Electronic Supplementary Material (ESI) for Food & Function.
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1 **Table S1. The 123 differential metabolites in obese rats**

Metabolite	Identification	Chemical class	Formula
EE 18:0	Ethyl Esters	Fatty Acyls	C2H5C18H35O2
EE 18:1	Ethyl Esters	Fatty Acyls	C2H5C18H33O2
EE 18:2	Ethyl Esters	Fatty Acyls	C2H5C18H31O2
EE 18:3	Ethyl Esters	Fatty Acyls	C2H5C18H29O2
EE 20:5	Ethyl Esters	Fatty Acyls	C2H5C20H29O2
FFA 10:0	Capric acid	Fatty Acyls	HC10H19O2
FFA 12:0	Lauric acid	Fatty Acyls	HC12H23O2
FFA 14:0	Myristic acid	Fatty Acyls	HC14H27O2
FFA 14:1	Fatty acids	Fatty Acyls	HC14H25O2
FFA 16:0	Palmitic acid	Fatty Acyls	HC16H31O2
FFA 16:1	Palmitic acid(d3)	Fatty Acyls	HC16H29O2
FFA 18:0	Stearic acid	Fatty Acyls	HC18H35O2
FFA 18:1	Oleic acid	Fatty Acyls	HC18H33O2
FFA 18:2	Linoleic acid	Fatty Acyls	HC18H31O2
FFA 18:3	Linolenic acid	Fatty Acyls	HC18H29O2
FFA 20:4	Arachidonic acid	Fatty Acyls	HC20H31O2
FFA 20:5	Eicosapentanoic acid	Fatty Acyls	HC20H29O2
FFA 22:6	Fatty acids	Fatty Acyls	HC22H31O2
GlcdE 18:0	Glucosylceramide E	Fatty Acyls	C3H5OC18H35O2
GlcdE 18:1	Glucosylceramide E	Fatty Acyls	C3H5OC18H33O2
GlcdE 18:2	Glucosylceramide E	Fatty Acyls	C3H5OC18H31O2

GlcdE 20:0	Glucosylceramide E	Fatty Acyls	C3H5OC20H39O2
GlcdE 20:1	Glucosylceramide E	Fatty Acyls	C3H5OC20H37O2
GlcdE 20:3	Glucosylceramide E	Fatty Acyls	C3H5OC20H33O2
GlcdE 20:4	Glucosylceramide E	Fatty Acyls	C3H5OC20H31O2
GlcdE 20:5	Glucosylceramide E	Fatty Acyls	C3H5OC20H29O2
GlcdE 22:1	Glucosylceramide E	Fatty Acyls	C3H5OC22H41O2
GlcdE 22:2	Glucosylceramide E	Fatty Acyls	C3H5OC22H39O2
GlcdE 22:4	Glucosylceramide E	Fatty Acyls	C3H5OC22H35O2
ME 10:0	Methyl Ethanolamines	Fatty Acyls	CH3C10H19O2
ME 12:0	Methyl Ethanolamines	Fatty Acyls	CH3C12H2302
ME 14:0	Methyl Ethanolamines	Fatty Acyls	CH3C14H27O2
ME 14:1	Methyl Ethanolamines	Fatty Acyls	CH3C14H25O2
ME 16:0	Methyl Ethanolamines	Fatty Acyls	CH3C16H31O2
ME 18:0	Methyl Ethanolamines	Fatty Acyls	CH3C18H3502
ME 18:1	Methyl Ethanolamines	Fatty Acyls	CH3C18H33O2
ME 18:2	Methyl Ethanolamines	Fatty Acyls	CH3C18H31O2
ME 18:3	Methyl Ethanolamines	Fatty Acyls	CH3C18H29O2
ME 20:0	Methyl Ethanolamines	Fatty Acyls	CH3C20H39O2
ME 20:4	Methyl Ethanolamines	Fatty Acyls	CH3C20H31O2
ME 22:1	Methyl Ethanolamines	Fatty Acyls	CH3C22H41O2
ME 24:1	Rumenic acid	Fatty Acyls	CH3C24H45O2
OAHFA_18:0/20:2	(O-acyl)-w-hydroxy fatty acid	Fatty Acyls	C18H35O2C20H35O2
OAHFA_18:0/22:1	(O-acyl)-w-hydroxy fatty acid	Fatty Acyls	C18H35O2C22H41O2

DAG 24:1	Diacylglycerols	Glycerolipids	OHC27H49O4
DAG 26:0	Diacylglycerols	Glycerolipids	OHC29H56O4
DAG 26:1	Diacylglycerols	Glycerolipids	OHC29H54O4
DAG 28:0	Diacylglycerols	Glycerolipids	OHC31H59O4
DAG 28:3	Diacylglycerols	Glycerolipids	OHC31H53O5
DAG 32:0	Diacylglycerols	Glycerolipids	OHC35H67O4
DAG 34:0	Diacylglycerols	Glycerolipids	OHC37H71O4
DAG 34:2	Diacylglycerols	Glycerolipids	OHC37H67O4
DAG 36:2	Diacylglycerols	Glycerolipids	C39H72O5
DAG 38:5	Diacylglycerols	Glycerolipids	OHC41H69O4
DAG 38:8	Diacylglycerols	Glycerolipids	OHC41H63O4
MAG 14:1	Monoacylglycerols	Glycerolipids	C17H34O4
MAG 16:0	hexadecanoyl-glycerol	Glycerolipids	C19H38O4
MAG 18:0	Monoacylglycerols	Glycerolipids	C21H42O4
MAG 18:2	Monoacylglycerols	Glycerolipids	C21H38O4
MAG 20:0	Monoacylglycerols	Glycerolipids	C23H46O4
MAG 20:3	Monoacylglycerols	Glycerolipids	C23H40O4
MAG 20:4	Monoacylglycerols	Glycerolipids	C23H38O4
MAG 20:5	Monoacylglycerols	Glycerolipids	C23H36O4
MAG 22:0	Monoacylglycerols	Glycerolipids	C25H50O4
MAG 22:1	Monoacylglycerols	Glycerolipids	C25H48O4
MAG 22:2	Monoacylglycerols	Glycerolipids	C25H46O4
MAG 22:4	Monoacylglycerols	Glycerolipids	C25H42O4

MGMG 10:0	-	Glycerolipids	-
MGMG 18:2	-	Glycerolipids	C21H38O4
MGMG 20:2	-	Glycerolipids	-
MGMG 20:5	MG(0:0/20:5(5Z,8Z,11Z,14Z,17Z)/0:0)	Glycerolipids	C23H36O4
LDGPP 20:2	-	Glycerophospholipids	-
LMMPE 10:0	lysomonomethyl PE	Glycerophospholipids	-
LMMPE 12:0	lysomonomethyl PE	Glycerophospholipids	-
LPA 16:1	Monoacylglycerophosphates	Glycerophospholipids	C19H37O7P
LPA 20:1	Monoacylglycerophosphates	Glycerophospholipids	PO4H2C23H43O3
LPA 20:2	Monoacylglycerophosphates	Glycerophospholipids	PO4H2C23H41O3
LPA 22:4	Monoacylglycerophosphates	Glycerophospholipids	PO4H2C25H41O3
LPC 20:2	lysophosphatidylcholine	Glycerophospholipids	C48H88NO8P
LPC 22:4	lysophosphatidylcholine	Glycerophospholipids	C46H84NO8P
LPE 12:0	Monoacylglycerophosphoethanolamines	Glycerophospholipids	C17H36NO7P
LPE 14:0	Monoacylglycerophosphoethanolamines	Glycerophospholipids	C19H40NO7P
LPE 18:2	Monoacylglycerophosphoethanolamines	Glycerophospholipids	C23H44NO7P
LPE 22:1	Monoacylglycerophosphoethanolamines	Glycerophospholipids	C27H54NO7P
LPE 26:0	Monoacylglycerophosphoethanolamines	Glycerophospholipids	C31H64NO7P
LPE O-16:0	Monoalkylglycerophosphoethanolamines	Glycerophospholipids	C21H46NO6P
LPE O-20:0	Monoalkylglycerophosphoethanolamines	Glycerophospholipids	C25H54NO6P
LPI 20:0	Diacylglycerophosphoinositols	Glycerophospholipids	C49H95O13P
LPIP 18:0	1-(1Z-alkenyl),2-acylglycerophosphoinositols	Glycerophospholipids	C45H87O12P
LPIP 18:1	1-(1Z-alkenyl),2-acylglycerophosphoinositols	Glycerophospholipids	C45H85O12P

LPS 12:0	Monoacylglycerophosphoserines	Glycerophospholipids	C18H36NO9P
LPS 14:0	Monoacylglycerophosphoserines	Glycerophospholipids	C20H40NO9P
LPS 16:0	Monoacylglycerophosphoserines	Glycerophospholipids	C22H44NO9P
MMPE 36:2	Monomethyl PE	Glycerophospholipids	-
PA 30:1	Diacylglycerophosphates	Glycerophospholipids	C33H61O8P
PA 30:4	Diacylglycerophosphates	Glycerophospholipids	C33H55O8P
PA 36:2	Diacylglycerophosphates	Glycerophospholipids	C39H77O7P
PA O-36:6	1-alkyl,2-acylglycerophosphates	Glycerophospholipids	C39H67O7P
PC 36:4	gamma-Linolenic acid	Glycerophospholipids	C5O4H13NPC39H67O4
PC 38:4	Monoacylglycerophosphocholines	Glycerophospholipids	C5O4H13NPC41H71O4
PC 40:6	Monoacylglycerophosphocholines	Glycerophospholipids	C5O4H13NPC43H71O4
PE 32:1	alpha-eleostearic acid	Glycerophospholipids	C2O4H7NPC35H65O4
PE 32:4	Phosphatidylethanolamine	Glycerophospholipids	C2O4H7NPC35H59O4
PE 36:3	Phosphatidylethanolamine	Glycerophospholipids	C23H42NO7P
PG 32:4	Diacylglycerophosphoglycerols	Glycerophospholipids	C38H67O10P
PI O-36:3	1-alkyl,2-acylglycerophosphoinositols	Glycerophospholipids	C45H89O12P
PIP 34:6	Diacylglycerophosphoinositol monophosphates	Glycerophospholipids	-
PIP 36:4	Diacylglycerophosphoinositol monophosphates	Glycerophospholipids	-
PIP2 42:11	Glycerophosphoinositol bisphosphates	Glycerophospholipids	-
Cer 28:1;2	Ceramides	Sphingolipids	C28H49NO3
Cer 30:0;2	Ceramides	Sphingolipids	C30H57NO3
Cer 32:0;2	Ceramides	Sphingolipids	C32H61NO3
Cer 34:0;2	Ceramides	Sphingolipids	C34H65NO3

Cer 42:0;2	Ceramides	Sphingolipids	C42H81NO3
HexCer 44:0;2	Monohexocylceramide	Sphingolipids	-
SGalCer 44:0;3	Simple Glc series	Sphingolipids	C50H93NO8
SM 34:1;2	Sphingomyelin	Sphingolipids	C39H79N2O6P
SM 34:2;2	Sphingomyelin	Sphingolipids	C39H77N2O6P
CE 16:0	cholesteryl ester	Sterol Lipids	C43H76O2
Des 15:0	Desmosterol	Sterol Lipids	C27H44O
Erg 18:3	Ergosterols 18:3	Sterol Lipids	-
Erg 20:3	Ergosterols 20:3	Sterol Lipids	-
Lan 18:1	Lanosterol	Sterol Lipids	C30H50O

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Table S2. The 55 lipids were significantly altered of model vs normal group from lipidomics

Metabolite	Chemical class	Fold Change	p-value	FDR
OAHFA_18:0/22:1	Fatty Acyls	3.72	–	–
OAHFA_18:0/20:2	Fatty Acyls	3.65	–	–
ME 24:1	Fatty Acyls	3.07	–	–
ME 18:3	Fatty Acyls	0.12	–	–
ME 18:2	Fatty Acyls	8.03	1.17E-10	5.32E-09
ME 16:0	Fatty Acyls	3.56	4.03E-04	3.13E-03
ME 12:0	Fatty Acyls	5.27	1.66E-09	2.43E-08
ME 10:0	Fatty Acyls	5.94	9.21E-10	1.52E-08
GlcdE 22:4	Fatty Acyls	6.76	2.57E-10	5.65E-09
GlcdE 20:4	Fatty Acyls	6.73	4.44E-10	8.37E-09
GlcdE 20:1	Fatty Acyls	0.17	–	–
GlcdE 20:0	Fatty Acyls	22.54	7.95E-03	3.75E-02
GlcdE 18:2	Fatty Acyls	0.3	–	–
GlcdE 18:1	Fatty Acyls	0.18	1.93E-04	2.12E-03
GlcdE 18:0	Fatty Acyls	0.31	–	–
FFA 20:4	Fatty Acyls	3.95	–	–
EE 18:3	Fatty Acyls	3.53	–	–
MGMG 20:5	Glycerolipids	2.74	–	–
MGMG 20:2	Glycerolipids	3.98	–	–
MGMG 10:0	Glycerolipids	0.23	2.13E-04	2.16E-03
MAG 22:4	Glycerolipids	2.2	–	–
MAG 22:2	Glycerolipids	2.11	–	–

MAG 20:5	Glycerolipids	2.26	–	–
MAG 20:4	Glycerolipids	0.04	2.38E-09	3.15E-08
MAG 20:3	Glycerolipids	6.97	1.73E-10	5.32E-09
MAG 20:0	Glycerolipids	3.65	3.49E-04	2.96E-03
MAG 18:2	Glycerolipids	0.25	1.62E-04	1.95E-03
MAG 18:0	Glycerolipids	3.07	5.34E-03	2.61E-02
MAG 16:0	Glycerolipids	6.29	2.02E-10	5.32E-09
MAG 14:1	Glycerolipids	2.12	–	–
DAG 38:5	Glycerolipids	2.15	–	–
DAG 34:0	Glycerolipids	2.8	–	–
DAG 26:1	Glycerolipids	0.17	–	–
PIP 36:4	Glycerophospholipids	0.33	–	–
PI O-36:3	Glycerophospholipids	0.3	–	–
PI O-36:3	Glycerophospholipids	0.3	–	–
PE 32:1	Glycerophospholipids	5.55	–	–
PC 40:6	Glycerophospholipids	2.16	–	–
PC 38:4	Glycerophospholipids	3.68	–	–
PC 36:4	Glycerophospholipids	3.45	–	–
PA 301	Glycerophospholipids	4.47	–	–
LPS 16:0	Glycerophospholipids	0.05	1.87E-10	5.32E-09
LPE O-16:0	Glycerophospholipids	0.33	–	–
LPE 26:0	Glycerophospholipids	3.12	–	–
LPE 12:0	Glycerophospholipids	2.2	–	–
LPC 20:2	Glycerophospholipids	2.75	–	–

LPA 20:2	Glycerophospholipids	4.43	−	−
LPA 16:1	Glycerophospholipids	3.51	−	−
SM 34:1;2	Sphingolipids	2.45	−	−
SGalCer 44:0;3	Sphingolipids	0.08	−	−
Cer 42:0;2	Sphingolipids	0.07	1.45E-12	1.92E-10
Cer 30:0;2	Sphingolipids	0.06	1.10E-03	7.67E-03
Cer 28:1;2	Sphingolipids	0.26	4.75E-03	2.51E-02
Des 15:0	Sterol Lipids	0.27	−	−
CE 16:0	Sterol Lipids	4.04	−	−