energy contributions (Fat, Protein, Carbohydrate) in the table are based on typical values reported for high-fat diet models (e.g., 60% of energy from fat) and standard control diets (e.g., 12% of energy from fat) in the literature. The percentages for protein and carbohydrate are theoretical values* derived from the total energy balance. 2. The mass percentages of ingredients refer to the method for preparing a custom high-fat diet described in the literature: standard rodent chow powder was used as the base, to which specific proportions of lard and cholesterol were added. 3. This composition table presents theoretical values based on the nutritional certificates of the standardized raw materials used, aiming to ensure transparency of the formulation and reproducibility of the experiment. All diets were thoroughly homogenized during preparation to ensure uniform distribution of components.

Table S2 Parameters of molecular docking between RSV and targets.

Target	center_x	center_y	center_z	Size_x	Size_y	Size_z
Tnf	-7.207	52.594	-49.911	64.05	64.05	64.05
Il1b	1.573	27.955	8.866	66.15	66.15	66.15
Ptgs2	-14.43	-35.293	32.233	60.55	60.55	60.55
Ifng	0.089	5.633	-1.066	52.15	52.15	52.15
Hras	-40.886	-14.258	27.652	63.35	63.35	63.35
Egfr	-6.007	4.75	-10.251	61.95	61.95	61.95
Il10	2.153	-5.806	46.902	47.25	47.25	47.25
Sirt1	11.734	-1.931	18.589	65.45	65.45	65.45
Sdhd	-3.451	-2.582	-4.727	62.65	62.65	62.65

Table S3 Primer Information

Gene	Forward Primer（5′-3′）	Reverse Primer（5′-3′）	Product Size/（bp)
β-actin	GTGACGTTGACATCCGTAAAGA	GTAACAGTCCGCCTAGAAGCAC	287
Cs	AGGAAGTTGGCAAAGACGTGTC	GCTGACAGGAATAGCGAGGGT	132
Mdh2	ATTGCCTCAAAGGTTGTGATGTG	GATGGTGGAGTTCACTGGGTT	182
Ptgs2	GAAATATCAGGTCATTGGTGGAGA	ATGCTCCTGCTTGAGTATGTCG	205
GTPase Hras	AGTACAGGGAGCAGATCAAGCG	TGGCTGATGTTTCAATGTAGGG	156
Sdhb	GAGGTGGATCTGAATAAGTGCG	AGACTTTGCTGAGGTCCGTG	190
Aco2	CAGGGCCAAGGACATAAACCA	GAATCAGTGCCGATCAGAAGAA	156
Nfkb p65	CGAGTCTCCATGCAGCTACG	TTTCGGGTAGGCACAGCAATA	212
Tnf	CCTCACACTCACAAACCACCAA	CTCCTGGTATGAGATAGCAAATCG	223
Il1β	GCATCCAGCTTCAAATCTCGC	TGTTCATCTCGGAGCCTGTAGTG	256
Sele	CTGCGAAGAAGGATTTGAACTGA	CTTGGACATTGTACCACTTGGC	294

Table S4 Antibodies Information

Primary Antibodies						Secondary Antibodies			
Antibodies Name	**origin**	**Item**	**Molecular weight（KDa）**	**Source**	**Dilution ratio**	**Antibodies Name**	**Origin**	**Item**	**Dilution ratio**
ACTIN	Servicebio	GB11001	45	Rabbit	1: 1000	HRP-conjugated goat anti-rabbit	Servicebio	GB23303	1：3000
PTGS2	Servicebio	GB115672	74	Rabbit	1: 500	HRP-conjugated goat anti-rabbit	Servicebio	GB23303	1：3000
SDHB	Servicebio	GB111344	28	Rabbit	1: 500	HRP-conjugated goat anti-rabbit	Servicebio	GB23303	1：3000
CS	Servicebio	GB111883	42	Rabbit	1: 500	HRP-conjugated goat anti-rabbit	Servicebio	GB23303	1：3000
ACO2	Servicebio	GB113832	95	Rabbit	1: 500	HRP-conjugated goat anti-rabbit	Servicebio	GB23303	1：3000
P65	Servicebio	GB11997	65	Rabbit	1: 500	HRP-conjugated goat anti-rabbit	Servicebio	GB23303	1：3000
MDH2	Servicebio	GB114349	36	Rabbit	1: 500	HRP-conjugated goat anti-rabbit	Servicebio	GB23303	1：3000
IL-1β	Servicebio	GB125602	31/28/35	Rat	1: 1000	HRP-conjugated Goat Anti-Rat	Servicebio	GB23302	1：3000
GTPase HRAS	Servicebio	GB111873	21	Rabbit	1: 100000	HRP-conjugated goat anti-rabbit	Servicebio	GB23303	1：3000
TNFα	Servicebio	GB11188	26	Rabbit	1: 1000	HRP-conjugated goat anti-rabbit	Servicebio	GB23303	1：3000
SELE	Servicebio	GB115442	67	Rabbit	1: 1000	HRP-conjugated goat anti-rabbit	Servicebio	GB23303	1：3000

Table S5 testicular differential metabolites in HFD_Oil vs control groups.

Mode	metabolite	rt	exact_mass	formula	VIP	Fold Change_HFD_Oil/control	log_2(FC_HFD_Oil/control)	*p*.value	FDR	KEGG	Adduct
pos	Isocitric acid	116.844	192.027	$C_6H_8O_7$	2.161951	0.28251	-1.8236	0.001597	0.219685	C00311	[M]+
pos	Vaccenic acid	1198.825	282.2559	$C_{18}H_{34}O_2$	2.093557	1.5159	0.60021	0.002736	0.253984	C08367	$[M^+H]+$
pos	PE(17:0/0:0)	921.254	467.3012	$C_{22}H_{46}NO_7P$	2.071626	0.42748	-1.2261	0.003211	0.263578	NA	$[M^+H]+$
pos	Tetrahydrodipicolinate	146.513	171.0532	$C_7H_9NO_4$	2.05865	0.28836	-1.794	0.00352	0.26727	C03972	$[M^+H]+$
pos	D-Alanyl-D-serine	383.331	176.0797	$C_6H_{12}N_2O_4$	2.045789	0.56584	-0.82153	0.003849	0.27435	C19719	[M]+
pos	Triacetate lactone	870.0525	126.0317	$C_6H_6O_3$	1.959853	5.8627	2.5516	0.0067	0.314534	C02752	$[M^+H]+$
pos	FAD	408.997	785.1571	$C_{27}H_{33}N_9O_{15}P_2$	1.937316	0.5012	-0.99653	0.007662	0.32558	C00016	$[M^+H]+$
pos	Oleoyl Ethanolamide-d4	810.0885	329.3232	$C_{20}H_{35}D_4NO_2$	1.929035	0.67273	-0.57191	0.008041	0.329519	NA	$[M^+H]+$
pos	6,15-diketo-13,14-dihydro Prostaglandin F1alpha	692.577	370.2355	$C_{20}H_{34}O_6$	1.914196	0.58849	-0.7649	0.008756	0.334102	NA	$[M^+H]+$
pos	Prostaglandin F1a-d9	725.83	365.3128	$C_{20}H_{27}D_9O_5$	1.861235	0.50289	-0.99169	0.011706	0.334102	NA	$[M^+H^-H_2O]+$
pos	1-Aminocyclohexanecarboxylic	108.3	143.094	$C_7H_{13}NO_2$	1.844	0.54375	-0.87898	0.012	0.334	NA	$[M^+H]+$

	acid	105	6		747			762	102		
pos	Sebacic acid	594.878	202.1205	$C_{10}H_{18}O_4$	1.83044	2.2554	1.1734	0.013736	0.341114	C08277	$[M^+H^-H_2O]+$
pos	Cholesterol	818.362	386.3549	$C_{27}H_{46}O$	1.821651	0.62961	-0.66747	0.014361	0.341114	C00187	$[M^+H]+$
pos	Oleamide	912.494	281.2719	$C_{18}H_{35}NO$	1.799346	2.6203	1.3897	0.016043	0.343304	C19670	$[M^+H]+$
pos	Methylitaconate	1031.66	144.0423	$C_6H_8O_4$	1.799303	0.58559	-0.77203	0.016046	0.343304	C02295	[M]+
pos	Iminoaspartic acid	184.236	131.0219	$C_4H_5NO_4$	1.782963	0.64029	-0.6432	0.01737	0.347966	C05840	$[M^+H]+$
pos	3-Furoic acid	116.588	112.016	$C_5H_4O_3$	1.774669	0.56534	-0.82281	0.018072	0.353095	NA	$[M^+H]+$
pos	3-Dehydroshikimate	65.934	172.0372	$C_7H_8O_5$	1.76478	1.8513	0.88858	0.018936	0.36022	C02637	$[M^+H]+$
pos	5-Methyl-2-furancarboxaldehyde	75.4831	110.0368	$C_6H_6O_2$	1.75118	2.7154	1.4412	0.020175	0.363706	C11115	$[M^+H]+$
pos	5-Methylthioadenosine	397.207	297.0896	$C_{11}H_{15}N_5O_3S$	1.749493	0.46891	-1.0926	0.020333	0.364484	C00170	$[M^+H]+$
pos	(R)-Amphetamine	1198.28	135.1048	$C_9H_{13}N$	1.746282	0.55478	-0.85001	0.020636	0.364829	C07514	$[M^+H]+$
pos	4-Aminobutyraldehyde	1060	87.0684	C_4H_9NO	1.692733	0.23309	-2.1011	0.026196	0.378558	C00555	$[M^+H]+$
pos	3-Indoleacetonitrile	744.741	156.0687	$C_{10}H_8N_2$	1.686613	2.7392	1.4538	0.026895	0.37959	C02938	[M]+
pos	1,4-dithiothreitol	358.9	154.012	$C_4H_{10}O_2S_2$	1.685	0.42576	-1.2319	0.027	0.379	C00	$[M^+H]+$

		17	2		665			005	59	265	
pos	Allantoin	1114.99	158.044	$C_4H_6N_4O_3$	1.677303	0.52951	-0.91727	0.027985	0.37959	C01551	[M]+
pos	Sphingosine 1-phosphate	815.4645	379.2488	$C_{18}H_{38}NO_5P$	1.670688	0.49136	-1.0251	0.028779	0.37959	C06124	$[M^+H]+$
pos	N-Formyl-L-methionine	1020.445	177.046	$C_6H_{11}NO_3S$	1.66112	1.858	0.89375	0.029957	0.383477	C03145	[M]+
pos	11-Dehydro-thromboxane B2	727.218	368.2199	$C_{20}H_{32}O_6$	1.657697	0.5956	-0.74758	0.030386	0.383477	C05964	$[M^+H]+$
pos	Norepinephrine	401.817	169.0739	$C_8H_{11}NO_3$	1.650455	0.28094	-1.8317	0.031311	0.385869	C00547	$[M^+H]+$
pos	Pelargonic acid	779.062	158.1307	$C_9H_{18}O_2$	1.632675	3.0761	1.6211	0.033666	0.388435	C01601	$[M^+H]+$
pos	Cortexolone	780.9105	346.2144	$C_{21}H_{30}O_4$	1.630929	0.61799	-0.69436	0.033904	0.388435	C05488	[M]+
pos	Tetrahydropteridine	69.64495	136.0749	$C_6H_8N_4$	1.625828	1.9114	0.93461	0.034607	0.389103	C05650	[M]+
pos	Anandamide	932.8285	347.2824	$C_{22}H_{37}NO_2$	1.591227	0.60063	-0.73545	0.039657	0.395291	C11695	$[M^+H]+$
pos	AMC Arachidonoyl Amide	869.921	461.293	$C_{30}H_{39}NO_3$	1.578546	1.848	0.88595	0.041634	0.397145	NA	$[M^+H]+$
pos	L-Serine	92.6057	105.0426	$C_3H_7NO_3$	1.570301	1.8332	0.87434	0.042958	0.398408	C00065	$[M^+H]+$
pos	2-Aminophenol	1074.47	109.0528	C_6H_7NO	1.570049	0.51399	-0.96018	0.042999	0.398408	C01987	$[M^+H]+$

pos	Hydroxyphenyllactic acid	1036.735	182.0582	$C_9H_{10}O_4$	1.570042	0.62877	-0.66941	0.043	0.398408	C03672	$[M^+H]+$
pos	Cytosine	122.0235	111.0433	$C_4H_5N_3O$	1.565734	0.67283	-0.57168	0.043704	0.402336	C00380	$[M^+H]+$
pos	DL-Glutamate	233.861	147.0532	$C_5H_9NO_4$	1.563226	0.64427	-0.63427	0.044117	0.403374	C00025	$[M^+H]+$
pos	LysoPE(16:1(9Z)/0:0)	835.561	451.2699	$C_{21}H_{42}NO_7P$	1.561584	0.64406	-0.63474	0.04439	0.403981	NA	$[M^+H]+$
pos	Chavicol	824.332	134.0732	$C_9H_{10}O$	1.560137	0.76673	-0.3832	0.044631	0.404 49	C16930	$[M^+H]+$
pos	Palmitoyl Serinol	841.9395	329.293	$C_{19}H_{39}NO_3$	1.539429	1.5636	0.64483	0.048184	0.407477	NA	$[M^+H]+$
pos	12(S)-HpETE	761.19	336.2301	$C_{20}H_{32}O_4$	1.534968	5.407	2.4348	0.048975	0.409487	C05965	$[M^+H^-H_2O]+$
neg	Diethylphosphate	527.411	154.0395	$C_4H_{11}O_4P$	2.453219	0.090948	-3.4588	7.4E-05	0.104725	C06608	$[M^-H]-$
neg	Thiamine	920.458	337.27	$C_{12}H_{17}N_4OS.HCl.Cl$	2.242174	0.67158	-0.57437	0.000927	0.200988	NA	[M]-
neg	Salicylic acid	387.51	138.0317	$C_7H_6O_3$	2.06117	0.64048	-0.64277	0.003901	0.234778	C00805	[M]-
neg	Docosatrienoic acid	891.1105	334.2872	$C_{22}H_{38}O_2$	1.95139	4.3408	2.1179	0.007766	0.281 47	NA	$[M^-H]-$
neg	Heptadecanoic acid	868.6425	270.4507	$C_{17}H_{34}O_2$	1.921147	0.58944	-0.76258	0.009221	0.290824	NA	$[M^-H]-$
neg	Sphinganine	920.3036	301.2981	$C_{18}H_{39}NO_2$	1.88258	0.74433	-0.42599	0.011367	0.311 64	C00836	[M]-

neg	Phosphoglycolic acid	80.20555	155.9824	$C_2H_5O_6P$	1.840963	0.59037	-0.7603	0.014084	0.322673	C00988	[M-H]-
neg	11-HEDE	907.7165	324.2664	$C_{20}H_{36}O_3$	1.811467	0.56372	-0.82694	0.016287	0.332286	NA	[M-H]-
neg	Citrate	1017.665	192.1235	$C_6H_8O_7$	1.810788	1.6055	0.68299	0.016341	0.332286	C00158	[M-H]-
neg	5-epi-Valiolol 7-phosphate	86.7514	274.0454	$C_7H_{15}O_9P$	1.791832	0.65739	-0.60517	0.017891	0.335184	C21204	[M-H]-
neg	3-Hydroxymethylglutaric acid	86.6348	162.0528	$C_6H_{10}O_5$	1.778053	0.69882	-0.51702	0.019084	0.335248	C03761	[M-H]-
neg	PI(16:0/16:0)	965.033	810.5258	$C_{41}H_{79}O_{13}P$	1.771147	2.8598	1.5159	0.019704	0.340389	NA	[M-H]-
neg	2-Deoxyadenosine	856.14	251.102	$C_{10}H_{13}N_5O_3$	1.757915	6.2416	2.6419	0.020934	0.343785	C00559	[M-H]-
neg	3-hydroxy-tetradecanoic acid	827.731	244.2038	$C_{14}H_{28}O_3$	1.744986	0.8333	-0.26309	0.02219	0.35245	NA	[M-H]-
neg	Stearic acid	774.5255	284.2715	$C_{18}H_{36}O_2$	1.714579	2.28	1.189	0.025363	0.356662	C01530	[M-H]-
neg	Fructose 1,6-bisphosphate	77.53865	339.996	$C_6H_{14}O_{12}P_2$	1.694435	0.59653	-0.74533	0.027642	0.369987	C00354	[M-H]-
neg	S-Succinylglutathione	191.235	407.0999	$C_{14}H_{21}N_3O_9S$	1.680351	0.48919	-1.0315	0.029322	0.37196	C03174	[M-H]-
neg	2-Heptanone	126.7835	114.1045	$C_7H_{14}O$	1.617298	1.6416	0.71513	0.037776	0.39232	C08380	[M]-
neg	Thymidine	782.957	242.0903	$C_{10}H_{14}N_2O_5$	1.616748	0.65736	-0.60524	0.037857	0.39232	C00214	[M-H_2O-H]-

neg	Pantothenic acid	190.2375	219.1107	$C_9H_{17}NO_5$	1.615154	0.5386	-0.89272	0.038091	0.39232	C00864	[M-H]-
neg	Uridine diphosphate-N-acetylglucosamine	86.6635	607.0816	$C_{17}H_{27}N_3O_{17}P_2$	1.604154	0.71229	-0.48946	0.03974	0.395369	C00043	[M-H]-
neg	D-Erythrose 4-phosphate	83.1303	200.0086	$C_4H_9O_7P$	1.599945	0.64647	-0.62935	0.040384	0.395369	C00279	[M-H]-
neg	16-Hydroxy hexadecanoic acid	850.023	272.2351	$C_{16}H_{32}O_3$	1.580583	2.442	1.288	0.043445	0.406046	C18218	[M]-
neg	Docosahexaenoic acid	967.4375	328.2402	$C_{22}H_{32}O_2$	1.564764	0.65535	-0.60967	0.046068	0.40668	C06429	[M-H]-
neg	Inosine	311.0155	268.0808	$C_{10}H_{12}N_4O_5$	1.562277	0.6754	-0.56619	0.04649	0.40668	C00294	[M-H]-
neg	Uridine	215.1425	244.0695	$C_9H_{12}N_2O_6$	1.559528	0.58503	-0.77342	0.04696	0.407464	C00299	[M-H]-
neg	2-Benzothiazolesulfonic acid	456.7875	214.9711	$C_7H_5NO_3S_2$	1.543452	0.43838	-1.1897	0.049778	0.417348	NA	[M-H]-

Table S6 testicular differential metabolites in HFD_RSV vs HFD_Oil groups.

Mode	metabolite	rt(s)	exact_mass	formula	VIP	Fold Change_HFD_Oil/control	log_2(FC_HFD_Oil/control)	*p*.value	FDR	KEGG	Adduct
pos	3-Dehydroshikimate	65.934	172.0372	$C_7H_8O_5$	2.639369	0.26474	-1.9174	2.1E-07	0.001243	C02637	[M+H]+
pos	N-Formyl-L-methionine	1020.445	177.046	$C_6H_{11}NO_3S$	2.591272	0.18082	-2.4673	1.19E-06	0.001763	C03145	[M]+
pos	Methylitaconate	1031.66	144.0423	$C_6H_8O_4$	2.208993	2.2517	1.171	0.000681	0.074375	C02295	[M]+
pos	Vaccenic acid	1198.825	282.2559	$C_{18}H_{34}O_2$	2.173623	0.68815	-0.53922	0.000949	0.083763	C08367	[M+H]+
pos	Triethylamine	109.849	101.1204	$C_6H_{15}N$	2.116819	2.5529	1.3522	0.001548	0.103177	C14691	[M]+
pos	16-Oxopalmitate	23.2259	270.2195	$C_{16}H_{30}O_3$	2.078819	0.089715	-3.4785	0.002095	0.117448	C19614	[M+H]+
pos	Hydroquinone	1035.35	110.0368	$C_6H_6O_2$	2.064917	0.33392	-1.5824	0.002329	0.121405	C00530	[M]+
pos	Triacetate lactone	870.0525	126.0317	$C_6H_6O_3$	2.026183	0.15559	-2.6842	0.003093	0.133818	C02752	[M+H]+
pos	N-phenethyldodecanamide	963.372	303.2562	$C_{20}H_{33}NO$	2.013771	7.0363	2.8148	0.003376	0.137443	NA	[M+H]+
pos	Morpholine	1026.685	87.0684	C_4H_9NO	2.002864	4.4929	2.1677	0.00364	0.139463	C14452	[M+H]+
pos	Isonicotinic acid	1197.535	123.032	$C_6H_5NO_2$	1.993302	0.7278	-0.45839	0.003885	0.140343	C07446	[M+H]+

pos	L-Cysteine	55.892	121.0197	$C_3H_7NO_2S$	1.939105	2.764	1.4668	0.00553	0.15842	C00096 7	[M]+
pos	Kyotorphin	92.6195	337.175	$C_{15}H_{23}N_5O_4$	1.875845	2.7756	1.4728	0.008088	0.18071	C02992 3	[M]+
pos	Bis(2-ethylhexyl) phthalate	1136.54	390.277	$C_{24}H_{38}O_4$	1.871934	4.3607	2.1246	0.008272	0.18125	NA	[M+H]+
pos	L-Sorbose	898.4675	180.0634	$C_6H_{12}O_6$	1.866941	0.21681	-2.2055	0.008511	0.18143	C00247	[M+H]+
pos	cis-4-Hydroxy-L-proline	1139.85	131.0582	$C_5H_9NO_3$	1.795085	0.27768	-1.8485	0.012585	0.21659	C01015	[M]+
pos	Valeric acid	94.9838	102.0681	$C_5H_{10}O_2$	1.7762	1.1897	0.25054	0.013869	0.22035	C00803	[M]+
pos	Phosphate	142.096	97.9769	H_3PO_4	1.774384	0.14917	-2.7449	0.013998	0.22035	C00009	[M+H]+
pos	LysoPC(18:0)	832.559	523.6832	$C_{26}H_{54}NO_7P$	1.744205	2.6044	1.381	0.016271	0.23302	NA	[M+H]+
pos	Octadecanamide	874.4765	283.2875	$C_{18}H_{37}NO$	1.725249	2.2829	1.1909	0.017836	0.24223	C13841 6	[M+H]+
pos	Glutaric acid	8.28623	132.0423	$C_5H_8O_4$	1.71414	0.49193	-1.0235	0.018804	0.24649	C00487 9	[M]+
pos	2-Oxoarginine	577.065	173.08	$C_6H_{11}N_3O_3$	1.700911	2.5412	1.3455	0.020009	0.25207	C03779 1	[M]+
pos	3-Sulfinylpyruvic acid	1035.73	151.9779	$C_3H_4O_5S$	1.699388	0.26805	-1.8994	0.020152	0.25218	C05527	[M+H]+
pos	Pelargonic acid	779.062	158.1307	$C_9H_{18}O_2$	1.693526	0.2692	-1.8932	0.020707	0.25545	C01604 1	[M+H]+

pos	Erucamide	982.005	337.584	$C_{22}H_{43}NO$	1.664544	0.23358	-2.098	0.023622	0.26976	NA	[M+H]+
pos	1,2,3-Trihydroxybenzene	357.54	126.0317	$C_6H_6O_3$	1.657202	0.068868	-3.86	0.024407	0.27371	C01108	[M+H]+
pos	1-Methylhistidine	414.823	169.0851	$C_7H_{11}N_3O_2$	1.640513	0.25319	-1.9817	0.026265	0.27919	C01152	[M+H]+
pos	Sebacic acid	594.878	202.1205	$C_{10}H_{18}O_4$	1.635484	0.52606	-0.92669	0.026845	0.28136	C08277	[M+H-H_2O]+
pos	Epinephrine	71.69825	183.0895	$C_9H_{13}NO_3$	1.627471	0.27333	-1.8713	0.027789	0.28431	C00788	[M]+
pos	5-Methyl-2-furancarboxaldehyde	75.4831	110.0368	$C_6H_6O_2$	1.616943	0.42329	-1.2403	0.029066	0.28851	C11115	[M+H]+
pos	1,4-dithiothreitol	358.917	154.0122	$C_4H_{10}O_2S_2$	1.604823	0.33874	-1.5617	0.030591	0.29087	C00265	[M+H]+
pos	5-Aminopentanoic acid	168.364	117.079	$C_5H_{11}NO_2$	1.598267	0.16693	-2.5827	0.03144	0.29450	C00431	[M+H]+
pos	Acetaminophen	343.553	151.0633	$C_8H_9NO_2$	1.585271	0.57211	-0.80564	0.033174	0.29892	C06804	[M]+
pos	Pyridostigmine	302.979	181.0977	$C_9H_{13}N_2O_2$	1.583049	0.44368	-1.1724	0.033478	0.29892	C07410	[M+H]+
pos	1-Hydroxy-2-naphthoate	439.8385	188.0473	$C_{11}H_8O_3$	1.555232	0.31459	-1.6684	0.037453	0.31248	C03203	[M+H-H_2O]+
pos	Palmitoyl Serinol	841.9395	329.293	$C_{19}H_{39}NO_3$	1.553013	0.6169	-0.69689	0.037785	0.31331	NA	[M+H]+

pos	(R)-3-Hydroxybutyric acid	79.5253	104.0473	$C_4H_8O_3$	1.550103	0.3724	-1.4251	0.038223	0.314173	C01089	[M+H-H_2O]+
pos	N-Acetyl-DL-tryptophan	557.691	246.1	$C_{13}H_{14}N_2O_3$	1.536343	0.15546	-2.6854	0.040345	0.31786	NA	[M+H]+
pos	Oleamide	912.494	281.2719	$C_{18}H_{35}NO$	1.526343	0.56058	-0.83502	0.04194	0.322077	C19670	[M+H]+
pos	Hydroxykynurenine	750.316	224.0797	$C_{10}H_{12}N_2O_4$	1.513259	0.56265	-0.82968	0.044097	0.325484	C02794	[M]+
pos	13E-Docosenamide	968.282	337.3345	$C_{22}H_{43}NO$	1.497316	1.5883	0.66744	0.046833	0.331318	NA	[M+H]+
pos	N-Arachidonyl Maleimide	922.926	369.2668	$C_{24}H_{35}NO_2$	1.490903	1.9523	0.96519	0.047968	0.331681	NA	[M+H]+
pos	N-Acetyl-DL-methionine	435.2355	191.062	$C_7H_{13}NO_3S$	1.485336	0.55757	-0.84277	0.048969	0.333546	C02712	[M+H]+
pos	O-Acetylserine	253.299	147.0532	$C_5H_9NO_4$	1.480672	0.25245	-1.9859	0.04982	0.336308	C00979	[M+H]+
neg	Citrate	1017.665	192.1235	$C_6H_8O_7$	2.707317	0.46535	-1.1036	0.000376	0.121731	C00158	[M-H]-
neg	Salicylic acid	387.51	138.0317	$C_7H_6O_3$	2.568581	1.7543	0.81092	0.001163	0.19936	C00805	[M]-
neg	Heptadecanoic acid	868.6425	270.4507	$C_{17}H_{34}O_2$	2.511119	1.4867	0.57213	0.001737	0.239508	NA	[M-H]-

neg	2-Heptanone	126.7835	114.1045	$C_7H_{14}O$	2.327905	0.51524	-0.95669	0.005189	0.34554	C08380	[M]-
neg	Docosatrienoic acid	891.1105	334.2872	$C_{22}H_{38}O_2$	2.251483	0.23938	-2.0626	0.00766	0.40935	NA	[M-H]-
neg	16-Hydroxy hexadecanoic acid	850.023	272.2351	$C_{16}H_{32}O_3$	2.135532	0.35019	-1.5138	0.013047	0.48889	C18218	[M]-
neg	13,14-dihydro-16,16-difluoro PGJ2	874.401	372.2112	$C_{20}H_{30}F_2O_4$	2.032006	2.4694	1.3042	0.019959	0.52714	NA	[M-H]-
neg	2-Deoxyadenosine	856.14	251.102	$C_{10}H_{13}N_5O_3$	1.976179	0.234	-2.0954	0.024679	0.56340	C00551	[M-H]-
neg	Maleic acid	1000.82	116.011	$C_4H_4O_4$	1.932572	2.4362	1.2847	0.028913	0.58473	C01384	[M-H]-
neg	Adenosine 5-diphosphoribose	973.602	559.32	$C_{15}H_{23}N_5O_{14}P_2$	1.875064	0.61495	-0.70147	0.035296	0.61868	NA	[M]-
neg	Uridine diphosphate glucose	85.4223	566.055	$C_{15}H_{24}N_2O_{17}P_2$	1.830817	2.2991	1.2011	0.040875	0.63339	C00029	[M-H]-
neg	PI(16:0/16:0)	965.033	810.5258	$C_{41}H_{79}O_{13}P$	1.773918	0.47772	-1.0658	0.048968	0.66037	NA	[M-H]-

Table S7 testicular differential metabolites in HFD_RSV vs control groups

Mode	metabolite	rt(s)	exact_mass	formula	VIP	Fold Change_HFD_Oil/control	log_2(FC_HFD_Oil/control)	*p*.value	FDR	KEGG	Adduct
pos	Phosphate	142.096	97.9769	H_3PO_4	2.092827	0.17928	-2.4797	0.000267	0.027554	C00009	[M+H]+
pos	Melamine	132.3565	126.0654	$C_3H_6N_6$	2.091918	0.44671	-1.1626	0.00027	0.027554	C08737	[M]+
pos	1,4-dithiothreitol	358.917	154.0122	$C_4H_{10}O_2S_2$	2.078751	0.14422	-2.7936	0.000315	0.028928	C00265	[M+H]+
pos	Acetaminophen	343.553	151.0633	$C_8H_9NO_2$	1.990876	0.43685	-1.1948	0.00081	0.043493	C06804	[M]+
pos	1-Methyladenosine	345.04	281.1124	$C_{11}H_{15}N_5O_4$	1.984474	0.42826	-1.2235	0.000862	0.045034	C02494	[M+H]+
pos	5-Methylcytidine	132.361	257.10117	$C_{10}H_{15}N_3O_5$	1.974646	0.44883	-1.1558	0.000948	0.047334	NA	[M+H]+
pos	Creatine	100.877	131.0695	$C_4H_9N_3O_2$	1.972251	0.40952	-1.288	0.00097	0.047421	C00300	[M+H]+
pos	N-Acetylglutamic acid	205.821	189.0637	$C_7H_{11}NO_5$	1.955975	0.48428	-1.0461	0.00113	0.051981	C00624	[M+H]+
pos	6,15-diketo-13,14-dihydro Prostaglandin F1alpha	692.577	370.23554	$C_{20}H_{34}O_6$	1.951801	0.62092	-0.68752	0.001174	0.052426	NA	[M+H]+
pos	7-Methylguanine	132.73	165.0651	$C_6H_7N_5O$	1.928407	0.49237	-1.0222	0.001449	0.057268	C02242	[M+H]+

pos	Iminoaspartic acid	184.236	131.0219	$C_4H_5NO_4$	1.919121	0.6372	-0.65019	0.001572	0.059577	C05840	[M+H]+
pos	1-Pyrroline-5-carboxylic acid	192.758	113.0477	$C_5H_7NO_2$	1.898904	0.18726	-2.4168	0.001867	0.0624	C04322	[M+H]+
pos	2-Dehydro-3-deoxy-L-rhamnonate	273.907	162.0528	$C_6H_{10}O_5$	1.895402	0.50969	-0.9723	0.001923	0.062531	C03979	[M+H]+
pos	N-phenethyldodecanamide	963.372	303.25621	$C_{20}H_{33}NO$	1.882507	6.0313	2.5925	0.002138	0.065539	NA	[M+H]+
pos	Hydroquinone	1035.35	110.0368	$C_6H_6O_2$	1.855744	0.29316	-1.7702	0.002648	0.069364	C00530	[M]+
pos	p-Hydroxyphenylacetic acid	236.4855	152.0473	$C_8H_8O_3$	1.842444	0.51206	-0.96562	0.002935	0.073263	C00642	[M+H]+
pos	Docosanamide	983.386	339.35012	$C_{22}H_{45}NO$	1.835867	0.44262	-1.1759	0.003086	0.074515	NA	[M+H]+
pos	PE(16:0/0:0)	878.689	453.2855	$C_{21}H_{44}NO_7P$	1.826921	0.58374	-0.77661	0.003301	0.076885	NA	[M+H]+
pos	Norepinephrine	401.817	169.0739	$C_8H_{11}NO_3$	1.825566	0.11666	-3.0996	0.003335	0.077212	C00547	[M+H]+
pos	3-Furoic acid	116.588	112.01605	$C_5H_4O_3$	1.822621	0.49316	-1.0199	0.003409	0.077699	NA	[M+H]+
pos	1-Aminocyclohexane carboxylic acid	108.3105	143.09463	$C_7H_{13}NO_2$	1.819522	0.54811	-0.86746	0.003488	0.078456	NA	[M+H]+
pos	Bis(2-ethylhexyl) phthalate	1136.54	390.27701	$C_{24}H_{38}O_4$	1.817915	4.7573	2.2501	0.00353	0.078616	NA	[M+H]+
pos	Cholesterol	818.362	386.3549	$C_{27}H_{46}O$	1.816736	0.61156	-0.70944	0.003561	0.078	C00187	[M+H]+

									616		
pos	Hydroxyphenyllactic acid	1036.735	182.058	$C_9H_{10}O_4$	1.815238	0.40461	-1.3054	0.0036	0.078944	C03672	[M+H]+
pos	2-Aminophenol	1074.47	109.0528	C_6H_7NO	1.806393	0.40289	-1.3115	0.00384	0.081844	C01987	[M+H]+
pos	Cytosine	122.0235	111.0433	$C_4H_5N_3O$	1.759618	0.59482	-0.74948	0.005331	0.093681	C00380	[M+H]+
pos	Ectoine	106.053	142.0742	$C_6H_{10}N_2O_2$	1.758567	0.29486	-1.7619	0.005369	0.093874	C06231	[M+H]+
pos	Cytidine	122.0235	243.0855	$C_9H_{13}N_3O_5$	1.748438	0.60213	-0.73186	0.005748	0.096522	C00475	[M+H]+
pos	Allocholic acid	934.499	408.2876	$C_{24}H_{40}O_5$	1.726232	0.34137	-1.5506	0.00665	0.103435	C00695	[M]+
pos	Creatinine	97.107	113.0589	$C_4H_7N_3O$	1.723818	0.65315	-0.61452	0.006755	0.103465	C00791	[M+H]+
pos	9-Riburonosyladenine	405.54	281.076	$C_{10}H_{11}N_5O_5$	1.711285	0.4528	-1.1431	0.007319	0.105851	C11501	[M]+
pos	2-Hydroxyglutarate	164.6995	148.0372	$C_5H_8O_5$	1.702901	0.35171	-1.5075	0.007716	0.108076	C03196	[M]+
pos	1-heptadecanoyl-sn-glycero-3-phosphocholine	922.541	509.34812	$C_{25}H_{52}NO_7P$	1.695693	0.40088	-1.3188	0.008071	0.109973	NA	[M+H]+
pos	Allose	987.8715	180.0634	$C_6H_{12}O_6$	1.675141	0.87071	-0.19974	0.009153	0.115201	C01487	[M+H]+
pos	N,N-Dimethylsphing	815.8735	327.3137	$C_{20}H_{41}NO_2$	1.664316	0.50791	-0.97737	0.009767	0.119	C13914	[M+H]+

	osine								251		
pos	PC(14:0/0:0)	822.193	467.30119	$C_{22}H_{46}NO_7P$	1.641662	0.60921	-0.71499	0.011156	0.127032	NA	[M+H]+
pos	allopurinol	132.6925	136.03851	$C_5H_4N_4O$	1.629003	0.67732	-0.56209	0.011996	0.131017	C06816	[M+H]+
pos	Phosphorylcholine	872.784	184.0739	$C_5H_{15}NO_4P$	1.616641	0.65126	-0.61869	0.012864	0.134088	C00588	[M+H]+
pos	Glutaric acid	8.28623	132.0423	$C_5H_8O_4$	1.613452	0.39906	-1.3253	0.013095	0.13472	C00489	[M]+
pos	1-Hexadecylamine	824.563	241.27694	$C_{16}H_{35}N$	1.60928	0.60399	-0.72741	0.013403	0.136263	NA	[M+H]+
pos	S-Cysteinosuccinic acid	110.9475	237.03071	$C_7H_{11}NO_6S$	1.603996	0.59801	-0.74176	0.0138	0.138222	NA	[M+H]+
pos	beta-Carotene	978.8425	536.4382	$C_{40}H_{56}$	1.581529	2.5419	1.3459	0.015594	0.145972	C02094	[M]+
pos	Octadecanamide	874.4765	283.2875	$C_{18}H_{37}NO$	1.576532	2.1042	1.0733	0.016016	0.148146	C13846	[M+H]+
pos	N-Acetylaspartylglutamic acid	234.05	304.0907	$C_{11}H_{16}N_2O_8$	1.566516	0.54883	-0.86558	0.016889	0.151262	C12270	[M+H]+
pos	Pimelic acid	1194.53	160.0736	$C_7H_{12}O_4$	1.566116	2.5242	1.3358	0.016925	0.151431	C02656	[M]+
pos	4-Quinolinecarboxylic acid	1036.355	173.0477	$C_{10}H_7NO_2$	1.562054	1.6977	0.76355	0.01729	0.152427	C06414	[M+H-H_2O]+
pos	Acetylphosphate	820.024	139.9875	$C_2H_5O_5P$	1.562019	0.27421	-1.8666	0.017293	0.152427	C00227	[M]+

pos	o-Hydroxylaminobenzoate	100.672	153.0426	$C_7H_7NO_3$	1.552773	0.69931	-0.516	0.018146	0.154678	C16235	[M+H]+
pos	N6-Acetyl-L-lysine	128.822	188.1161	$C_8H_{16}N_2O_3$	1.550445	0.61522	-0.70082	0.018366	0.155539	C02727	[M+H]+
pos	Betaine	94.9751	117.079	$C_5H_{11}NO_2$	1.544854	0.69685	-0.52108	0.018902	0.157728	C00719	[M+H]+
pos	L-Aspartic acid	93.53955	133.0375	$C_4H_7NO_4$	1.53355	1.4204	0.50632	0.020023	0.161813	C00049	[M+H]+
pos	4-Hydroxyphenylacetaldehyde	100.5795	136.0524	$C_8H_8O_2$	1.52889	0.63667	-0.65138	0.0205	0.163873	C03765	[M]+
pos	L-Asparagine	92.6878	132.0535	$C_4H_8N_2O_3$	1.518659	3.1257	1.6442	0.021577	0.167479	C00152	[M+H]+
pos	Methyleugenol	818.4555	178.0994	$C_{11}H_{14}O_2$	1.511156	0.75091	-0.41329	0.022393	0.170595	C10454	[M+H]+
pos	Phenylacetaldehyde	77.1635	120.0575	C_8H_8O	1.508614	0.66527	-0.58799	0.022675	0.171638	C00601	[M+H]+
pos	Guanosine	310.0815	283.0917	$C_{10}H_{13}N_5O_5$	1.505151	0.5742	-0.80037	0.023064	0.172924	C00387	[M+H]+
pos	gamma-L-Glutamyl-L-cysteinyl-beta-alanine	229.032	321.0995	$C_{11}H_{19}N_3O_6S$	1.497548	0.60758	-0.71885	0.023934	0.174472	C04544	[M+H]+
pos	Deoxycytidine	132.001	227.0906	$C_9H_{13}N_3O_4$	1.496087	0.58175	-0.78154	0.024104	0.175387	C00881	[M+H]+
pos	4-Aminocatechol	1164.57	125.0477	$C_6H_7NO_2$	1.492296	0.32055	-1.6414	0.02455	0.176894	C18351	[M+H]+

pos	LysoPC(18:0)	832.559	523.6832	$C_{26}H_{54}NO_7P$	1.490162	2.0222	1.0159	0.024804	0.177885	NA	[M+H]+
pos	PE(17:0/0:0)	921.254	467.30119	$C_{22}H_{46}NO_7P$	1.489956	0.61434	-0.7029	0.024829	0.177885	NA	[M+H]+
pos	L-Glutamine	93.55835	146.0691	$C_5H_{10}N_2O_3$	1.471453	1.2631	0.33702	0.027114	0.18489	C00064	[M+H]+
pos	Undecanoic acid	4.297315	186.162	$C_{11}H_{22}O_2$	1.463541	0.30144	-1.73	0.028138	0.187595	C17715	[M+H]+
pos	Spermine	80.026	202.2157	$C_{10}H_{26}N_4$	1.463425	0.52403	-0.93229	0.028153	0.187595	C00750	[M+H]+
pos	Epinephrine	71.69825	183.0895	$C_9H_{13}NO_3$	1.456703	0.26558	-1.9128	0.029047	0.19174	C00788	[M]+
pos	L-Serine	92.6057	105.0426	$C_3H_7NO_3$	1.456255	1.8062	0.85294	0.029107	0.191956	C00065	[M+H]+
pos	Xanthosine	333.539	284.0757	$C_{10}H_{12}N_4O_6$	1.455102	0.58029	-0.78515	0.029263	0.192339	C01762	[M+H]+
pos	Pipecolic acid	94.48175	129.079	$C_6H_{11}NO_2$	1.454001	1.106	0.14539	0.029412	0.193104	C00408	[M+H]+
pos	Palmitoylethanolamide	973.944	299.2824	$C_{18}H_{37}NO_2$	1.450333	0.58988	-0.7615	0.029913	0.194538	C16512	[M+H]+
pos	N-Acetyl-DL-methionine	435.2355	191.062	$C_7H_{13}NO_3S$	1.449197	0.59274	-0.75453	0.03007	0.194986	C02712	[M+H]+
pos	Kyotorphin	92.6195	337.175	$C_{15}H_{23}N_5O_4$	1.444841	2.04	1.0286	0.030676	0.196069	C02993	[M]+
pos	O-Acetylserine	253.299	147.0532	$C_5H_9NO_4$	1.440207	0.28125	-1.8301	0.03133	0.198	C00979	[M+H]+

									218		
pos	3-Indoleacetonitrile	744.741	156.0687	$C_{10}H_8N_2$	1.436542	2.0022	1.0016	0.031855	0.200154	C02938	[M]+
pos	Heptanoic acid	96.4838	130.0994	$C_7H_{14}O_2$	1.435755	2.2851	1.1922	0.031969	0.200543	C17714	[M+H-H_2O]+
pos	O-Ureido-L-serine	471.2405	163.0593	$C_4H_9N_3O_4$	1.42004	0.42269	-1.2423	0.034302	0.206356	C20639	[M+H]+
pos	Aminocaproic acid	1120.26	131.0946	$C_6H_{13}NO_2$	1.419736	0.35294	-1.5025	0.034348	0.206356	C02378	[M+H]+
pos	Pyroglutamic acid	184.303	129.0426	$C_5H_7NO_3$	1.418811	0.61403	-0.70362	0.03449	0.206356	C01879	[M+H]+
pos	Cortexolone	780.9105	346.2144	$C_{21}H_{30}O_4$	1.417174	0.65299	-0.61487	0.034741	0.20704	C05488	[M]+
pos	Prostaglandin F1a-d9	725.83	365.31277	$C_{20}H_{27}D_9O_5$	1.414593	0.5569	-0.84451	0.03514	0.207548	NA	[M+H-H_2O]+
pos	1,2,3-Trihydroxybenzene	357.54	126.0317	$C_6H_6O_3$	1.412472	0.25056	-1.9968	0.03547	0.208262	C01108	[M+H]+
pos	Vanillylmandelic acid	197.683	198.0528	$C_9H_{10}O_5$	1.409617	0.67772	-0.56125	0.035919	0.209542	C05584	[M+H-H_2O]+
pos	Linoleoyl Ethanolamide	937.779	323.28243	$C_{20}H_{37}NO_2$	1.397967	1.4756	0.5613	0.037792	0.214944	NA	[M+H]+
pos	Morpholine	1026.685	87.0684	C_4H_9NO	1.395891	2.0561	1.0399	0.038133	0.21519	C14452	[M+H]+
pos	Ile-Gly-OH	292.4335	296.10084	$C_{13}H_{16}N_2O_6$	1.392874	0.61059	-0.71172	0.038633	0.216134	NA	[M+H]+

pos	Aniline	77.2809	93.0578	C_6H_7N	1.383369	0.63637	-0.65205	0.040241	0.219082	C00292	[M+H]+
pos	D-Ribose	77.41645	150.0528	$C_5H_{10}O_5$	1.381299	0.6437	-0.63554	0.040598	0.219456	C00121	[M+H]+
pos	Caffeine	1110.2	194.0804	$C_8H_{10}N_4O_2$	1.376027	0.38615	-1.3727	0.041516	0.221752	C07481	[M+H]+
pos	NADP	115.0585	744.0833	$C_{21}H_{29}N_7O_{17}P_3$	1.373191	0.40275	-1.312	0.042017	0.222916	C00006	[M+H]+
pos	Myristic acid	764.266	228.2089	$C_{14}H_{28}O_2$	1.366906	1.0883	0.12212	0.043143	0.22565	C06424	[M+H]+
pos	2-Oxoarginine	577.065	173.08	$C_6H_{11}N_3O_3$	1.365138	1.8473	0.88541	0.043463	0.226326	C03771	[M]+
pos	Oxoglutaric acid	77.38215	146.0215	$C_5H_6O_5$	1.360958	0.65664	-0.60682	0.044228	0.228599	C00026	[M]+
pos	Mesaconate	77.4508	130.0266	$C_5H_6O_4$	1.353192	0.65306	-0.61471	0.045676	0.231728	C01732	[M]+
pos	DL-Glutamate	233.861	147.0532	$C_5H_9NO_4$	1.350069	0.65311	-0.61461	0.046268	0.23267	C00025	[M+H]+
pos	CMP	107.9385	323.0519	$C_9H_{14}N_3O_8P$	1.346769	0.69636	-0.52209	0.046899	0.234065	C00055	[M+H]+
pos	N-Formyl-L-methionine	1020.445	177.046	$C_6H_{11}NO_3S$	1.3404	0.33597	-1.5736	0.048136	0.237291	C03145	[M]+
pos	Oxidized glutathione	132.711	612.152	$C_{20}H_{32}N_6O_{12}S_2$	1.337101	0.42166	-1.2459	0.048786	0.238902	C00127	[M+H]+
pos	Sphingosine	815.4645	379.2488	$C_{18}H_{38}NO_5P$	1.331974	0.50634	-0.98181	0.049809	0.241	C06124	[M+H]+

	1-phosphate								218		
neg	Diethylphosphate	527.411	154.0395	$C_4H_{11}O_4P$	2.457769	0.10351	-3.2722	7.17E-06	0.005122	C06608	[M-H]-
neg	2-Phospho-D-glyceric acid	80.32405	185.9929	$C_3H_7O_7P$	2.086925	0.43924	-1.1869	0.001039	0.047144	C00631	[M-H]-
neg	Thiamine	920.458	337.27	$C_{12}H_{17}N_4OS.HCl.Cl$	2.039275	0.63028	-0.66593	0.001558	0.056195	NA	[M]-
neg	D-Glycerate 3-phosphate	79.16115	185.9929	$C_3H_7O_7P$	1.966666	0.47652	-1.0694	0.002731	0.072793	C00197	[M-H_2O-H]-
neg	Ribose 1-phosphate	84.52055	230.0192	$C_5H_{11}O_8P$	1.942364	0.61224	-0.70784	0.003253	0.080179	C00620	[M-H]-
neg	D-Xylitol	97.7756	152.0685	$C_5H_{12}O_5$	1.931911	0.67299	-0.57135	0.0035	0.083466	C00379	[M-H]-
neg	L-Alanine	101.042	89.0477	$C_3H_7NO_2$	1.89464	0.68362	-0.54874	0.004507	0.094775	C00041	[M-H]-
neg	Guanidinosuccinic acid	557.9025	175.0593	$C_5H_9N_3O_4$	1.878231	0.36601	-1.45	0.005018	0.099275	C03139	[M]-
neg	3-Hydroxymethylglutaric acid	86.6348	162.0528	$C_6H_{10}O_5$	1.869056	0.62779	-0.67164	0.005322	0.102269	C03761	[M-H]-
neg	Glutathioselenol	82.1383	387.0003	$C_{10}H_{17}N_3O_6SSe$	1.829536	0.55245	-0.85608	0.006806	0.112288	C18871	[M]-
neg	N-Acetyl-alpha-D-glucosamine 1-phosphate	85.3514	301.0563	$C_8H_{16}NO_9P$	1.792599	0.67442	-0.56829	0.00847	0.122008	C04501	[M-H]-
neg	Inosine	311.0155	268.0808	$C_{10}H_{12}N_4O_5$	1.772603	0.58625	-0.77042	0.009495	0.127	C00294	[M-H]-

neg	Guanosine-5-triphosphate	80.2823	522.991	$C_{10}H_{16}N_5O_{14}P_3$	1.75275	0.51879	-0.94677	0.010606	0.133177432	C00044	[M-H]-
neg	Epiandrosterone	961.095	290.2246	$C_{19}H_{30}O_2$	1.743755	0.55631	-0.84603	0.011142	0.136281	C07635	[M-H]-
neg	Chenodeoxycholic acid	735.557	392.2927	$C_{24}H_{40}O_4$	1.729219	0.30225	-1.7262	0.012051	0.141601	C02528	[M-H]-
neg	ADP	100.528	427.0294	$C_{10}H_{15}N_5O_{10}P_2$	1.696971	0.64535	-0.63185	0.014276	0.151895	C00008	[M-H]-
neg	3-hydroxy-tetradecanoic acid	827.731	244.20383	$C_{14}H_{28}O_3$	1.620598	0.8577	-0.22146	0.020808	0.186955	NA	[M-H]-
neg	D-Erythrose 4-phosphate	83.1303	200.0086	$C_4H_9O_7P$	1.57088	0.64724	-0.62764	0.02615	0.212695	C00279	[M-H]-
neg	13,14-dihydro-16,16-difluoro PGJ2	874.401	372.21122	$C_{20}H_{30}F_2O_4$	1.566959	1.9857	0.98964	0.026611	0.214015	NA	[M-H]-
neg	1H-Indole-3-carboxaldehyde	598.855	145.0528	C_9H_7NO	1.526161	0.61971	-0.69033	0.031789	0.234801	C08493	[M-H]-
neg	Anserine	108.0705	240.1222	$C_{10}H_{16}N_4O_3$	1.509132	0.54781	-0.86824	0.034161	0.243708	C01262	[M-H]-
neg	alpha-D-Galactose 1-phosphate	83.93335	260.0297	$C_6H_{13}O_9P$	1.495186	0.65268	-0.61554	0.0362	0.251348	C00446	[M-H]-
neg	Enterolactone	719.123	298.1205	$C_{18}H_{18}O_4$	1.491991	6.2863	2.6522	0.03668	0.253151	C18165	[M-H]-
neg	Dimethylglycine	86.8195	103.0633	$C_4H_9NO_2$	1.462446	0.7581	-0.39953	0.041344	0.269562	C01026	[M-H]-

neg	Sorbitol	93.6963	182.079	$C_6H_{14}O_6$	1.444921	0.87053	-0.20004	0.044311	0.277819	C00794	[M-H]-
neg	Adenosine 5-diphosphoribose	973.602	559.32	$C_{15}H_{23}N_5O_{14}P_2$	1.421761	0.60983	-0.71353	0.04847	0.288712	NA	[M]-

Table S8 Target information of RSV against oligospermia and the dysbiosis of gut microbiota caused by obesity

No.	Gene symbol	Uniprot ID	Protein name
1	*Sod2*	P09671	Superoxide dismutase [Mn], mitochondrial
2	*Tpm3*	P21107	Tropomyosin alpha-3 chain
3	*Slc9a3*	G3X939	Sodium/hydrogen exchanger 3
4	*Apoa2*	P09813	Apolipoprotein A-II (Apo-AII)
5	*Snca*	O55042	Alpha-synuclein
6	*Hras*	Q61411	GTPase HRas
7	*Il10*	P18893	Interleukin-10 (IL-10)
8	*Egfr*	Q01279	Epidermal growth factor receptor
9	*Erbb2*	P70424	Receptor tyrosine-protein kinase erbB-2
10	*Epo*	P07321	Erythropoietin
11	*Arl6*	O88848	ADP-ribosylation factor-like protein 6
12	*Pon1*	P52430	Serum paraoxonase/arylesterase 1 (PON 1)
13	*Ifng*	P01580	Interferon gamma (IFN-gamma)
14	*Cdkn1c*	P49919	Cyclin-dependent kinase inhibitor 1C (Cyclin-dependent kinase inhibitor p57)
15	*Tnf*	P06804	Tumor necrosis factor (TNF-a)
16	*Ptgs2*	Q05769	Prostaglandin G/H synthase 2
17	*Nfkb1*	P25799	Nuclear factor NF-kappa-B p105 subunit

18	*Oat*	P29758	Ornithine aminotransferase, mitochondrial
19	*Nlrp3*	Q8R4B8	NACHT, LRR and PYD domains-containing protein 3
20	*Apob*	E9Q414	Apolipoprotein B-100 (Apo B-100)
21	*Ephx2*	P34914	Bifunctional epoxide hydrolase 2
22	*Pml*	Q60953	Protein PML
23	*Ahr*	P30561	Aryl hydrocarbon receptor (Ah receptor) (AhR)
24	*Cyp19a1*	P28649	Aromatase (Cytochrome P450 19A1)
25	*Kcnh1*	Q60603	Potassium voltage-gated channel subfamily H member 1
26	*Sdhb*	Q9CQA3	Succinate dehydrogenase [ubiquinone] iron-sulfur subunit, mitochondrial
27	*Ace*	P09470	Angiotensin-converting enzyme (ACE)
28	*Cftr*	P26361	Cystic fibrosis transmembrane conductance regulator (CFTR)
29	*Pbx1*	P41778	Pre-B-cell leukemia transcription factor 1 (Homeobox protein PBX1)
30	*Sirt1*	Q923E4	NAD-dependent protein deacetylase sirtuin-1
31	*Il1b*	P10749	Interleukin-1 beta (IL-1 beta)

Note: *Cxcl8* was not mapped in mouse.

Table S9 The evaluation of hub genes by CytoHubba.

Gene symbol	Rank methods in CytoHubba					Rank
	Degree	BetweennessCentrality	ClosenessCentrality	ClusteringCoefficient	Stress	
Tnf	19	0.21797553	0.80645161	0.47368421	364	1
Il1b	17	0.11497553	0.75757576	0.55147059	250	2
Ifng	15	0.03454497	0.67567568	0.65714286	116	3
Ptgs2	15	0.0365172	0.67567568	0.64761905	116	4
Il10	14	0.02978571	0.65789474	0.67032967	102	5
Egfr	14	0.05664418	0.64102564	0.62637363	124	6
Hras	14	0.10138228	0.65789474	0.61538462	172	7
Sirt1	13	0.09366005	0.64102564	0.66666667	170	8

Table S10 Targets and RSV binding free energy and sites

Targets	Binding free energy (ΔG, kcal/mol)	Hydrogen bond interaction residues	Hydrophobic interaction residues	π-π stacking residue
TNF-α	-6.9	Tyr72, Ser99, Pro100, Cys101	Pro102	Trp114
IL-1β	-7.0	Leu73, Asp75, Asp76, Arg99	Trp106	-
PTGS2	-7.9	Cys47	Leu152, Pro153	-
IFN-γ	-6.5	Phe50, Tyr74, Thr101	Leu51, Gln67, Ile70, Ile71, Leu98, Phe102	Tyr74
HRAS	-7.4	Asp33, Asn116, Lys117, Ala146, Lys147	Phe28, Val29, Tyr32, Lys117, Ala146	-
EGFR	-6.6	Lys28, Glu84, Lys294	Val30, Phe287, Thr290, Val292	-
IL-10	-6.2	Gln63, Arg106	Glu115, Lys117	-
SIRT1	-8.1	Tyr18, Asp219, Ser379	Phe193, Val242, Ile309, Ile351	-
SDHB	-6.7	Tyr47, Met135	Tyr47, Tyr130, Val137	Tyr130

Original Images for Blots or Gels

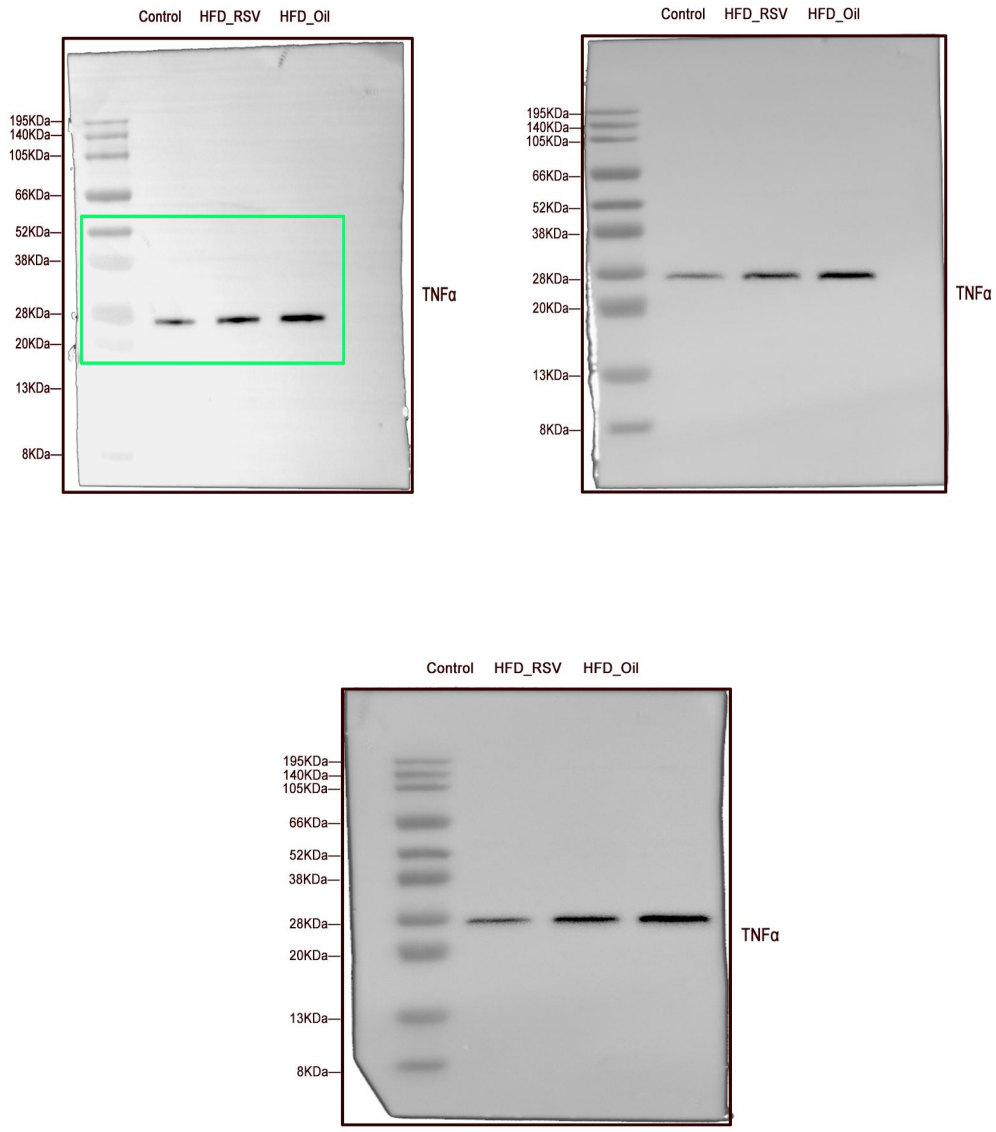

Fig.S10 (A) Uncropped Western Blot Images for TNFα

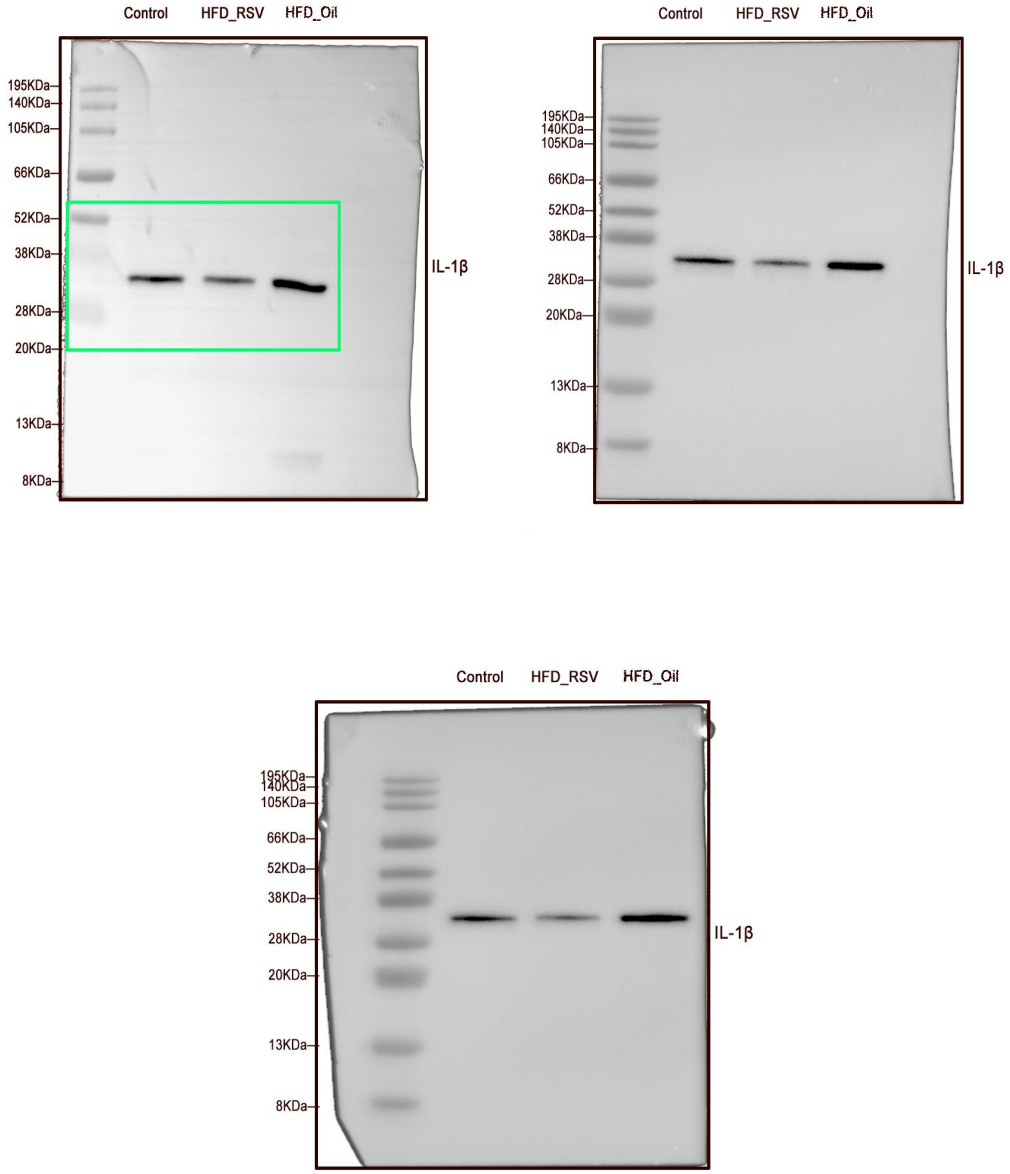

Fig.S10 (B) Uncropped Western Blot Images for IL-1β

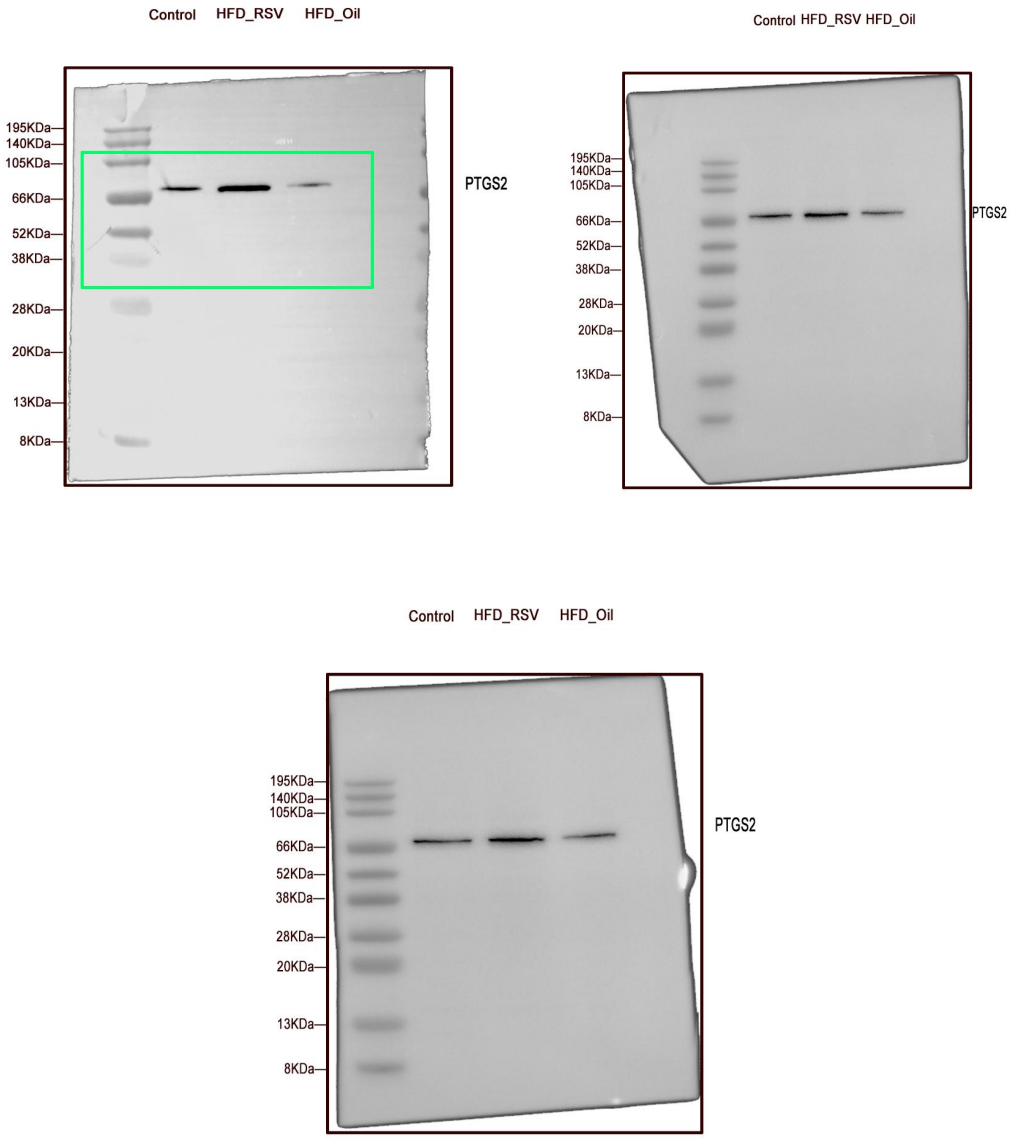

Fig.S10(C) Uncropped Western Blot Images for PTGS2

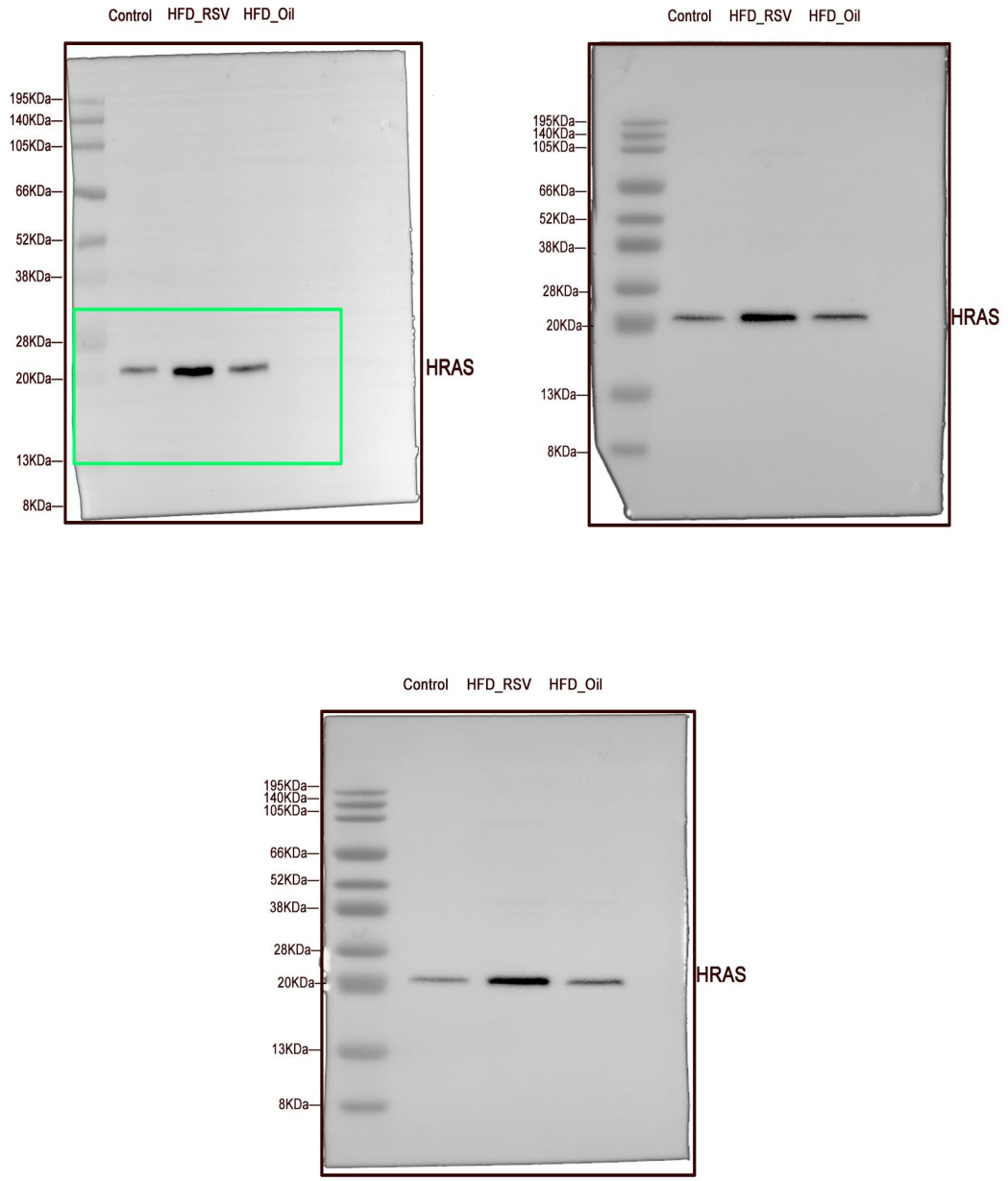

Fig.S10 (D) Uncropped Western Blot Images for HRAS

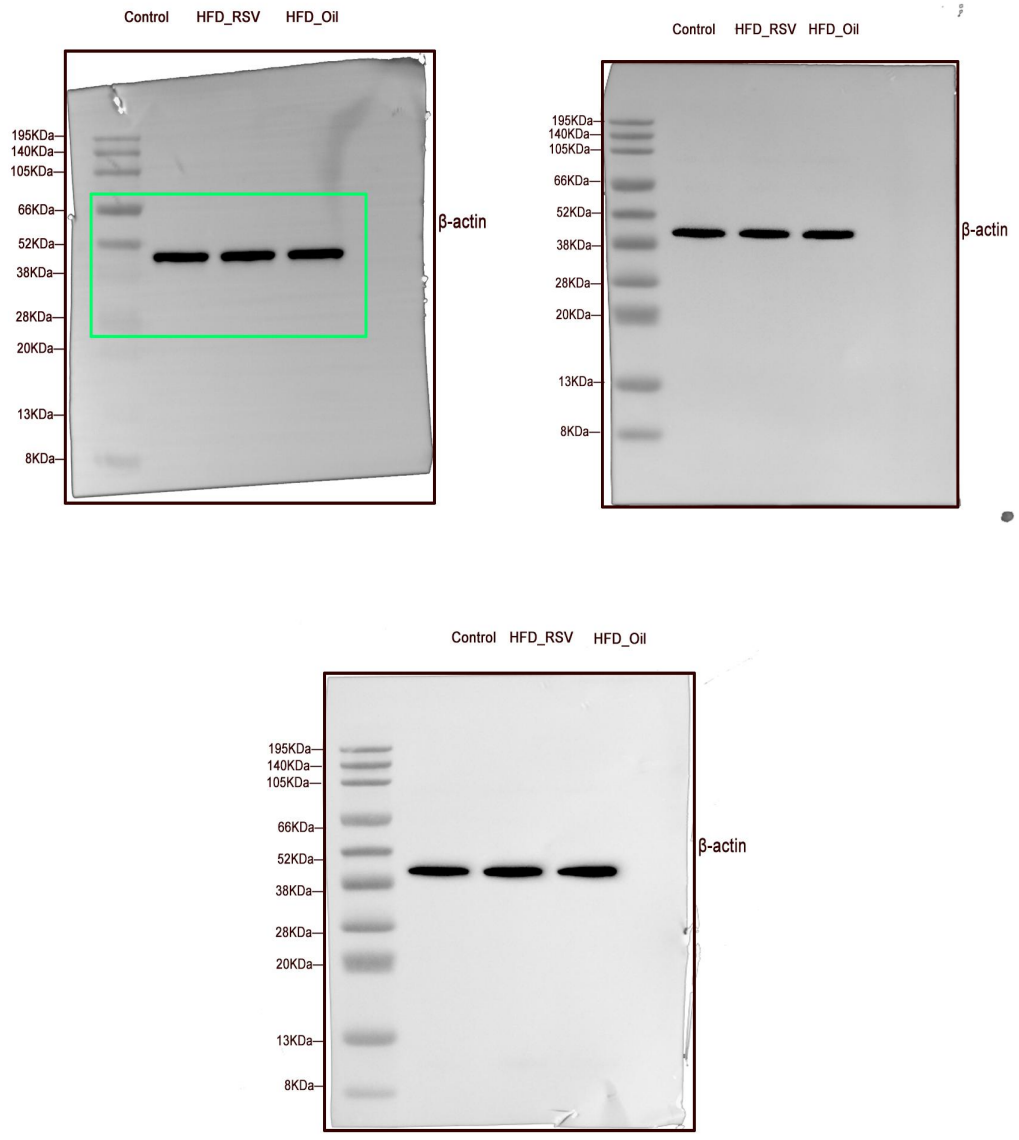

Fig.S10 (E) Uncropped Western Blot Images for β-actin in CLR signaling pathway

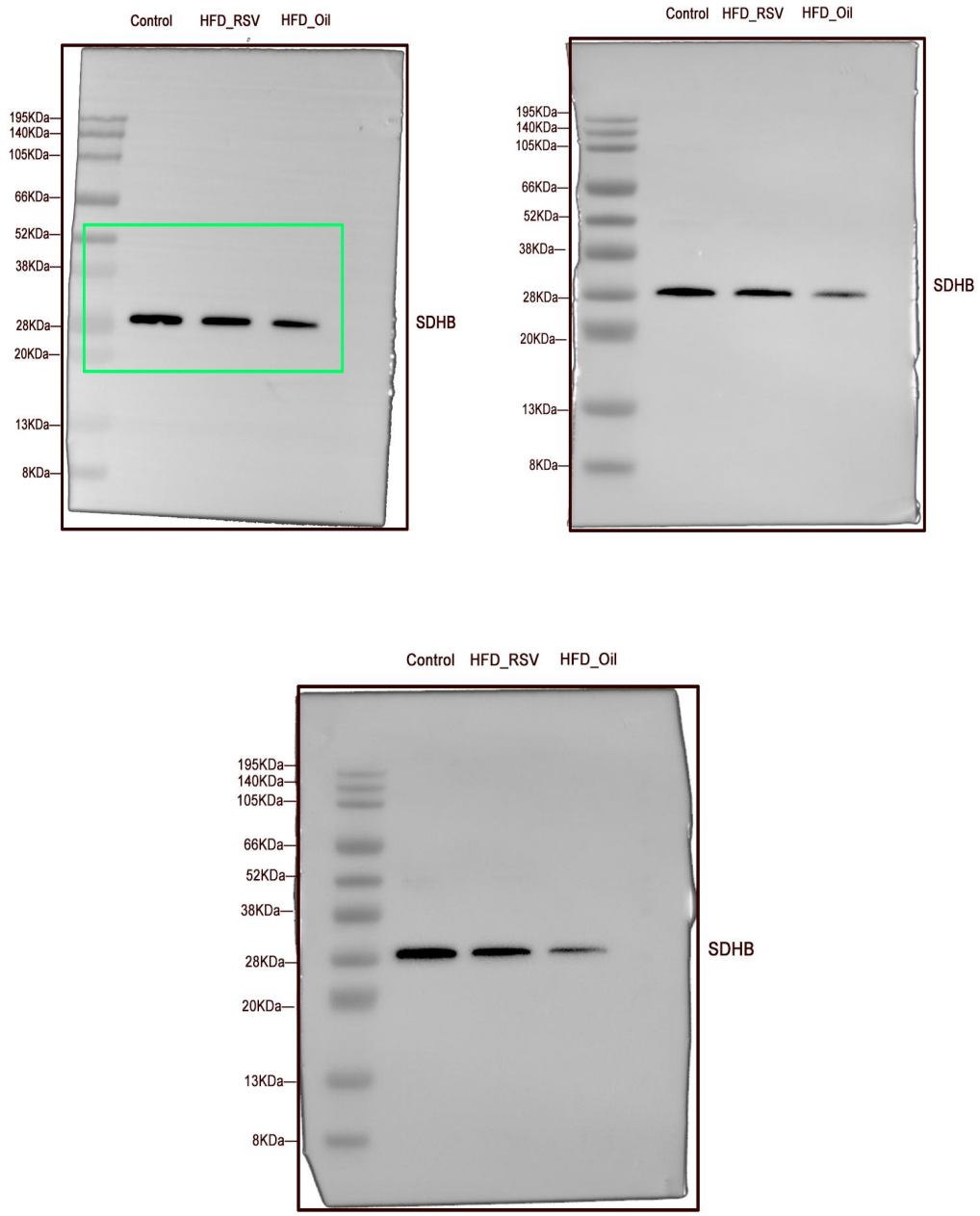

Fig.S11 (A) Uncropped Western Blot Images for SDHB

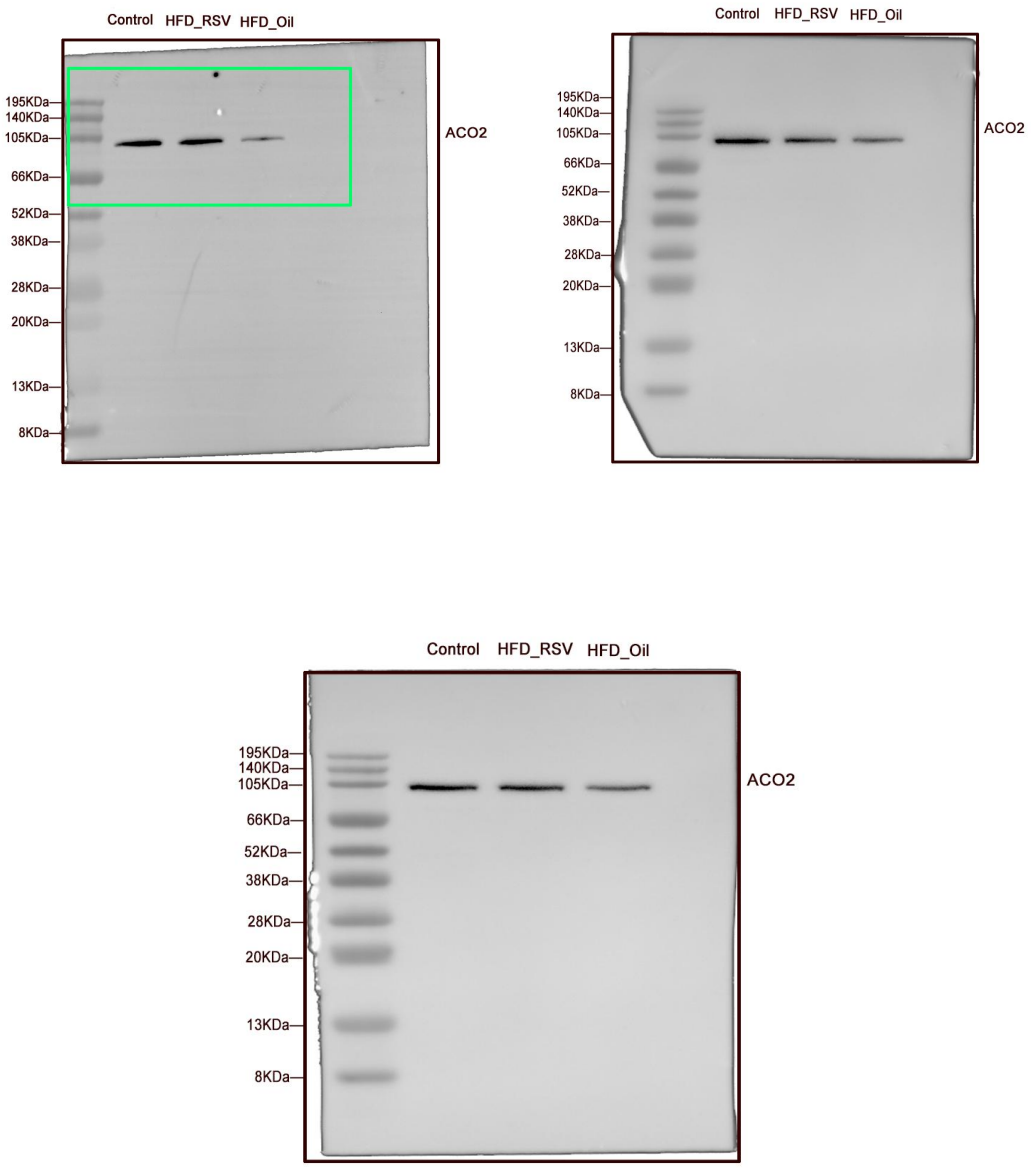

Fig.S11 (B) Uncropped Western Blot Images for ACO2

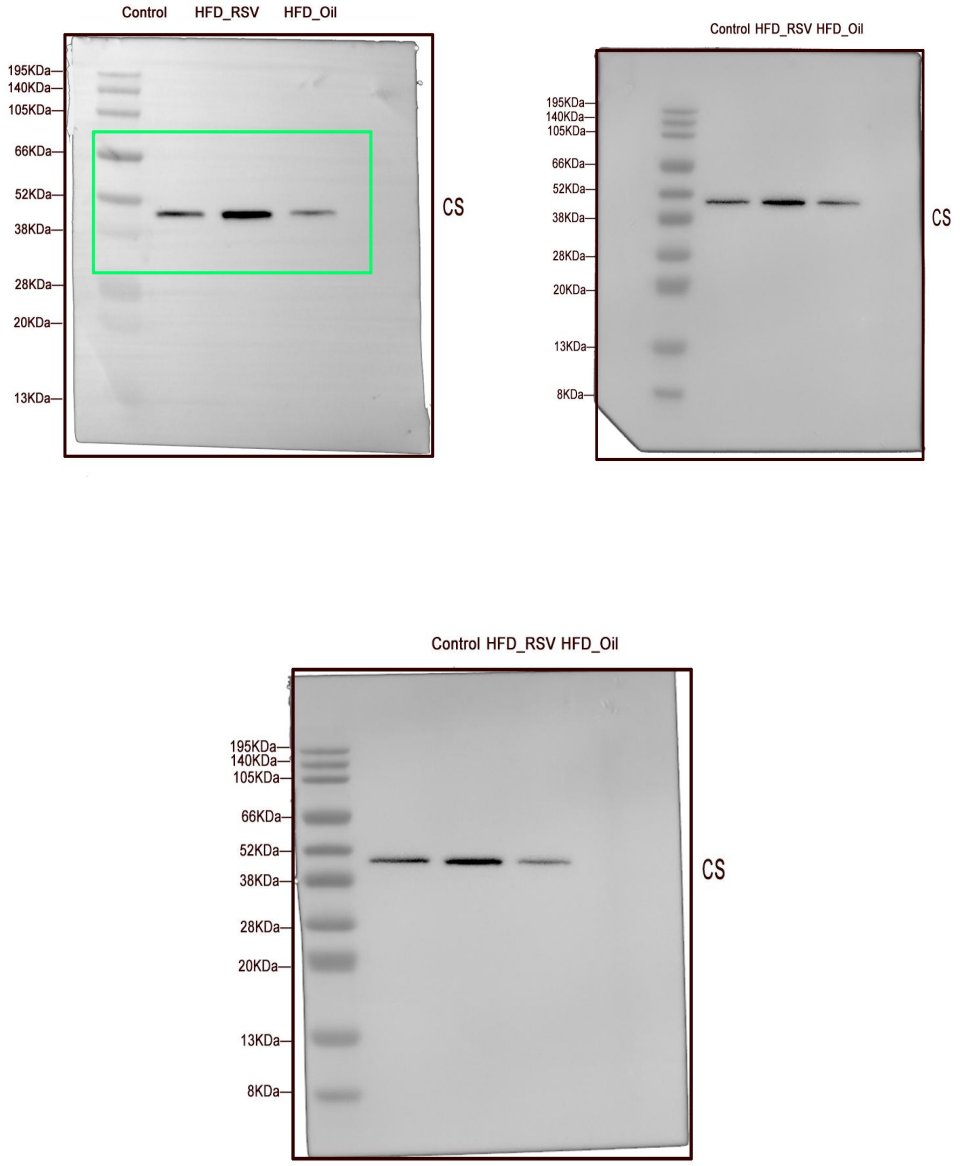

Fig.S11 (C) Uncropped Western Blot Images for CS

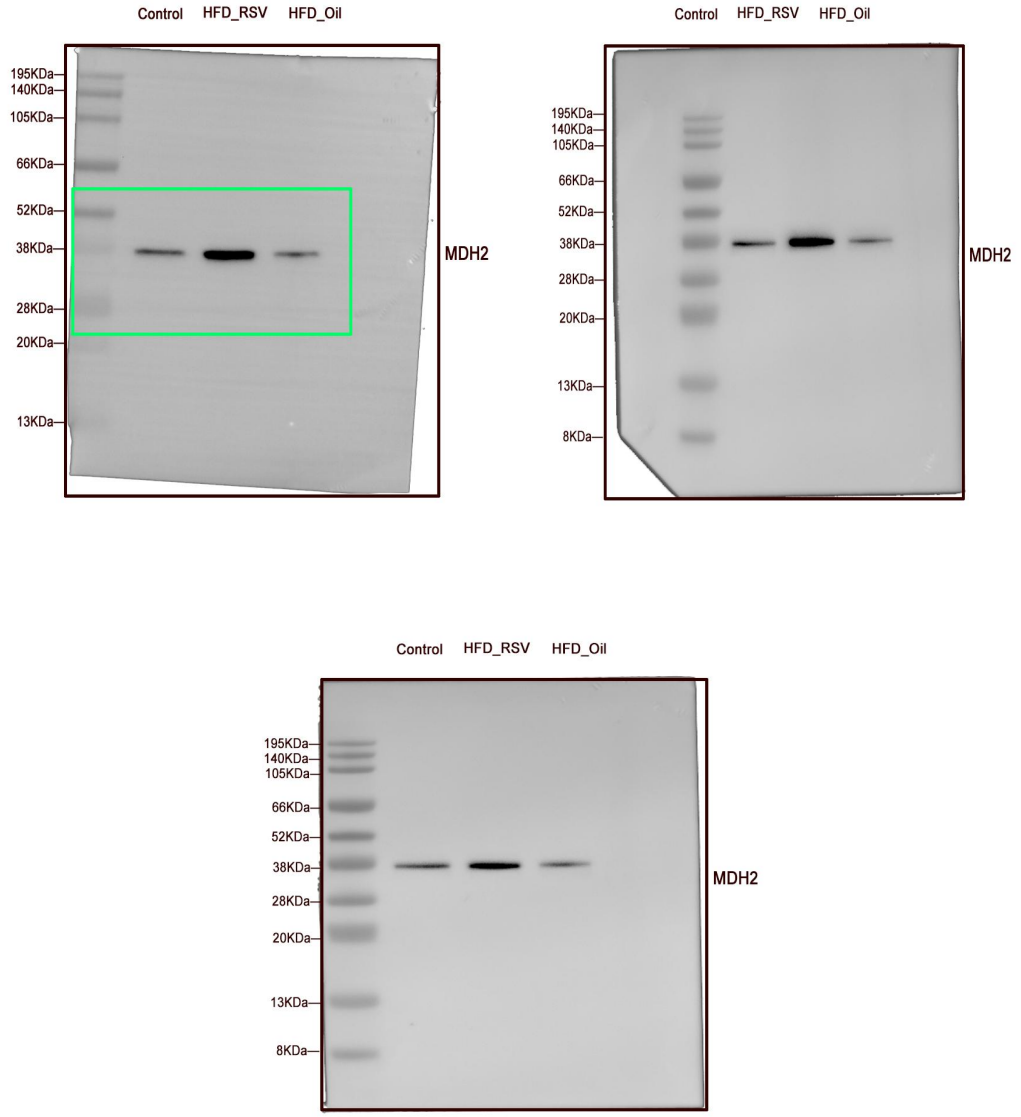

Fig.S11 (D) Uncropped Western Blot Images for MDH2

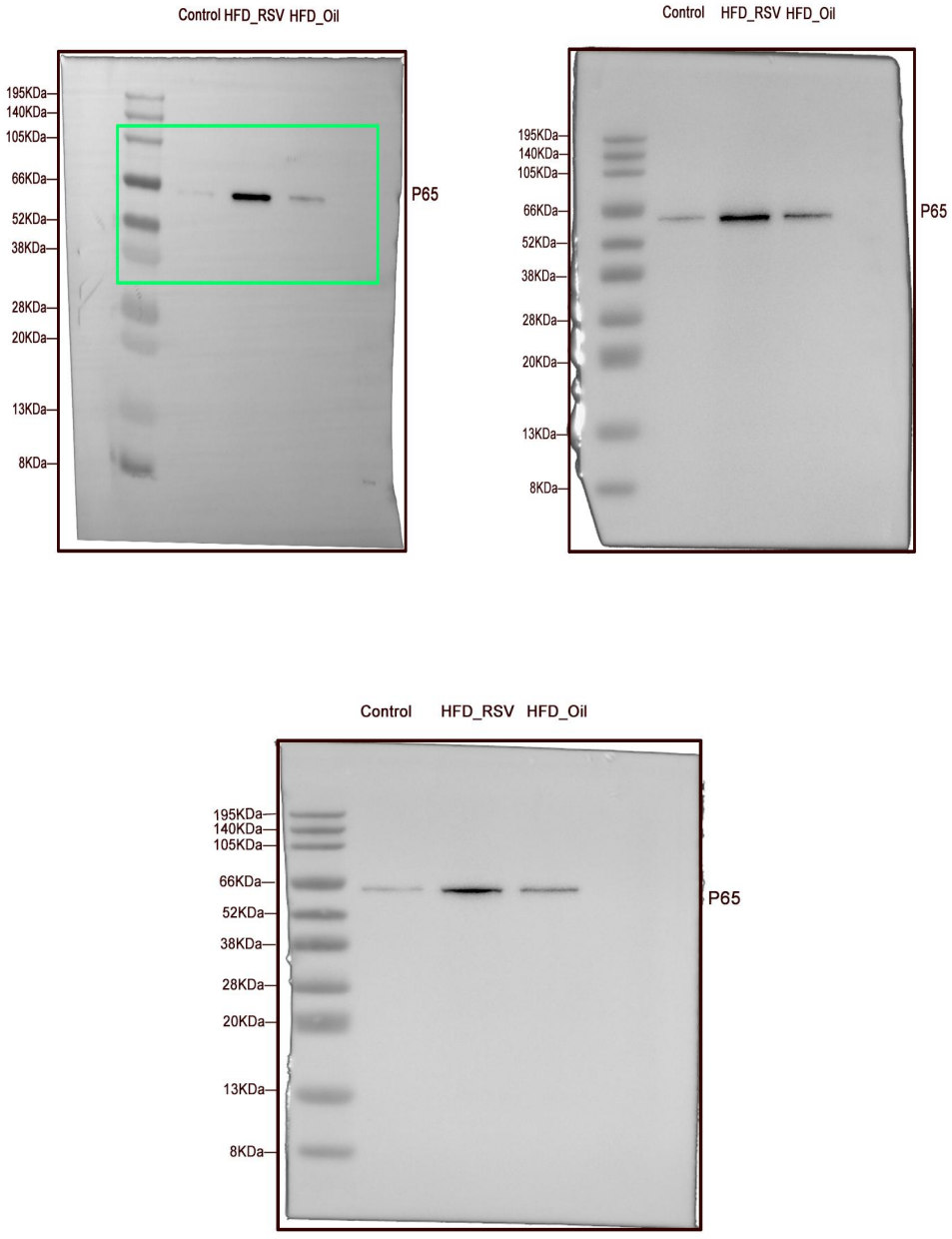

Fig.S11 (E) Uncropped Western Blot Images for P65

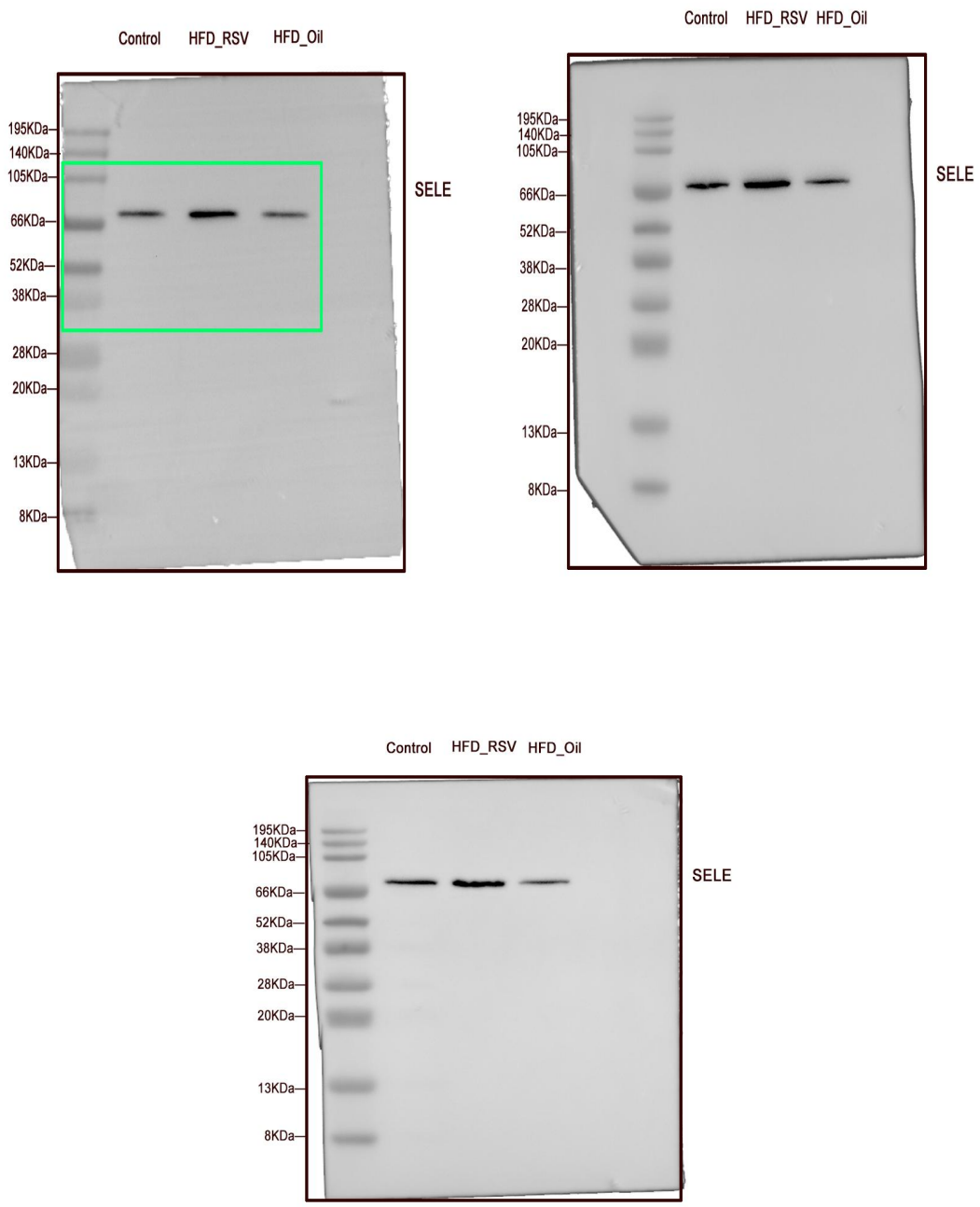

Fig.S11 (F) Uncropped Western Blot Images for SELE

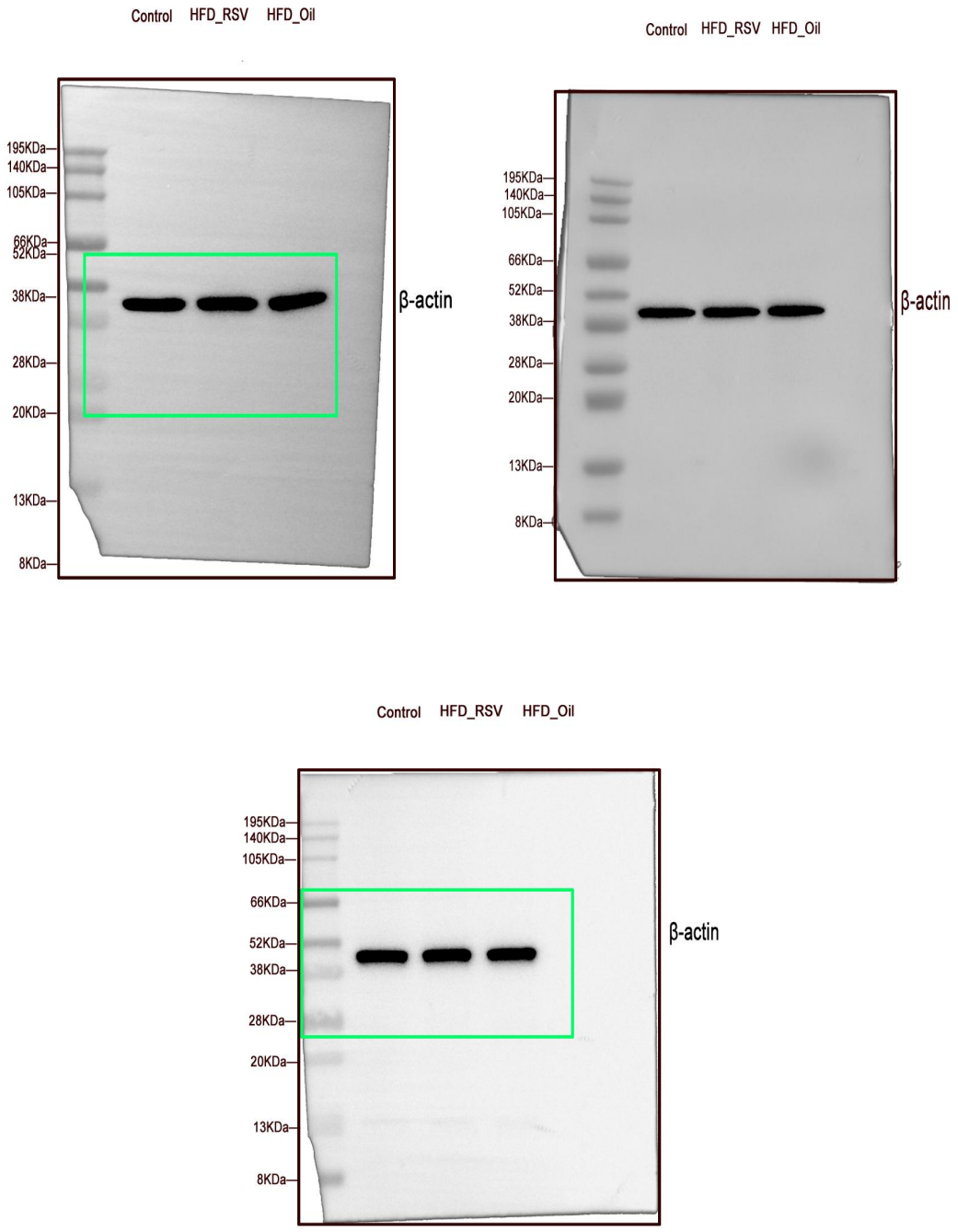

Fig.S11 (G) Uncropped Western Blot Images for β-actin in TCA cycle and NF-κB signaling pathway