

Food & Function

Combination of *Lacticaseibacillus paracasei* BEPC22 and *Lactiplantibacillus plantarum* BELP53 attenuates fat accumulation and alters the metabolome and gut microbiota in mice with high-fat diet-induced obesity

Na-Rae Lee^{a¶}, Tae-Jun Kwon^{b¶}, Eui-Chun Chung^{c¶}, Jaewoong Bae^{c¶}, Song-Hui Soung⁴, Hyun-Ji Tak⁴, Jun-Young Choi^b, Young-Eun Lee^f, Nak Won Hwang^c, Jong Seo Lee^c, Kum-Joo Shin^c, Choong Hwan Lee^{a,d}, KilSoo Kim^{b,e*}, Seokjin Kim^{c**}

^aResearch Institute for Bioactive-Metabolome Network, Konkuk University, Seoul 05029, Republic of Korea

^bPreclinical Research Center, Daegu-Gyeongbuk Medical Innovation Foundation (K-MEDI hub), Daegu 41061, Republic of Korea.

^cR&D Center, Hecto Healthcare Co., Ltd., Seoul 06142, Republic of Korea.

^dDepartment of Bioscience and Biotechnology, Konkuk University, Seoul 05209, Republic of Korea.

^eCollege of Veterinary Medicine, Kyungpook National University, 80 Daehakro, Buk-gu, Daegu 41566, Korea.

^fCognitive science research group, Korea Brain Research Institute, Daegu 41062

¶These authors contributed equally to this work.

Corresponding authors

Choong-Hwan Lee^{b,e*}

Professor, Dept. of Preclinical Research Center, Daegu-Gyeongbuk Medical Innovation Foundation (K-MEDI hub)

120 Neungdong-ro, Gwangjin-gu, Daegu, 41061, Republic of Korea

Tel: +82-2-2049-6177

Fax: +82-2-455-4291

E-mail: chlee123@konkuk.ac.kr

Seokjin Kim^{c**}

Director, R&D Institute, Hecto Healthcare Co.

5F, Teheran-ro 223, Gangnam-gu, Seoul, 06142, Republic of Korea

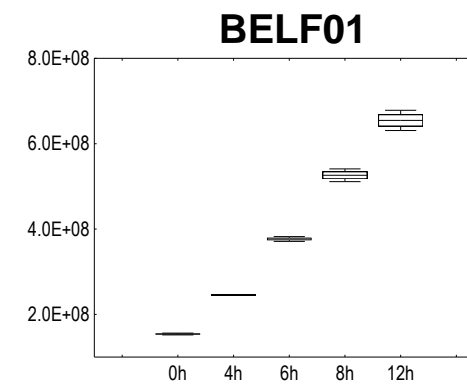
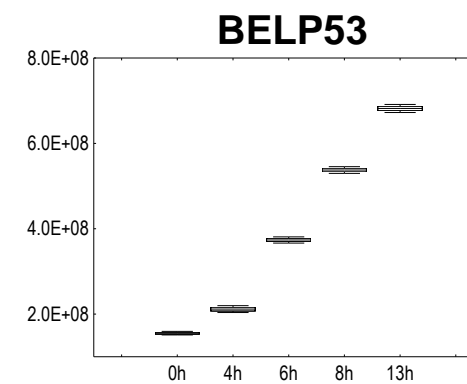
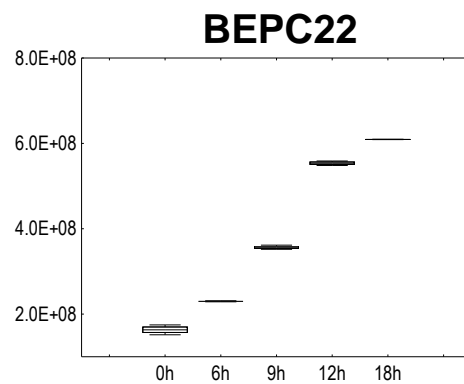
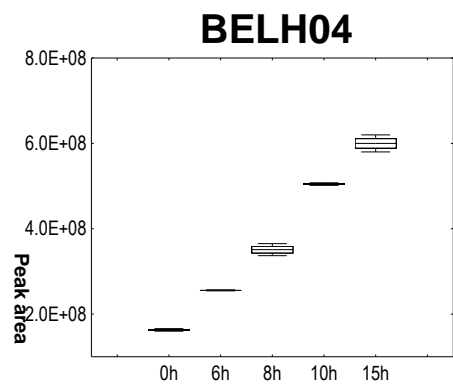
Tel: +82-2-6941-0580

Fax: +82-2-543-1649

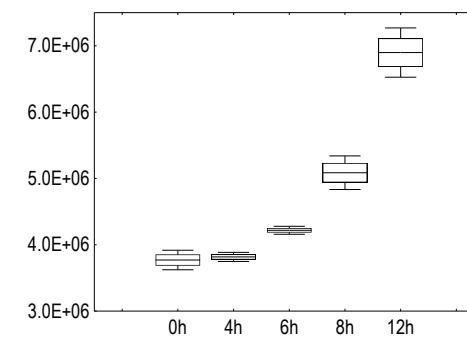
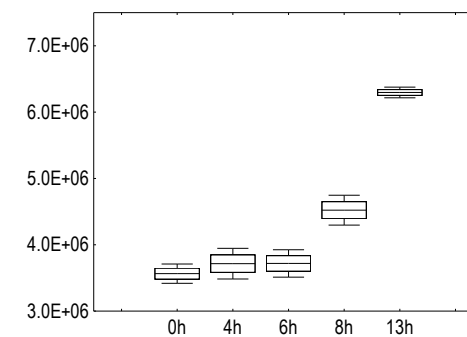
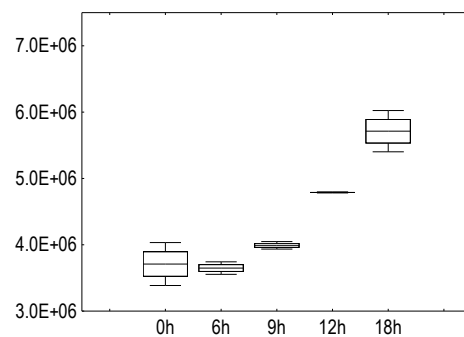
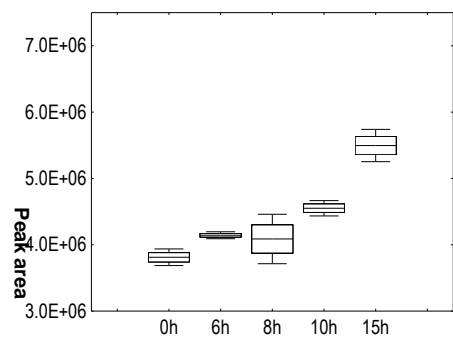
E-mail: jinkim@hecto.co.kr

Electronic Supplementary Information

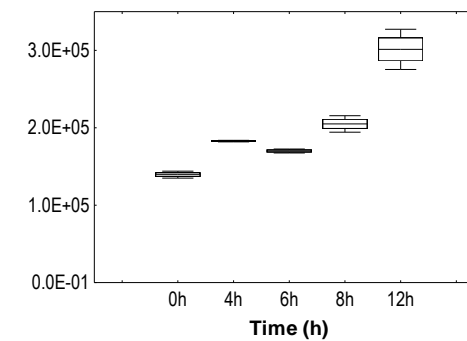
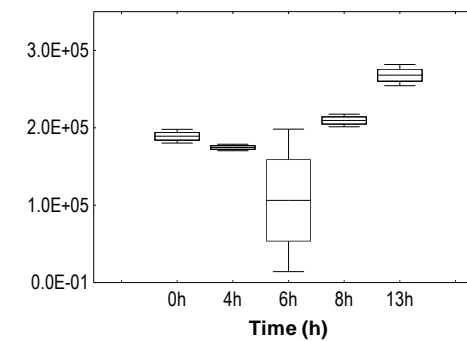
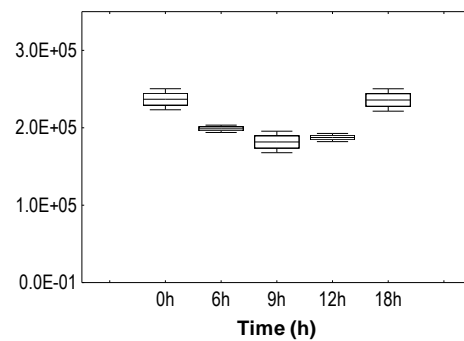
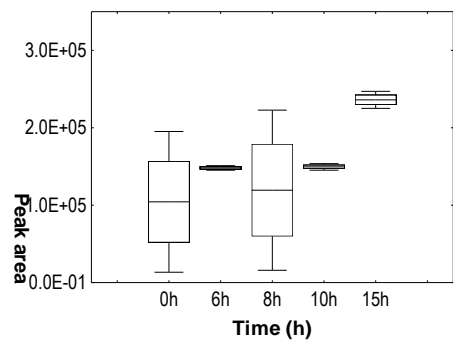
Lactic acid



Glycolic acid

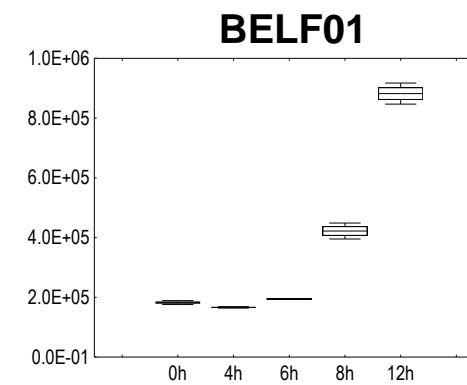
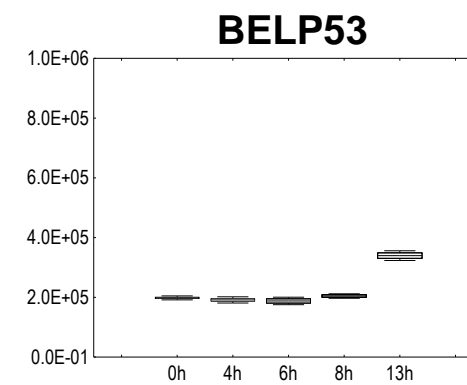
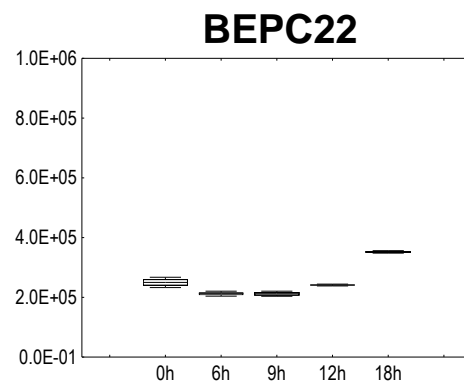
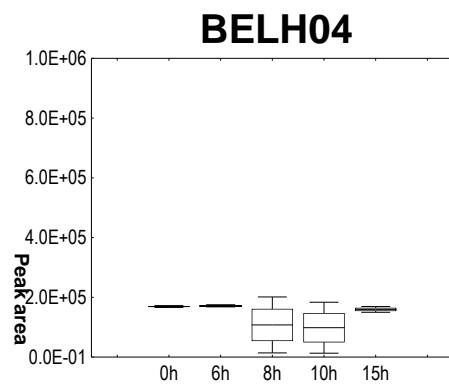


Oxalic acid

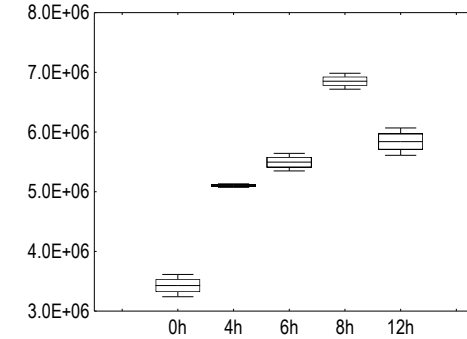
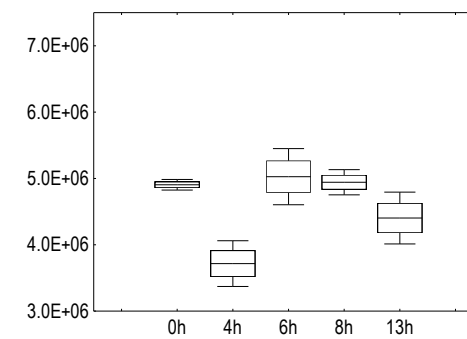
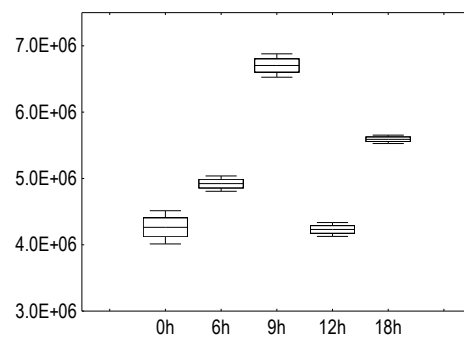
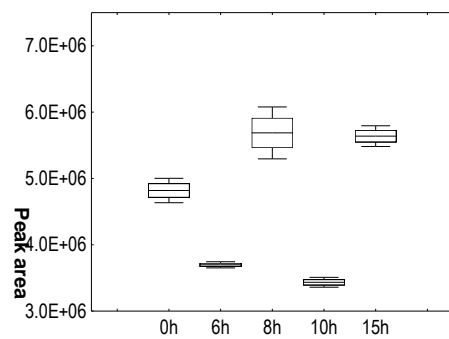


Electronic Supplementary Information

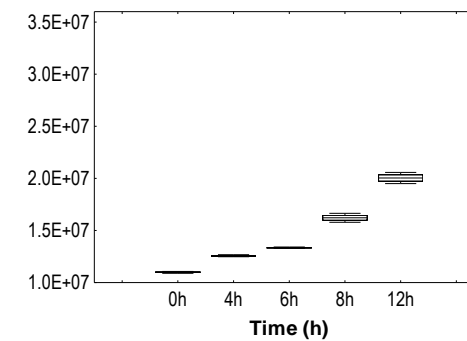
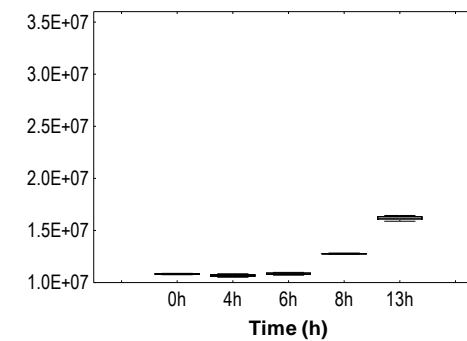
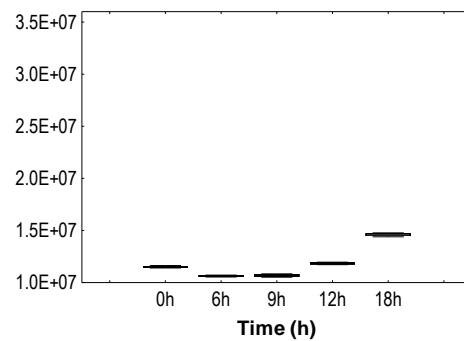
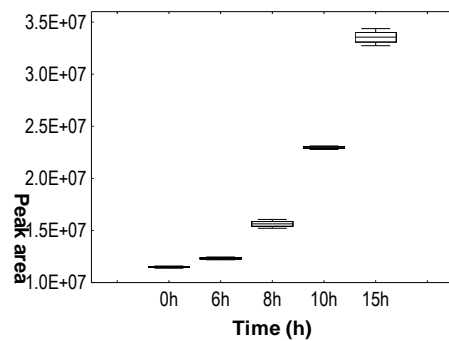
Malonic acid



Urea

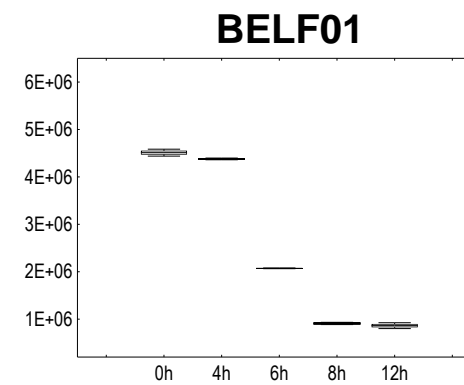
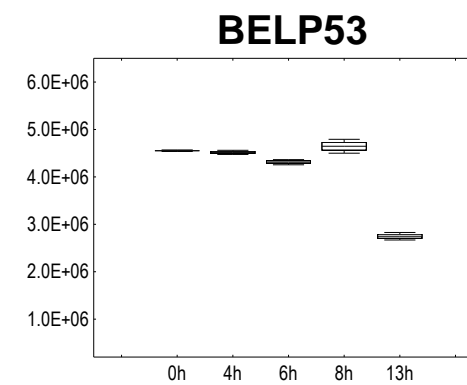
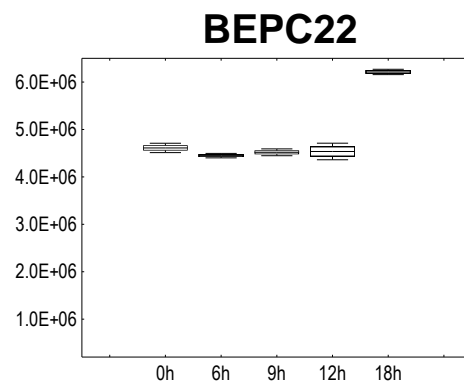
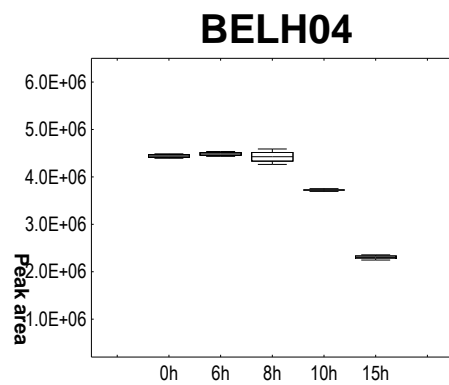


Succinic acid

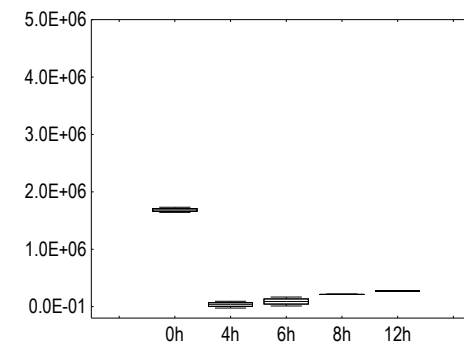
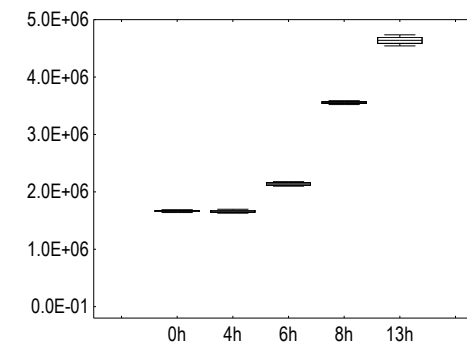
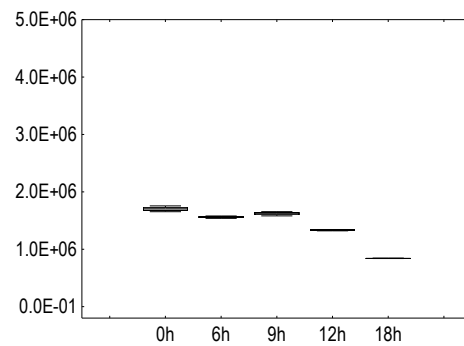
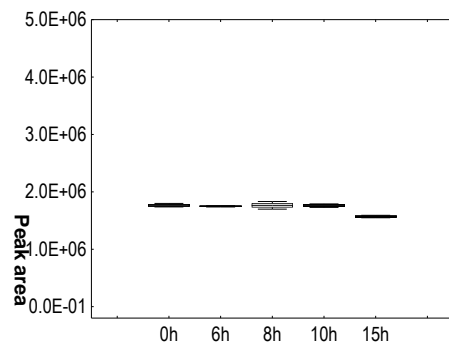


Electronic Supplementary Information

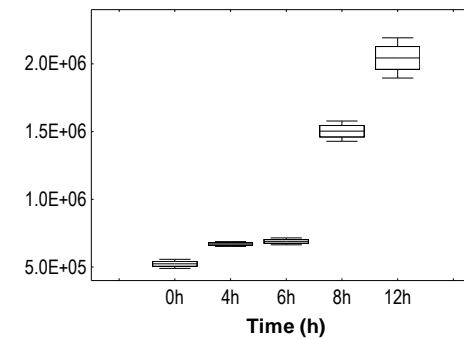
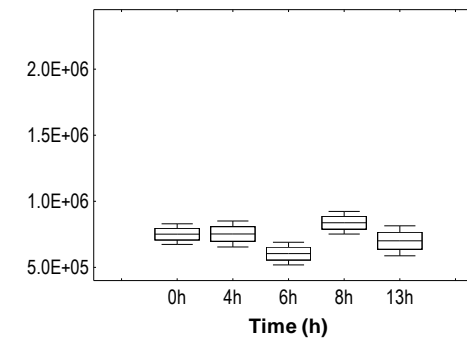
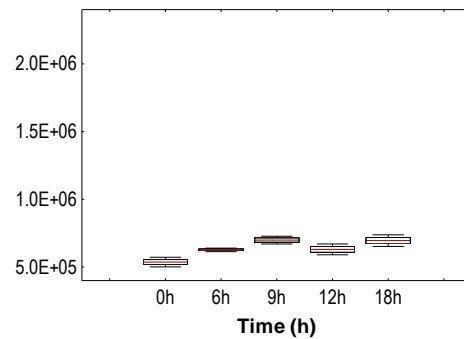
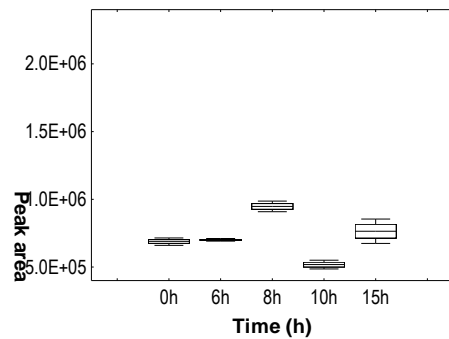
Glyceric acid



Malic acid



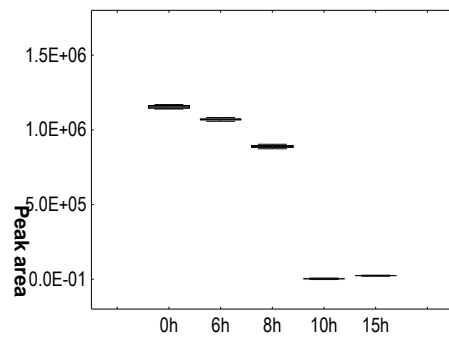
Taurine



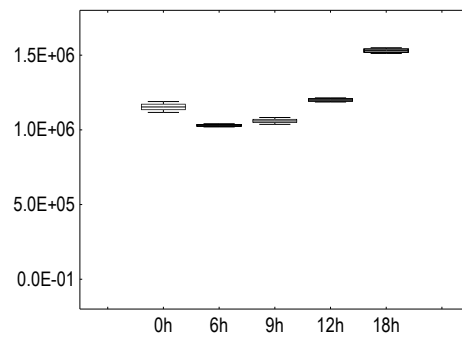
Electronic Supplementary Information

BELH04

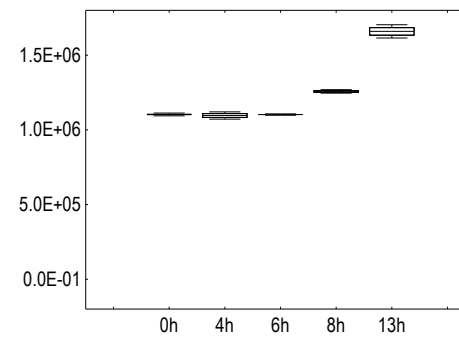
Orotic acid



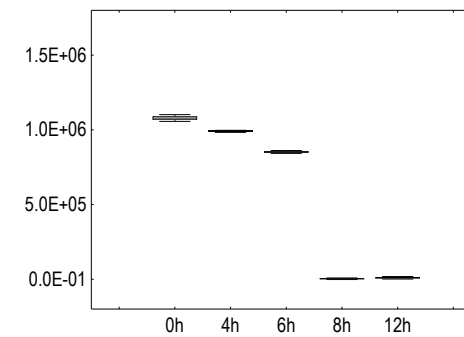
BEPC22



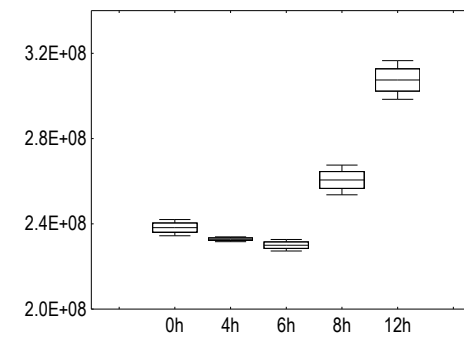
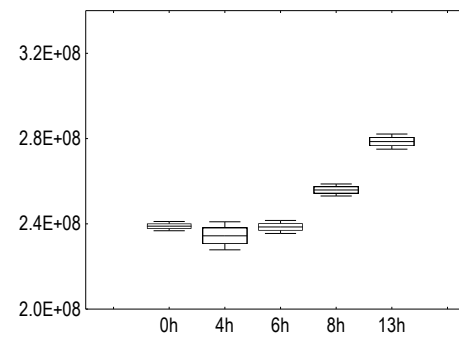
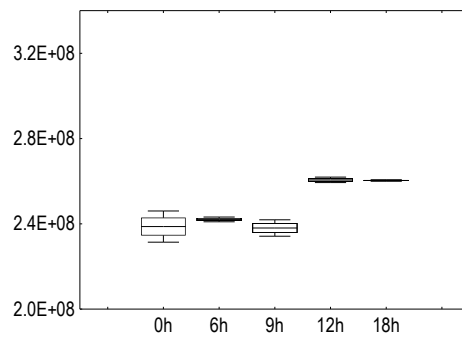
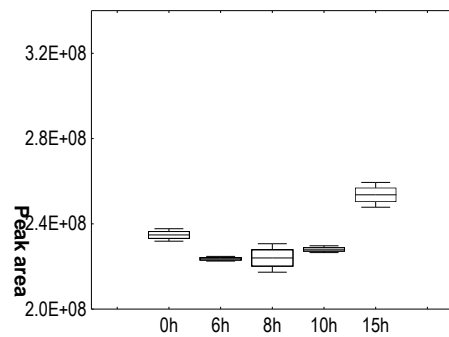
BELP53



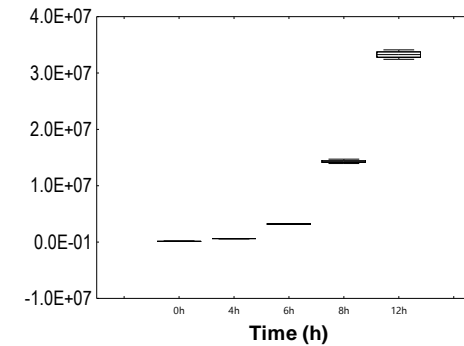
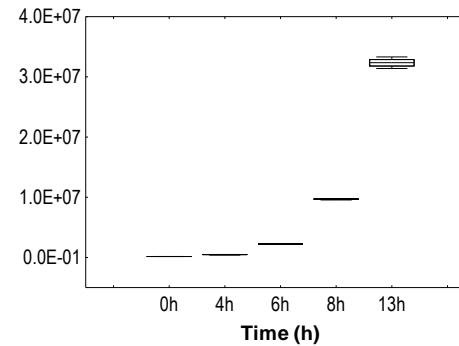
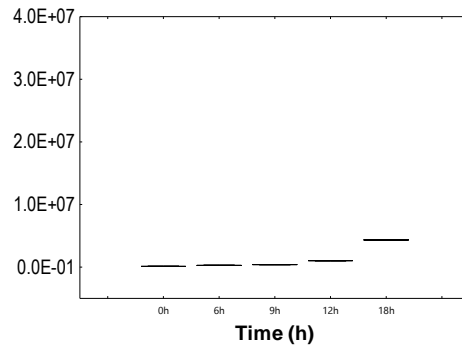
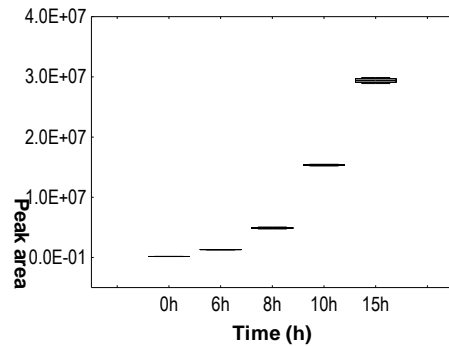
BELF01



Citric acid



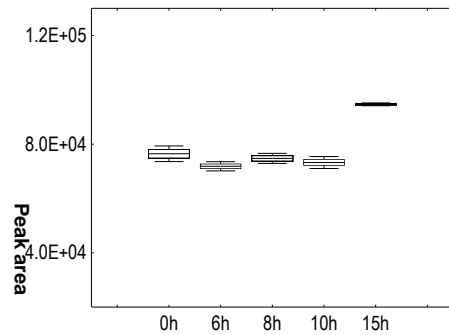
3-Phenyllactic acid



Electronic Supplementary Information

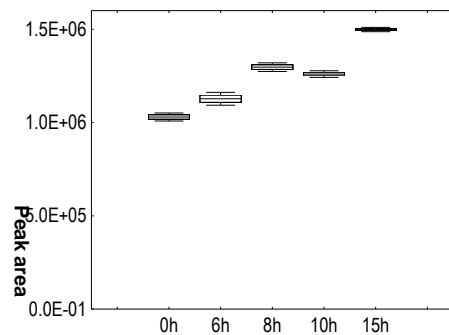
BELH04

Aconitic acid

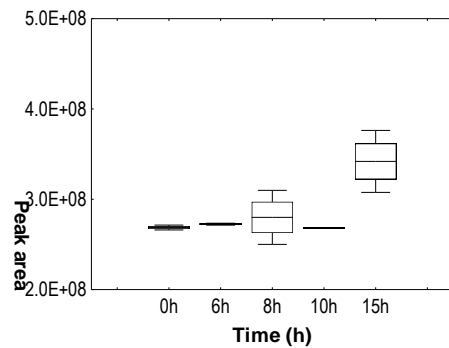


BEPC22

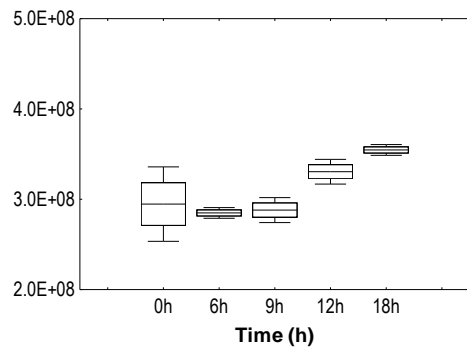
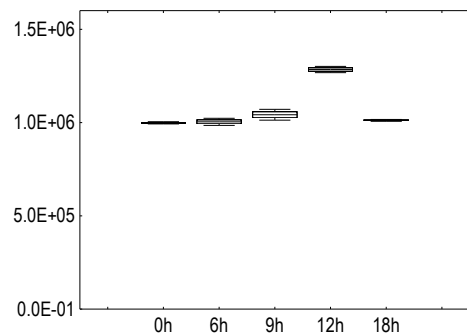
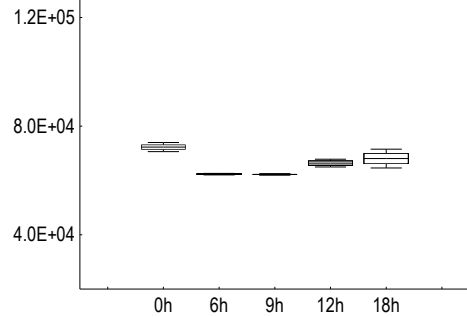
Gluconic acid



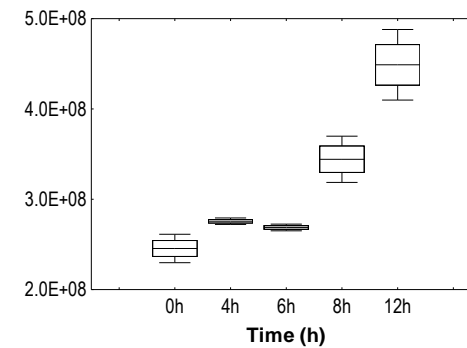
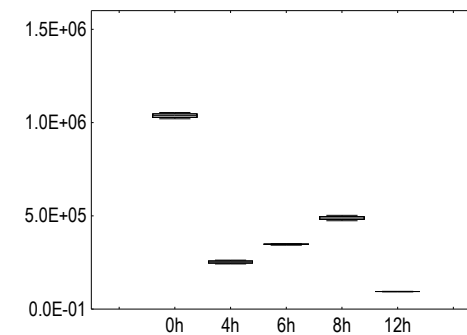
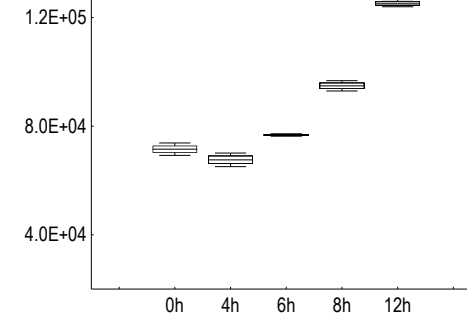
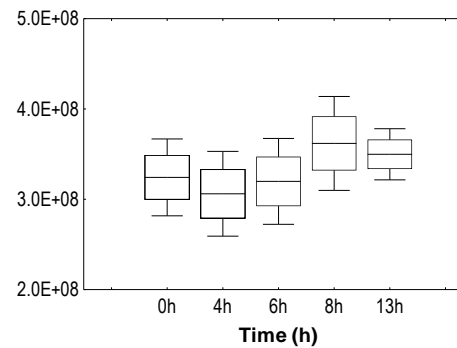
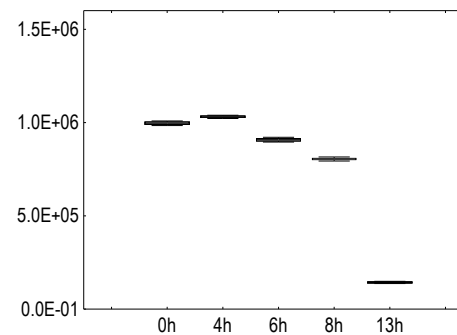
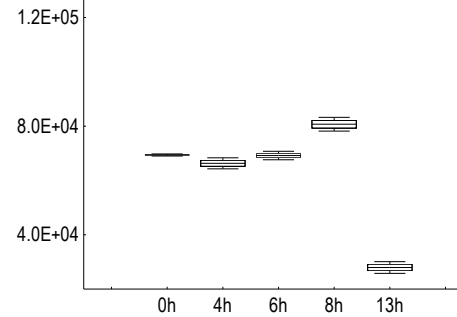
Alanine



BELP53



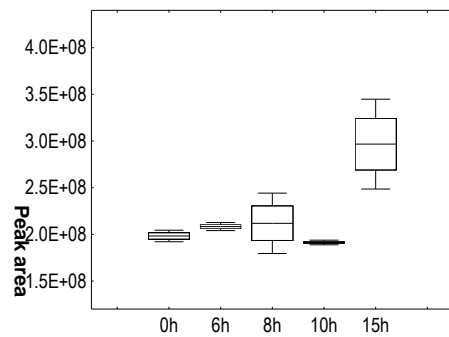
BELF01



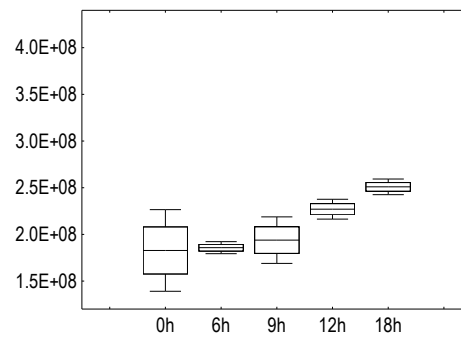
Electronic Supplementary Information

BELH04

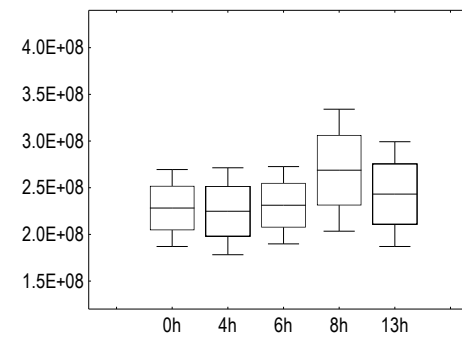
Valine



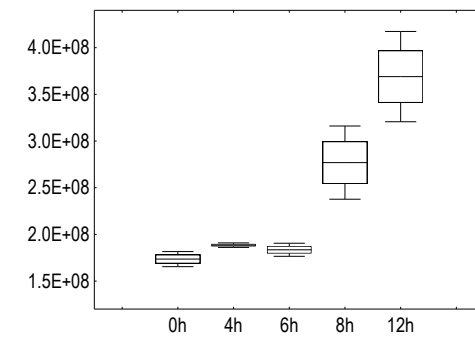
BEPC22



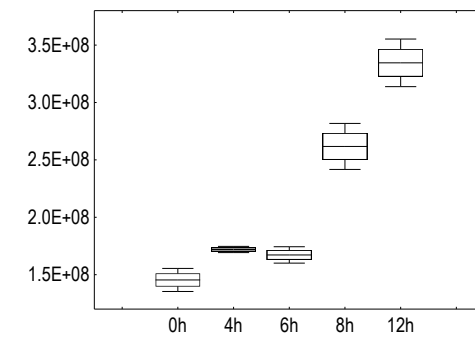
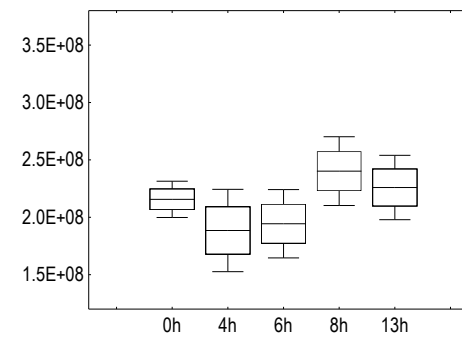
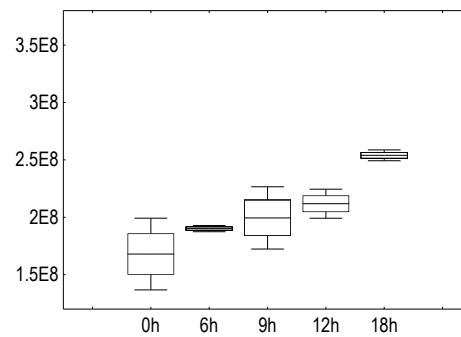
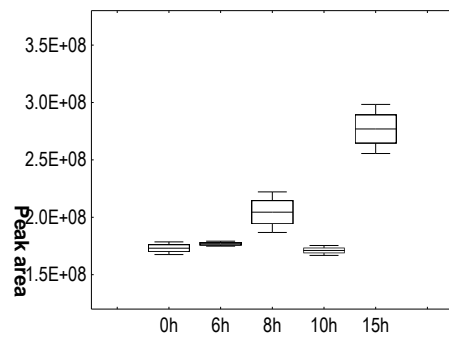
BELP53



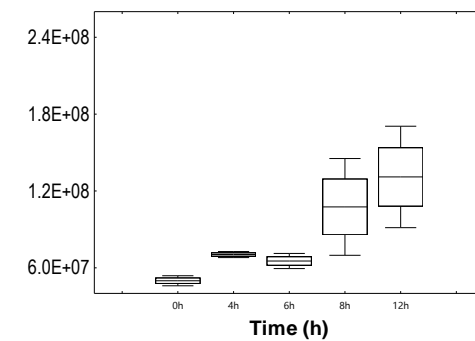
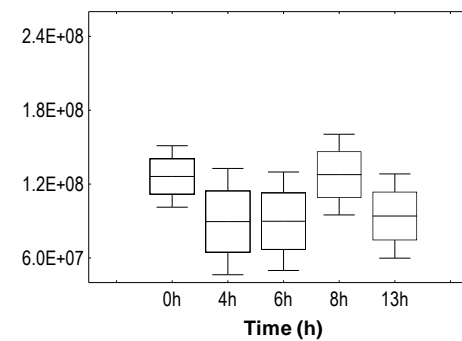
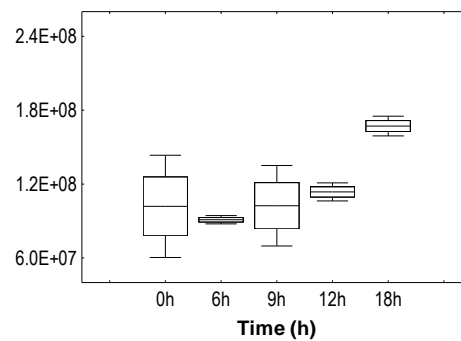
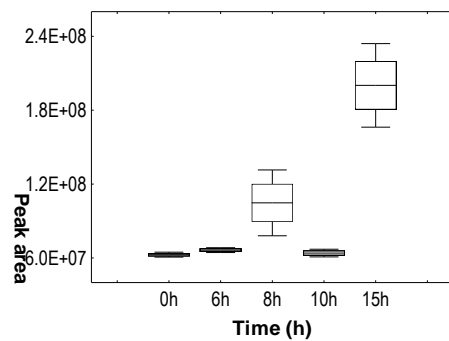
BELF01



Isoleucine

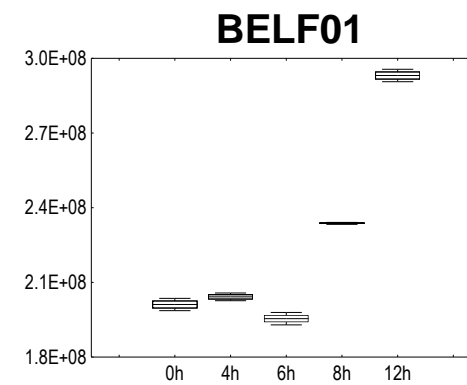
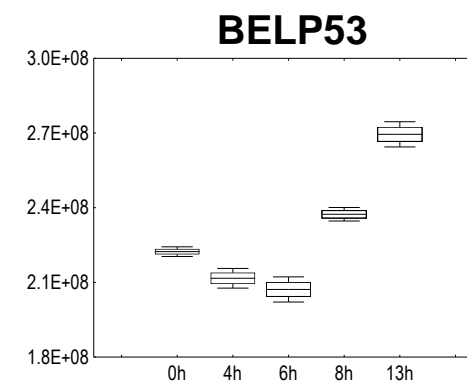
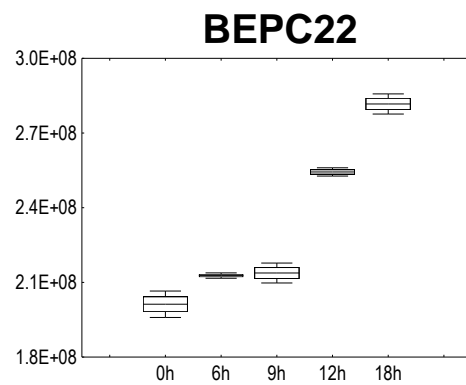
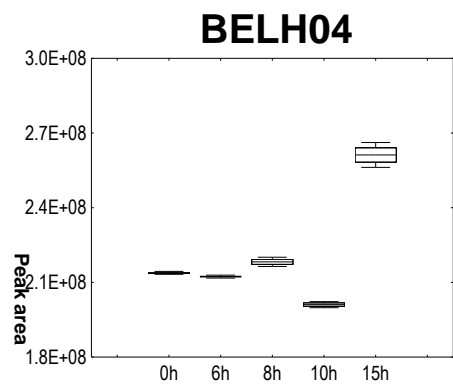


Proline

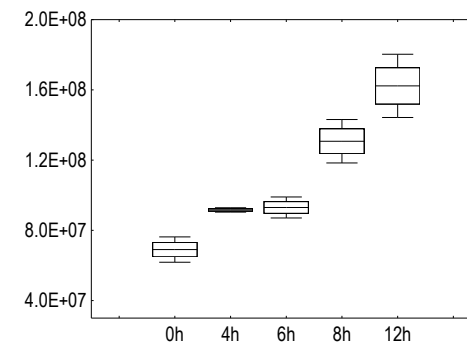
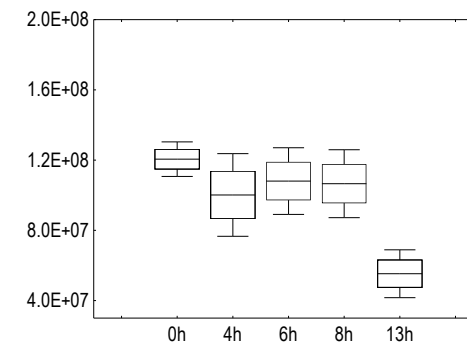
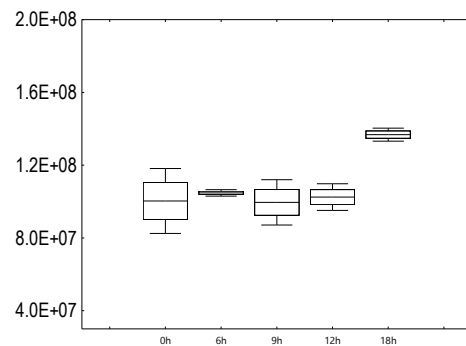
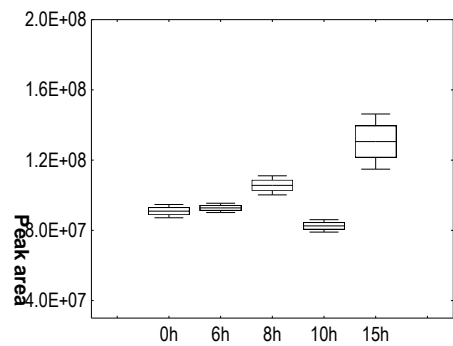


Electronic Supplementary Information

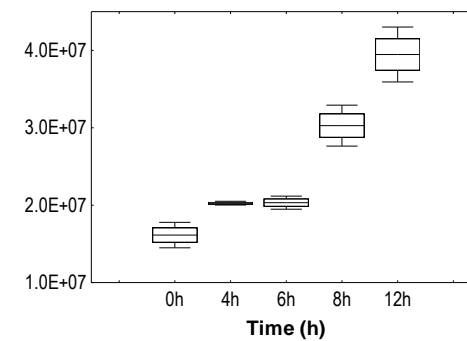
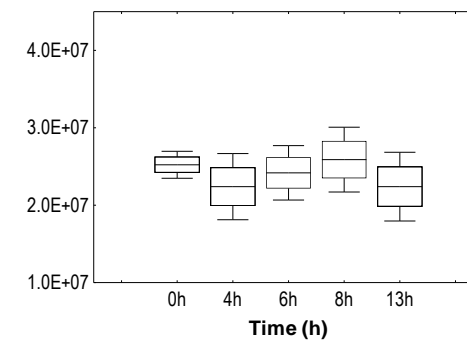
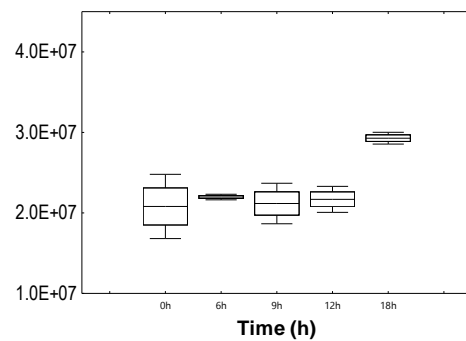
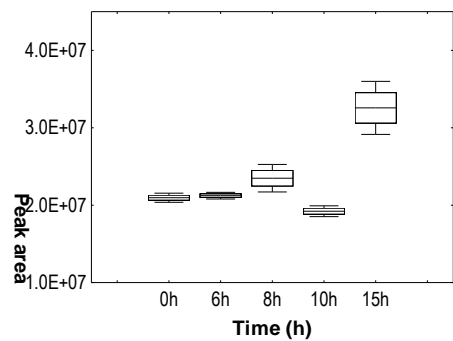
Glycine



Serine



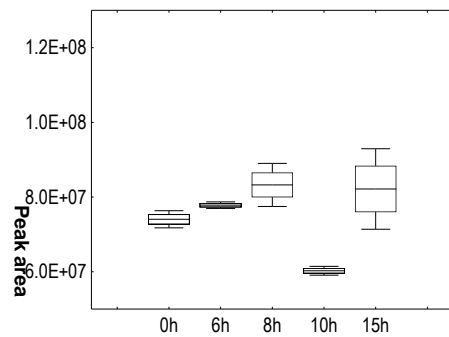
Threonine



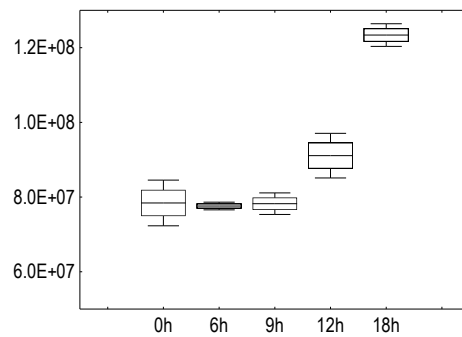
Electronic Supplementary Information

BELH04

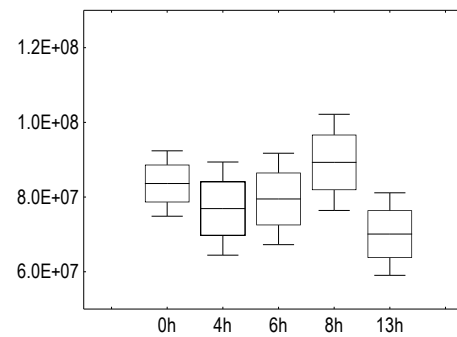
Aspartic acid



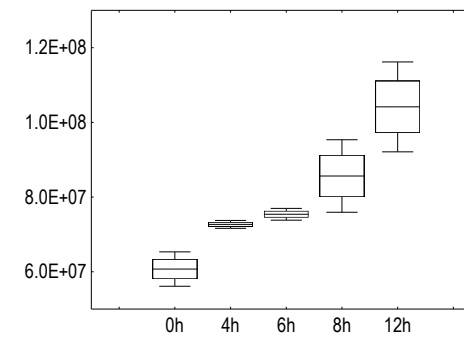
BEPC22



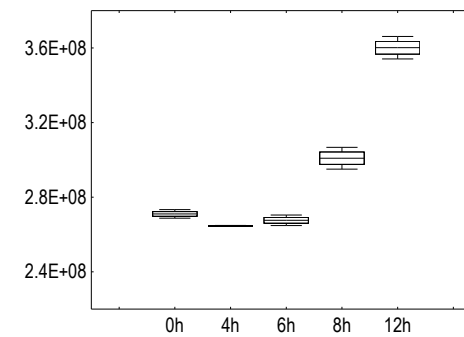
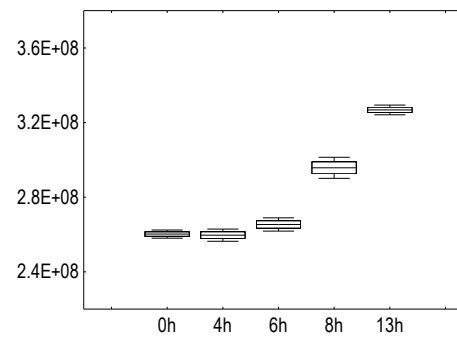
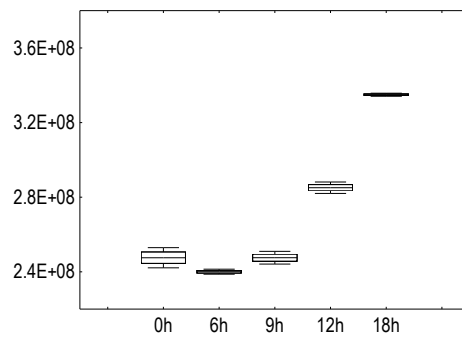
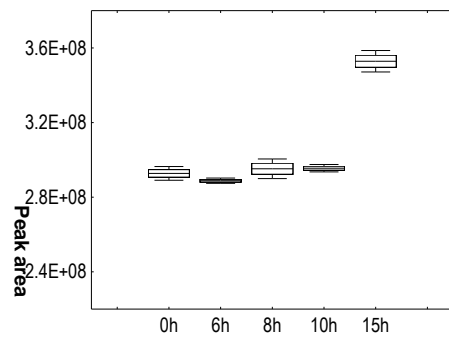
BELP53



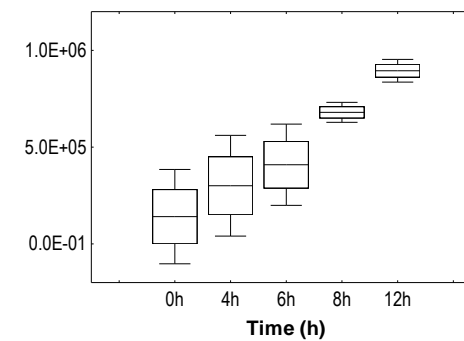
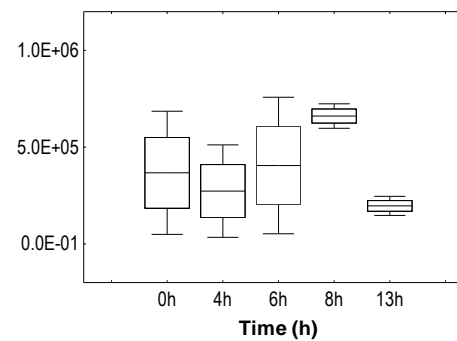
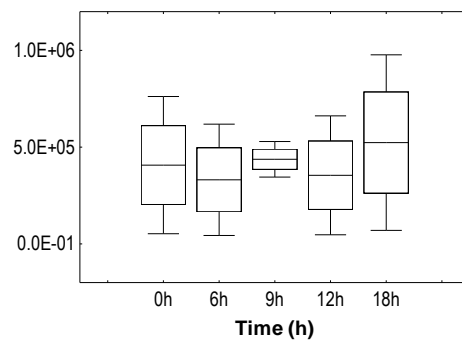
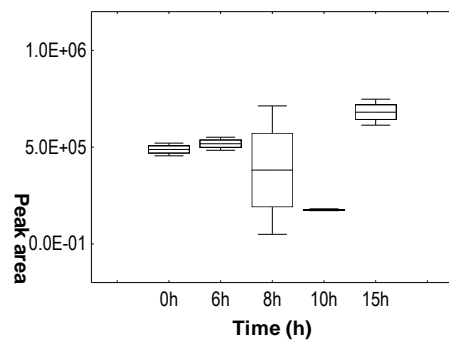
BELF01



5-Oxoproline

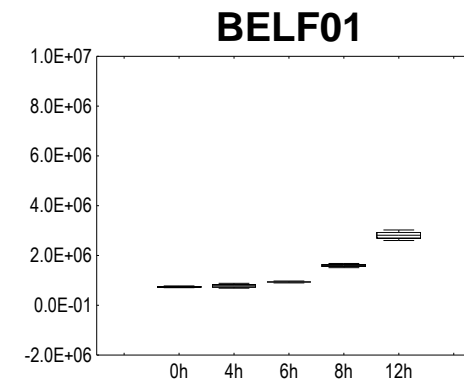
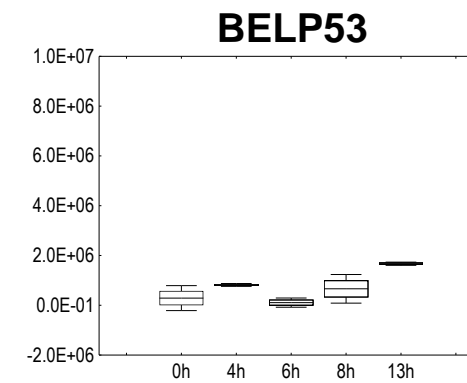
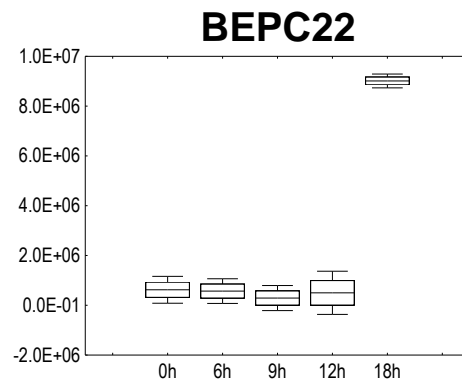
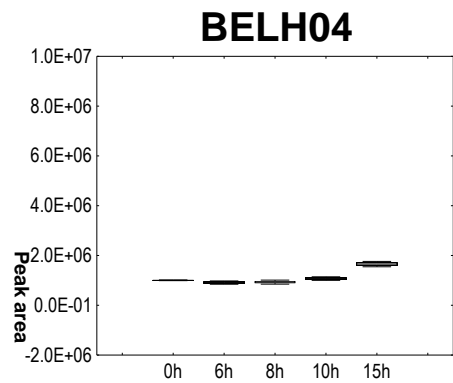


Cysteine

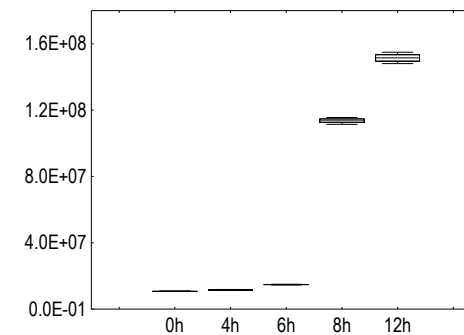
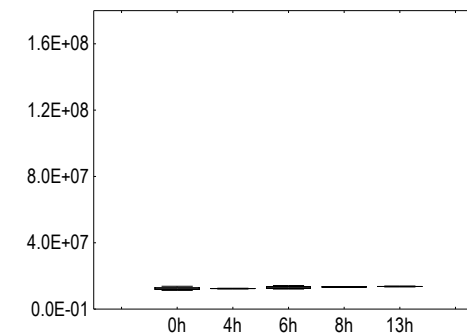
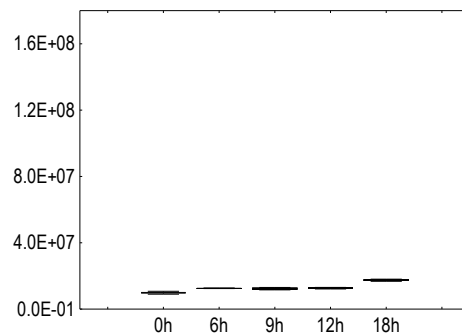
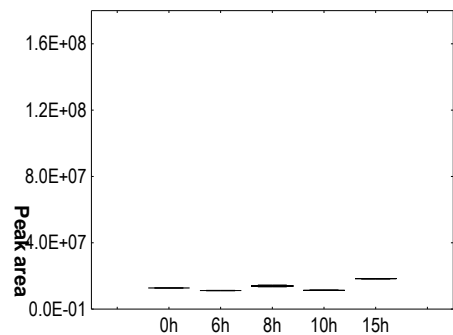


Electronic Supplementary Information

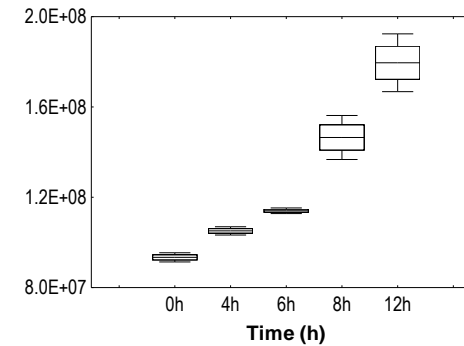
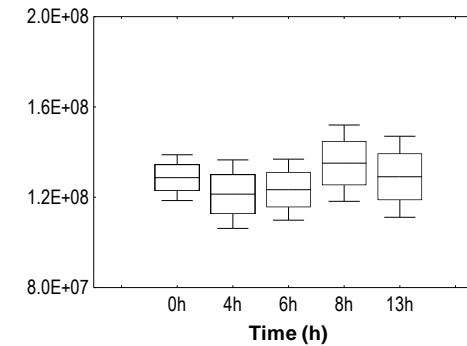
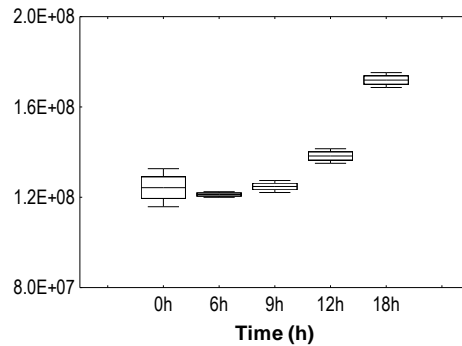
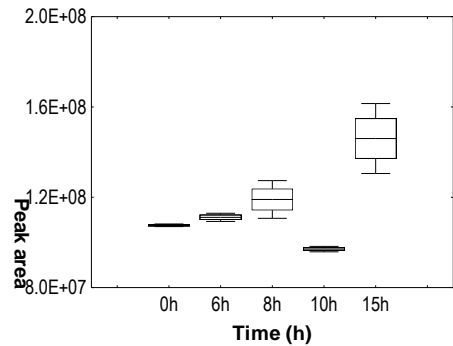
**2-Hydroxy
glutaric acid**



Ornithine

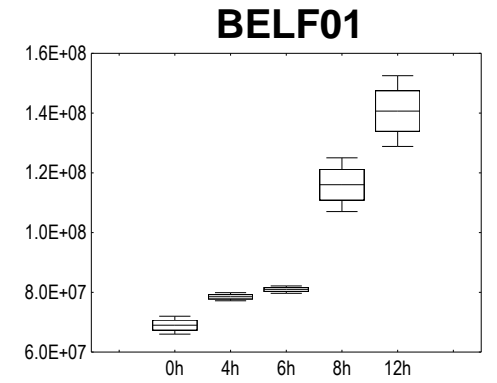
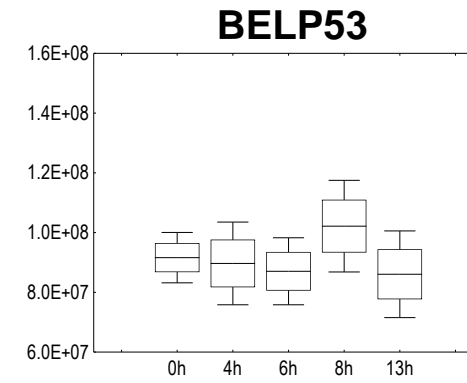
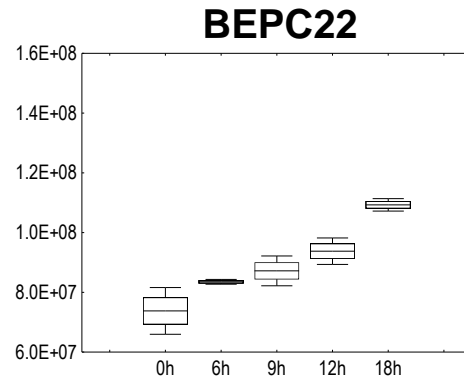
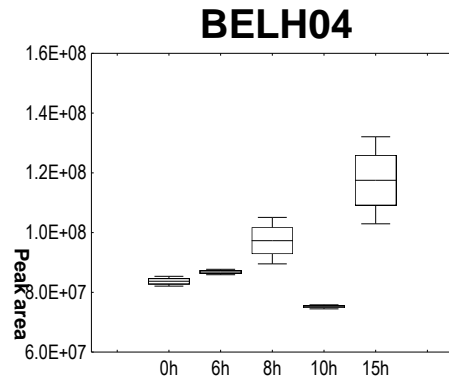


Glutamic acid

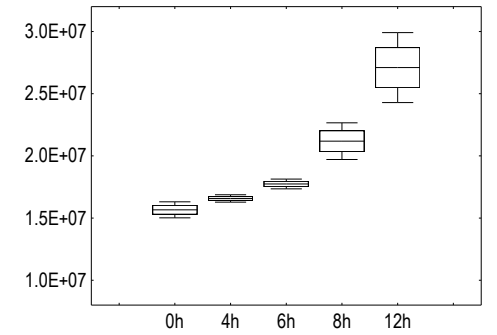
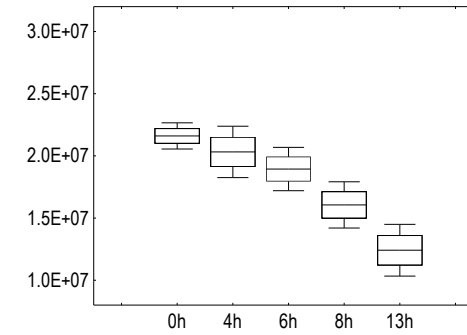
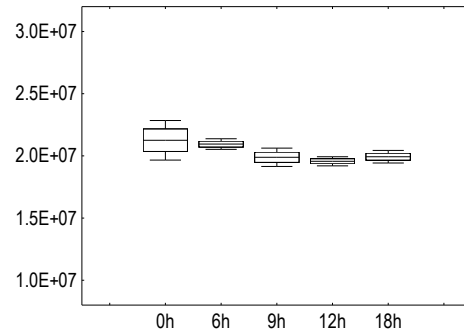
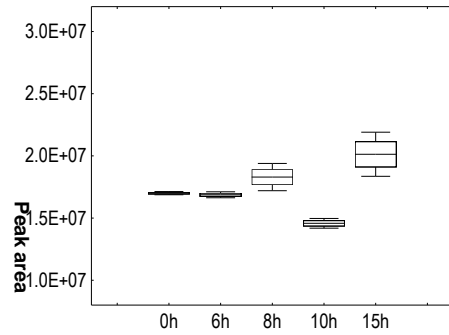


Electronic Supplementary Information

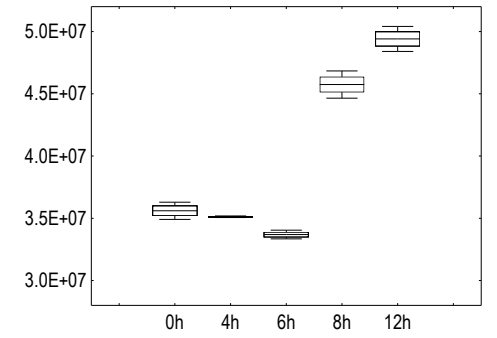
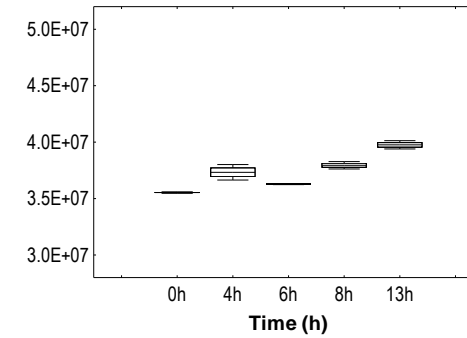
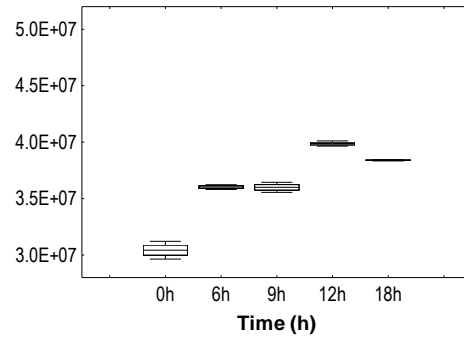
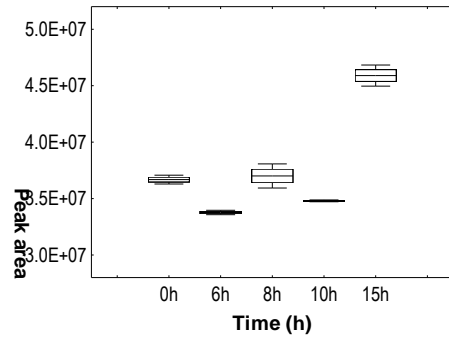
Phenylalanine



Asparagine

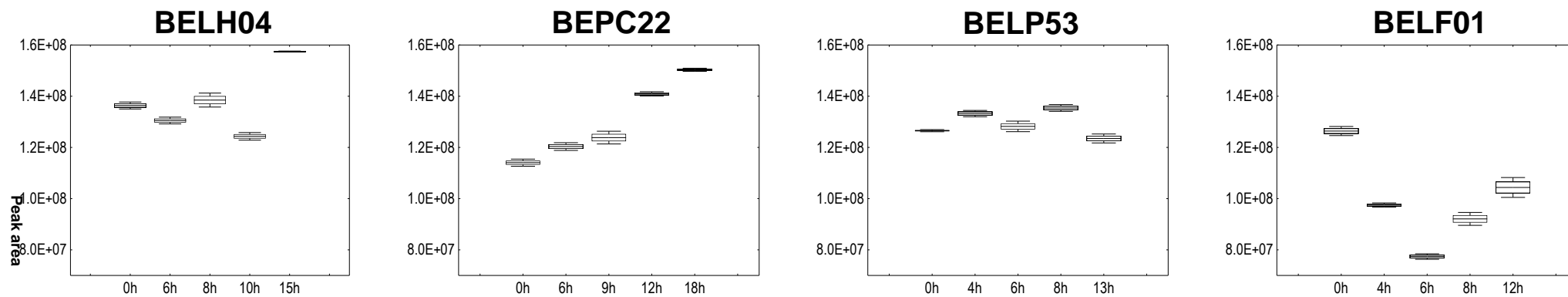


Lysine

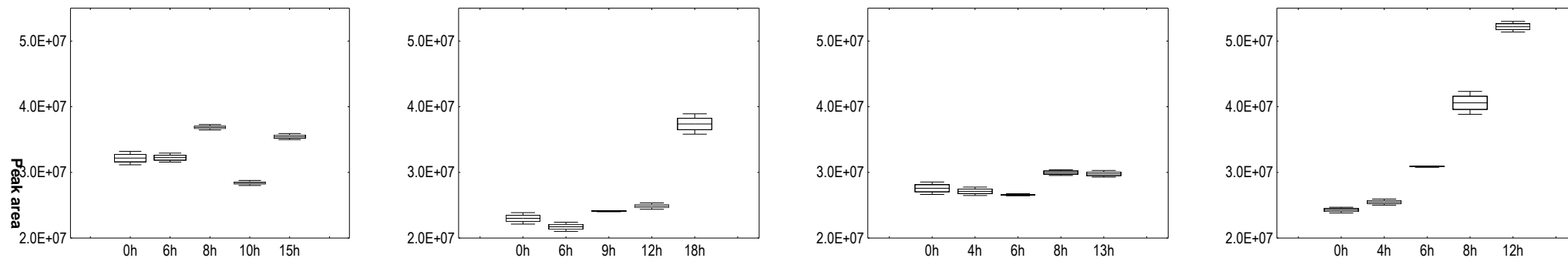


Electronic Supplementary Information

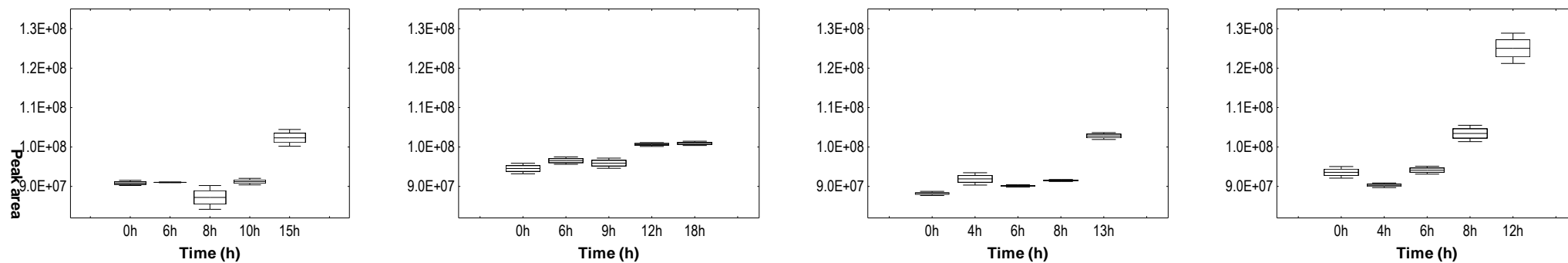
Tyrosine



Tryptophan



Glycerol



Electronic Supplementary Information

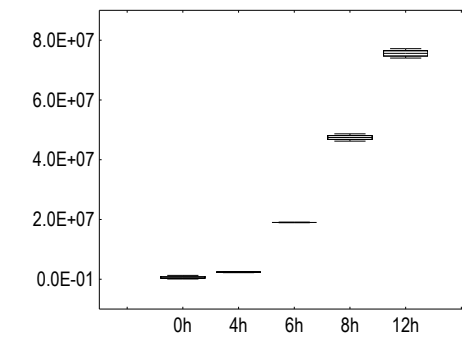
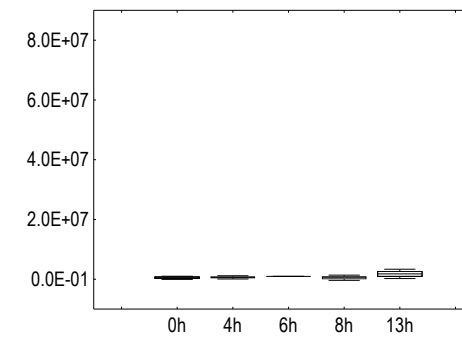
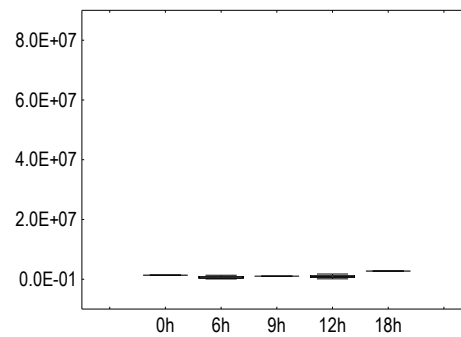
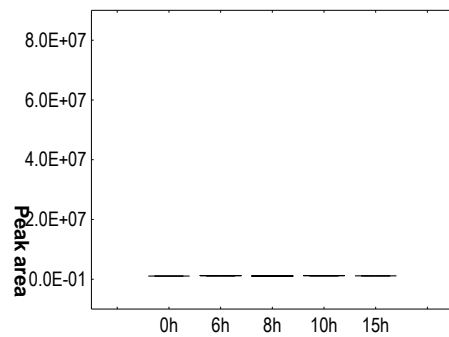
BELH04

BEPC22

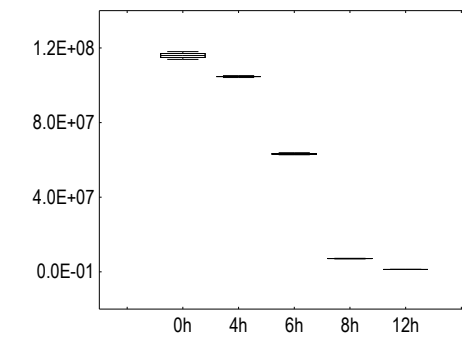
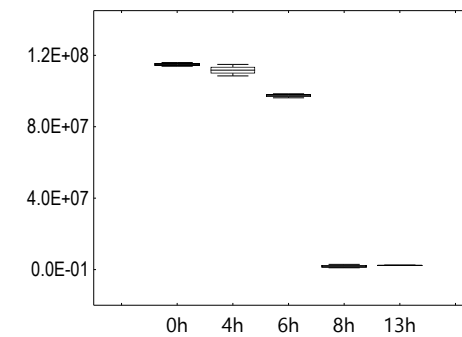
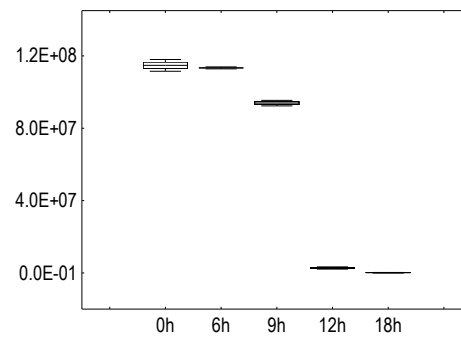
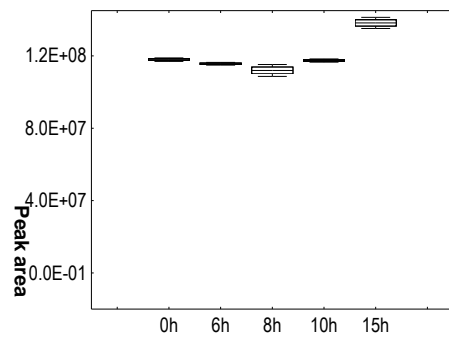
BELP53

BELF01

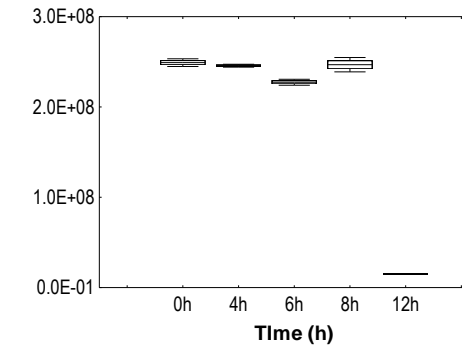
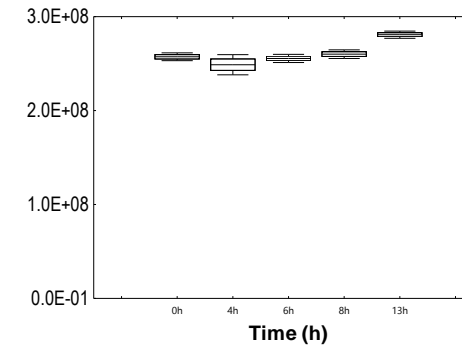
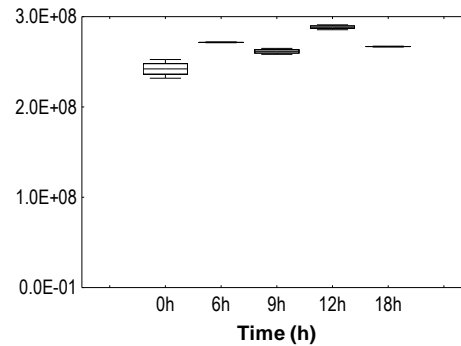
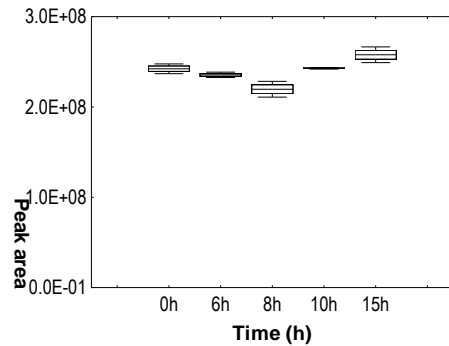
Erythritol



Fructose

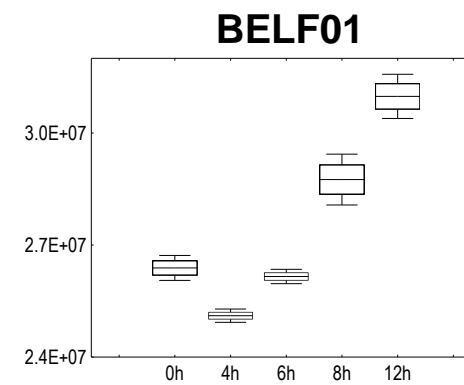
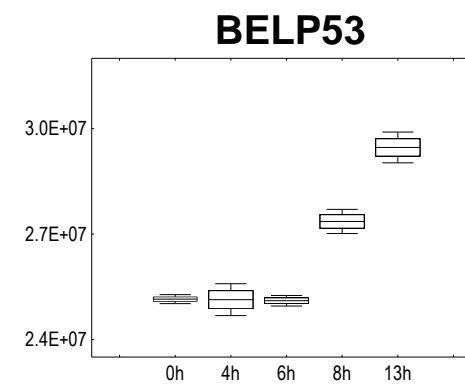
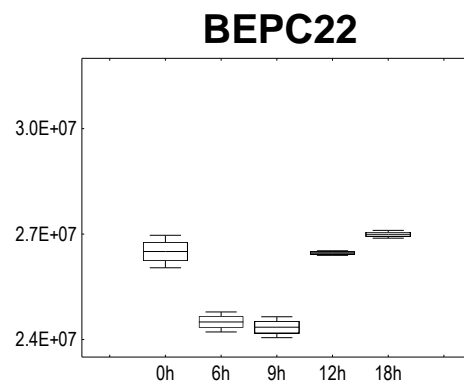
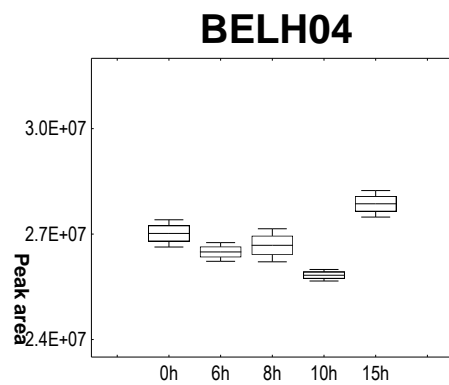


Glucose

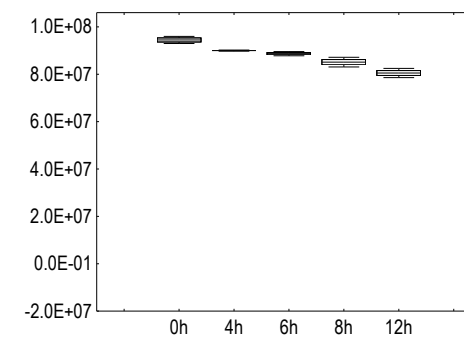
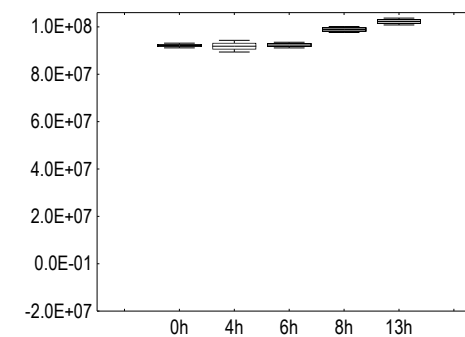
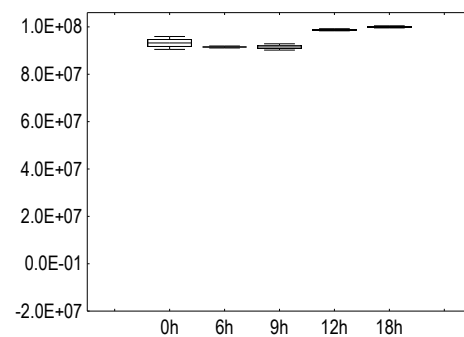
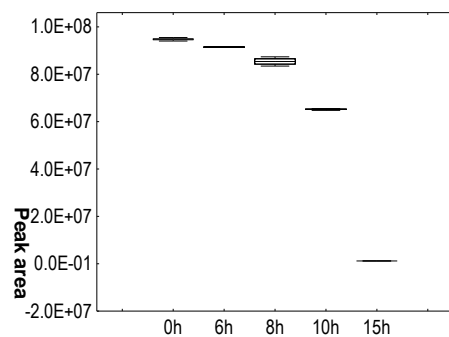


Electronic Supplementary Information

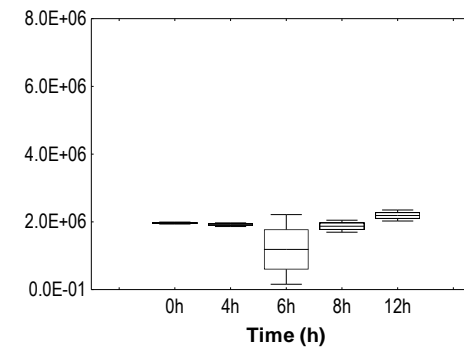
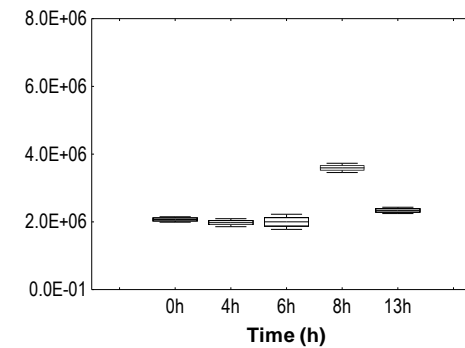
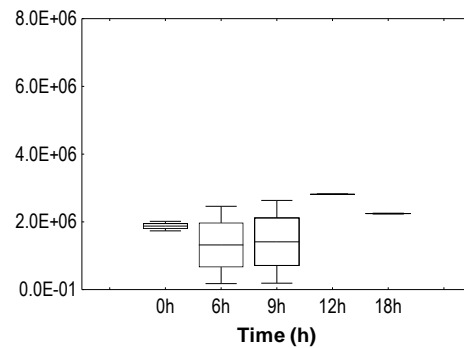
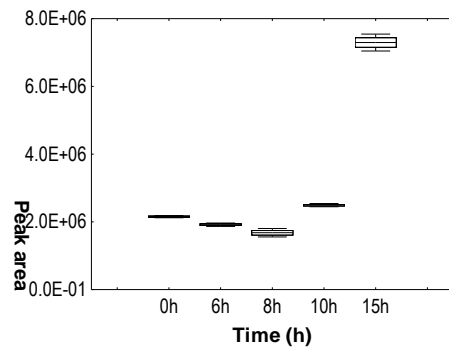
Myo-inositol



Lactose



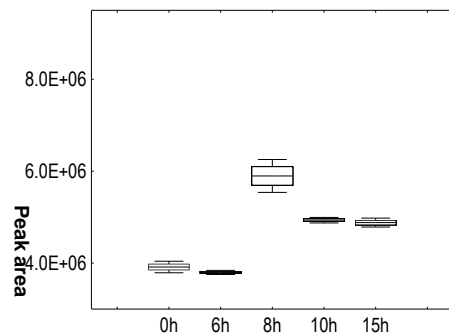
1,3-Propanediol



Electronic Supplementary Information

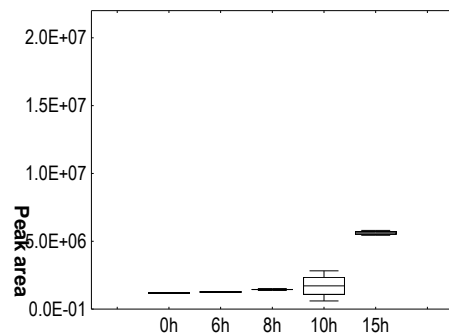
BELH04

Hexanoic acid

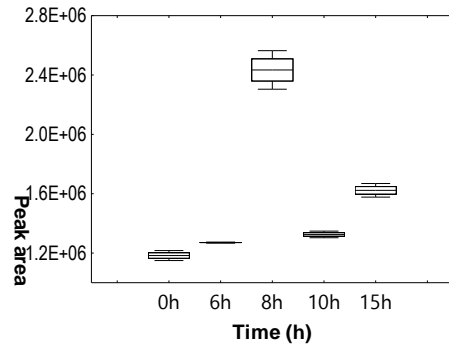


BEPC22

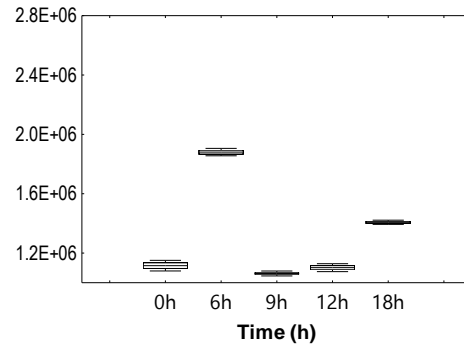
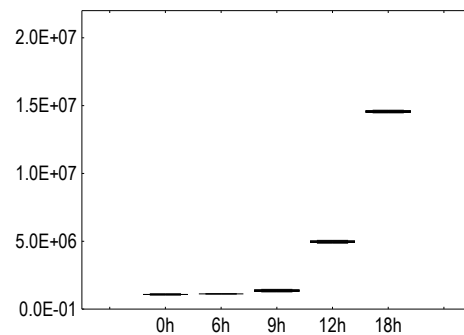
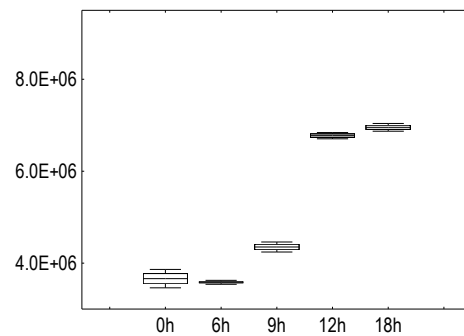
2-Hydroxy-3-methylbutyric acid



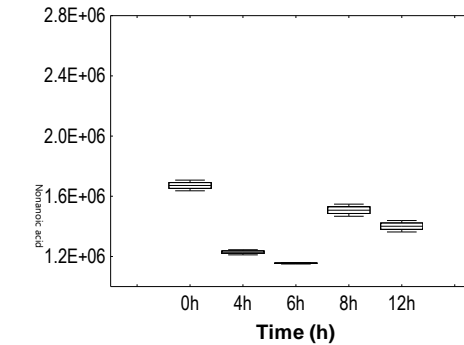
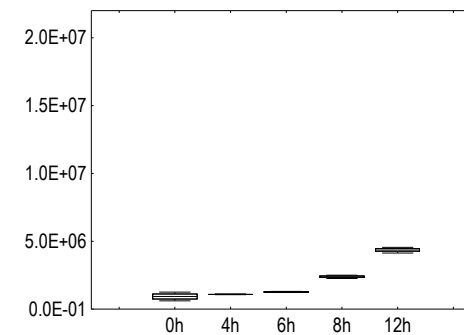
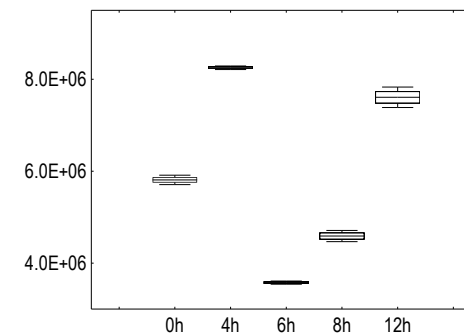
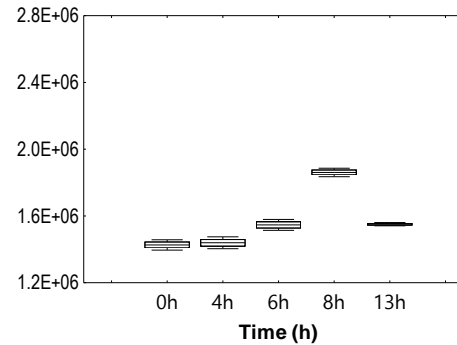
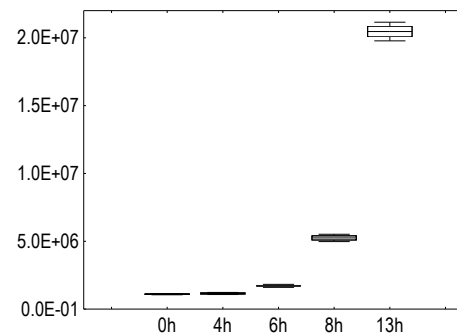
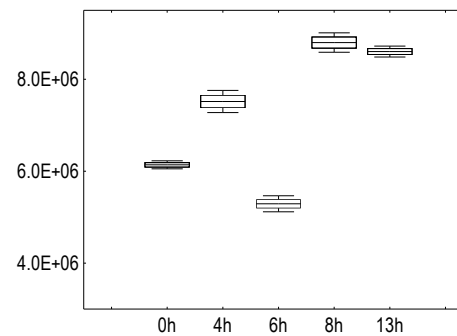
Nonanoic acid



BELP53



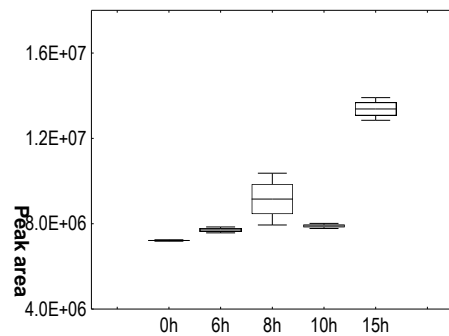
BELF01



Electronic Supplementary Information

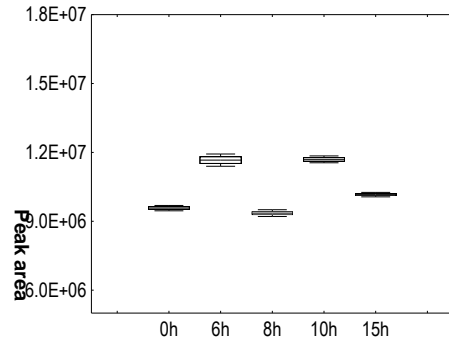
BELH04

4-Aminobutanoic acid

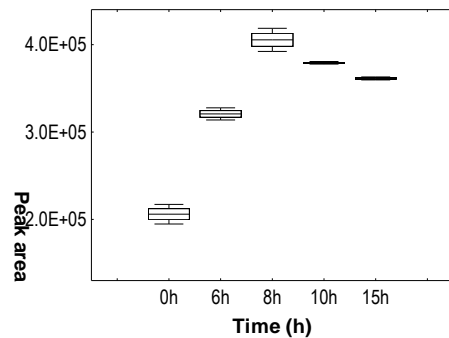


BEPC22

Palmitic acid

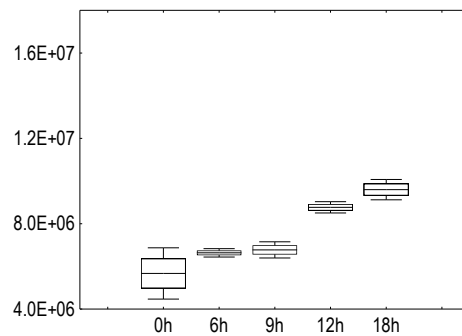


Oleic acid

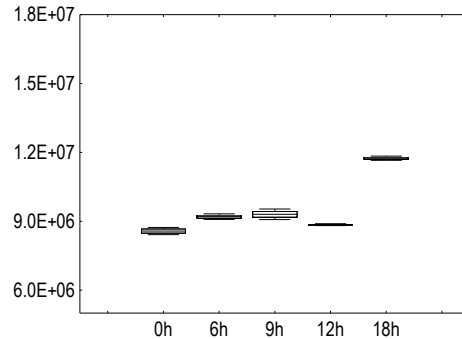


BELP53

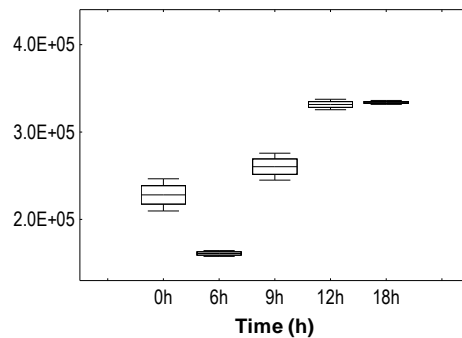
4-Aminobutanoic acid



Palmitic acid

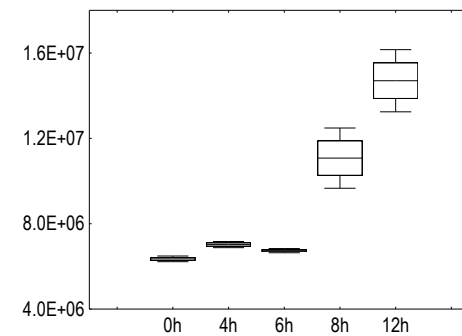


Oleic acid

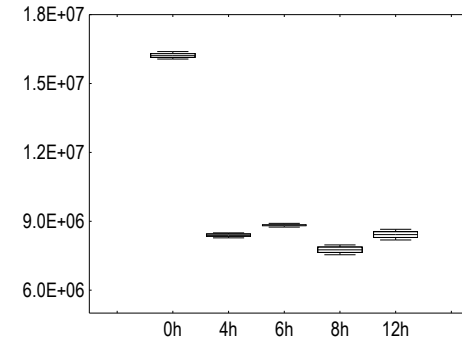


BELF01

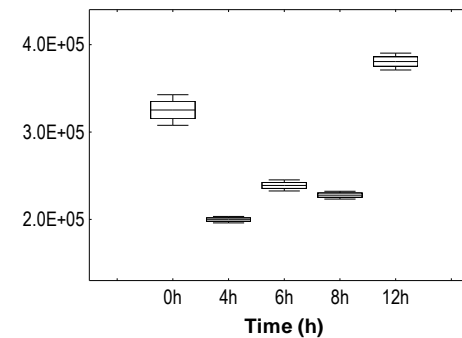
4-Aminobutanoic acid



Palmitic acid

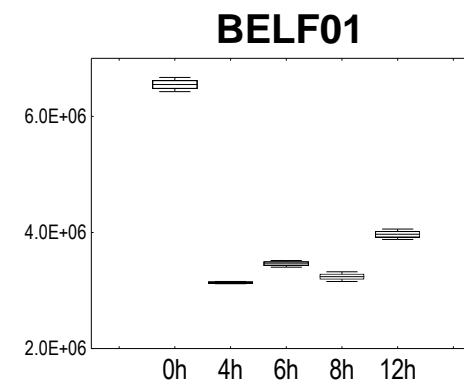
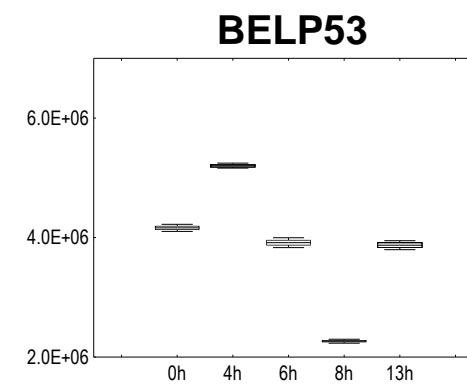
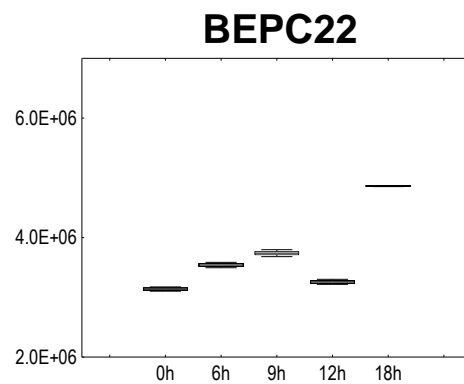
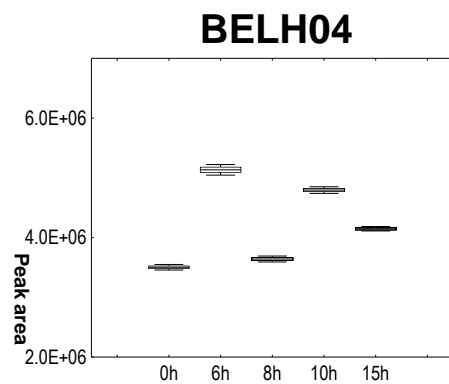


Oleic acid

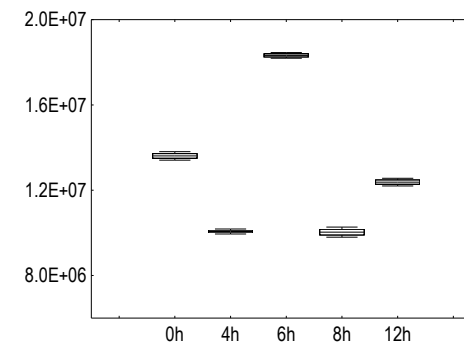
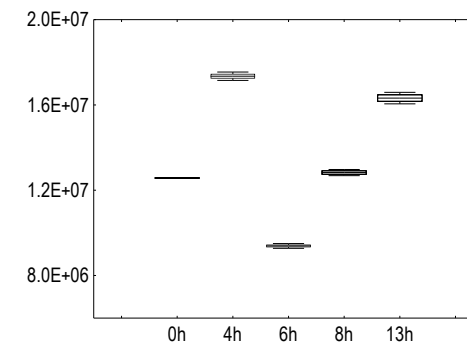
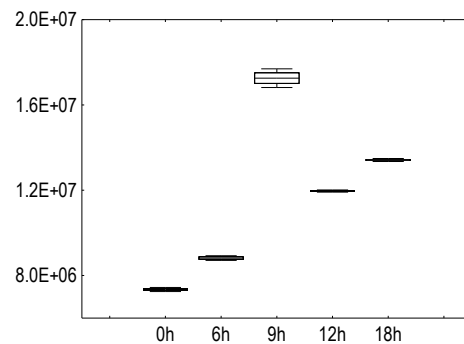
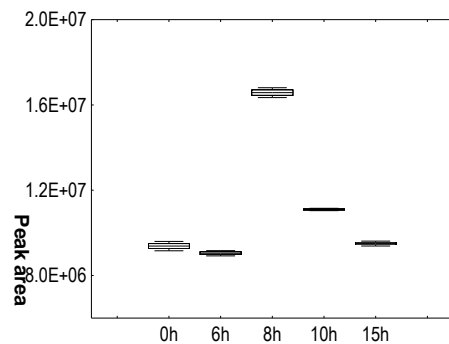


Electronic Supplementary Information

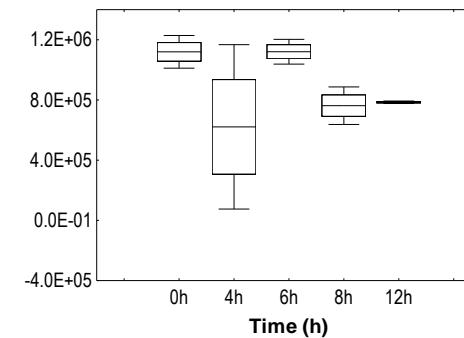
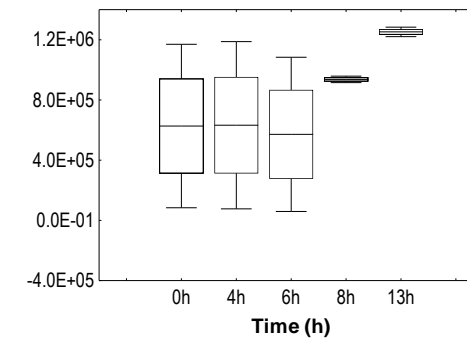
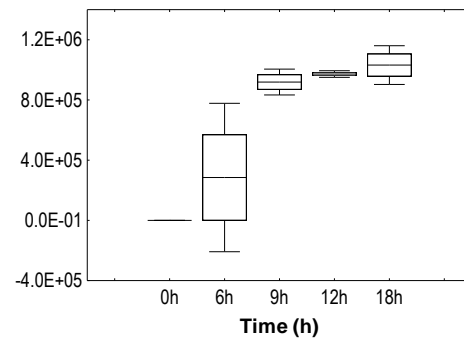
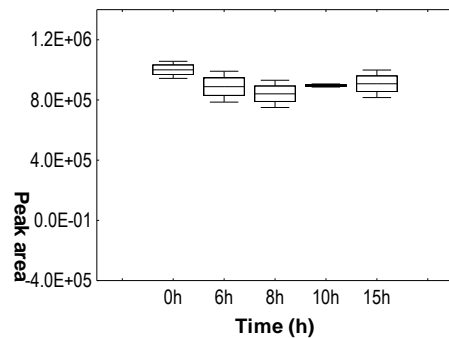
Stearic acid



Oleamide

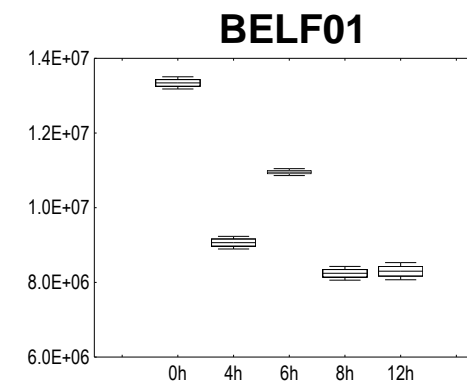
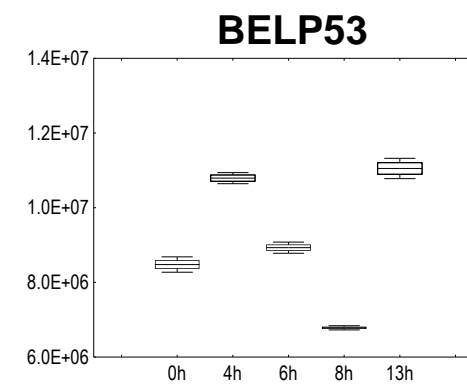
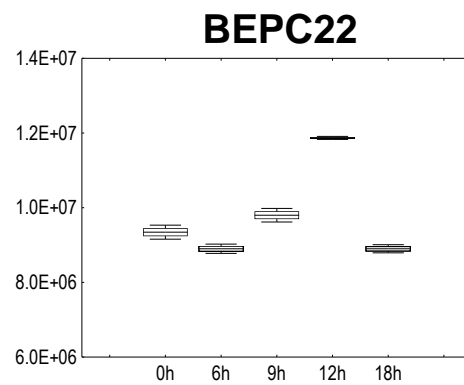
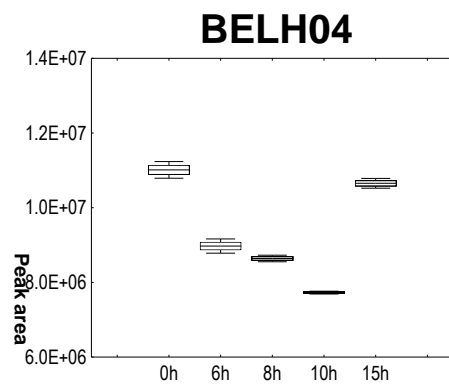


Palmitoylglycerol

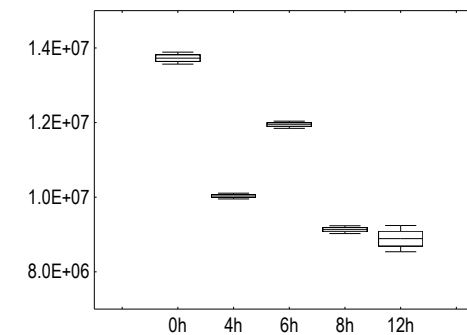
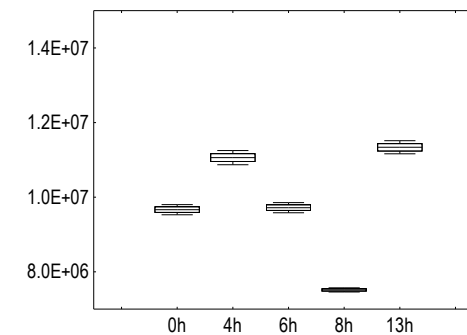
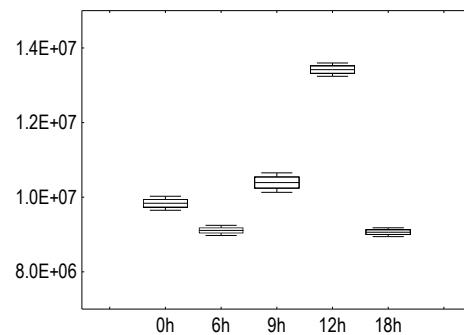
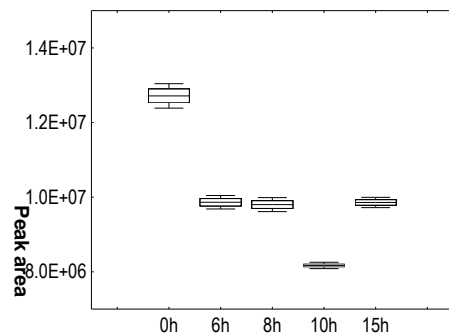


Electronic Supplementary Information

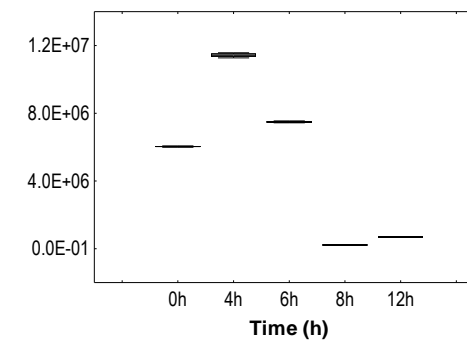
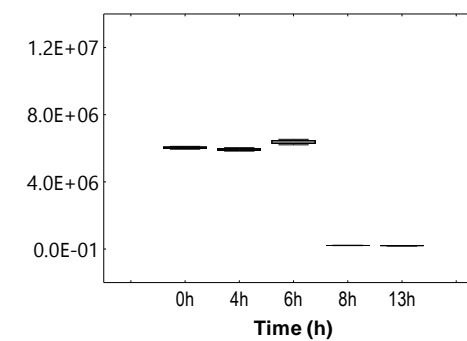
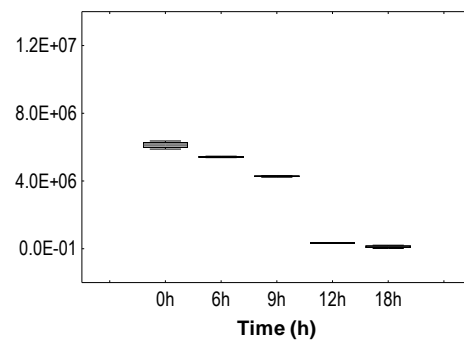
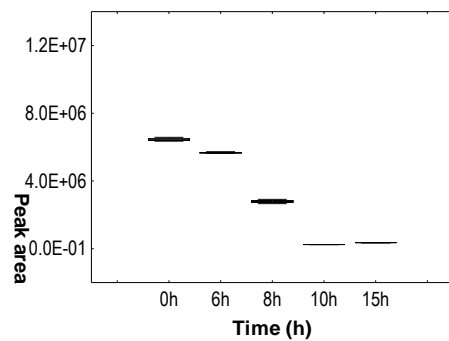
Monopalmitin



Glycerol monostearate



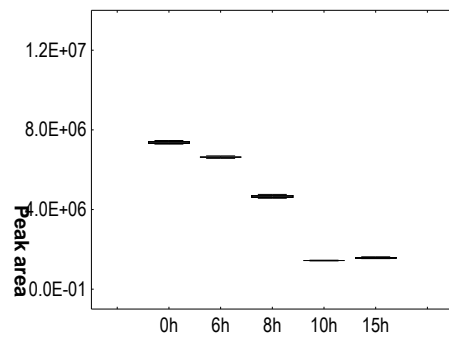
Uracil



Electronic Supplementary Information

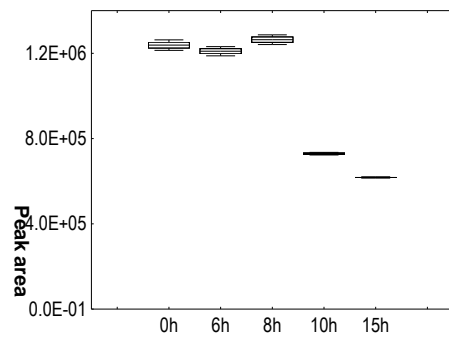
BELH04

Adenine

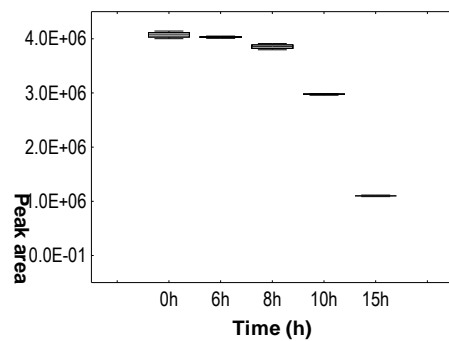


BEPC22

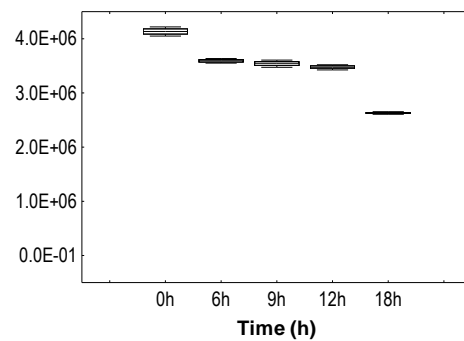
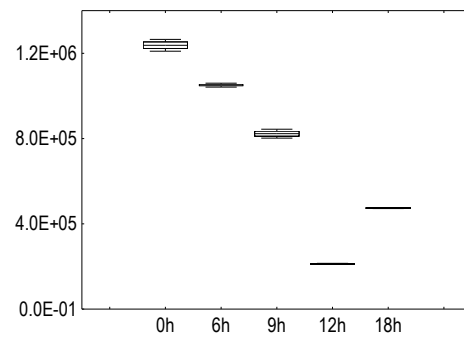
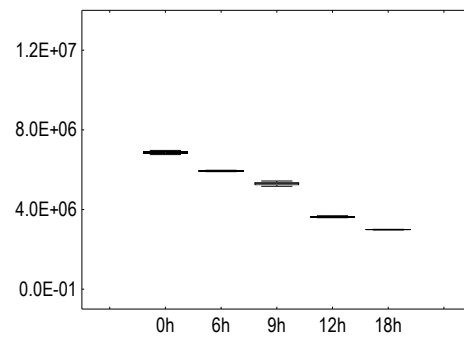
Xanthine



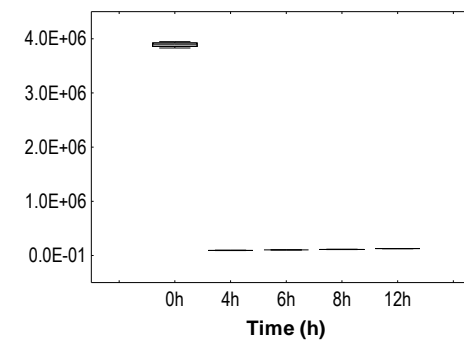
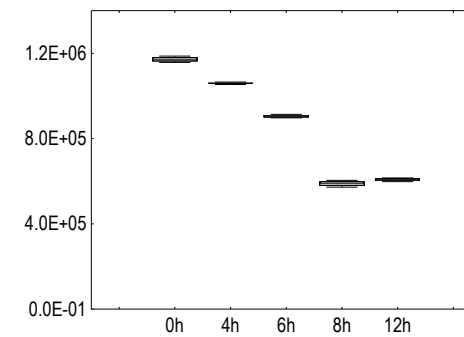
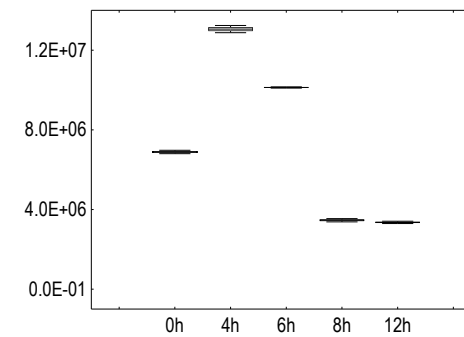
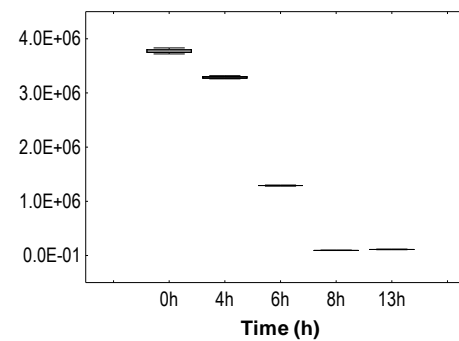
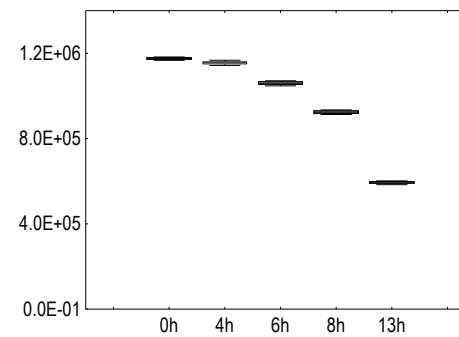
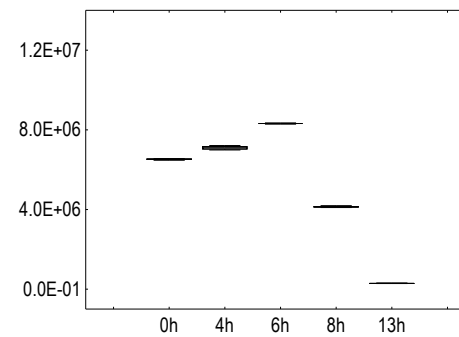
Adenosine



BELP53

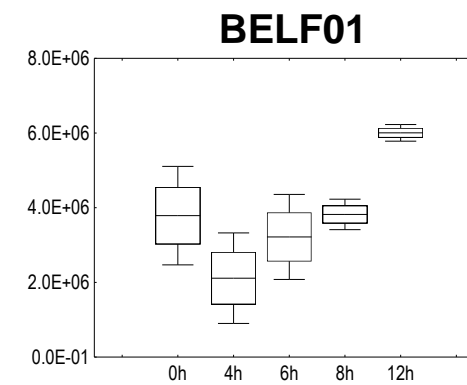
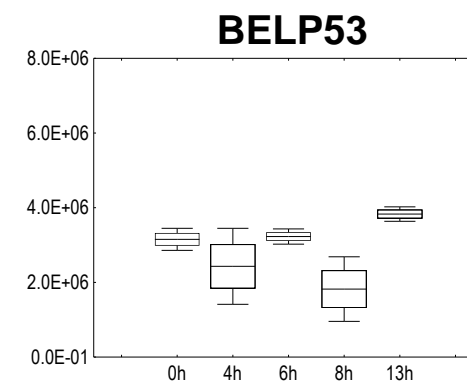
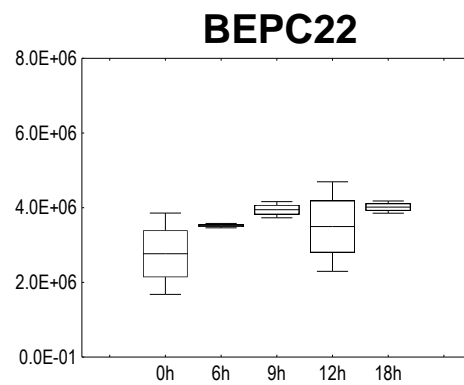
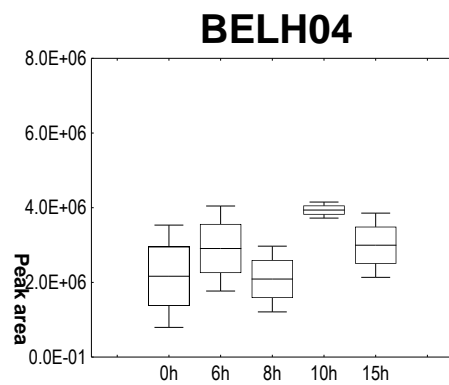


BELF01

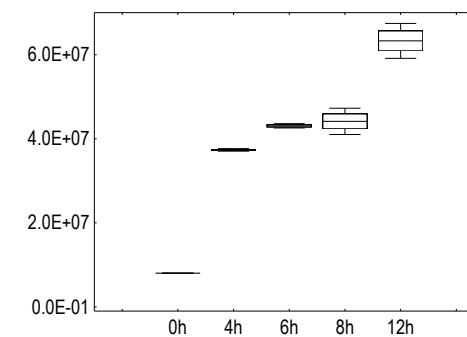
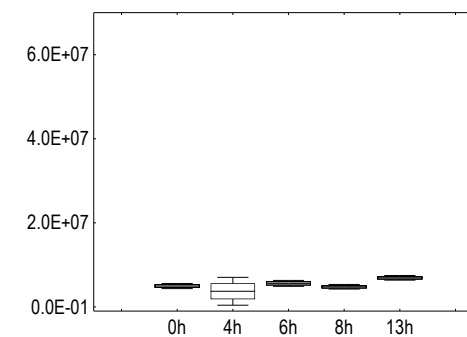
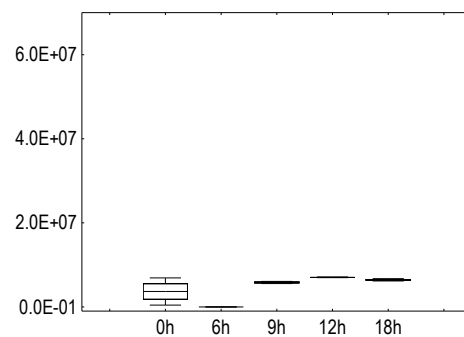
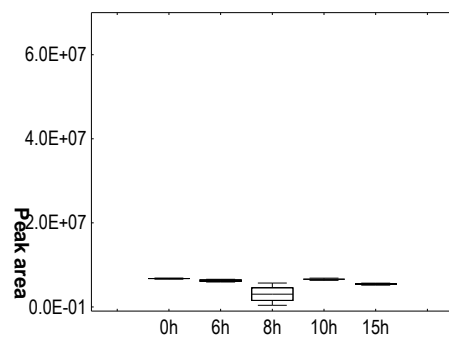


Electronic Supplementary Information

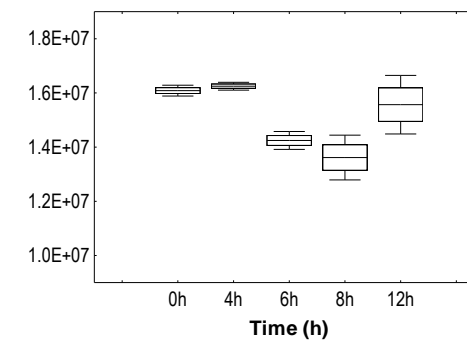
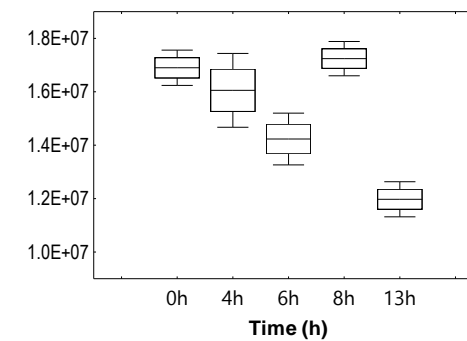
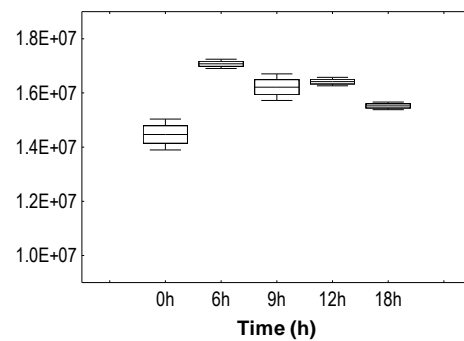
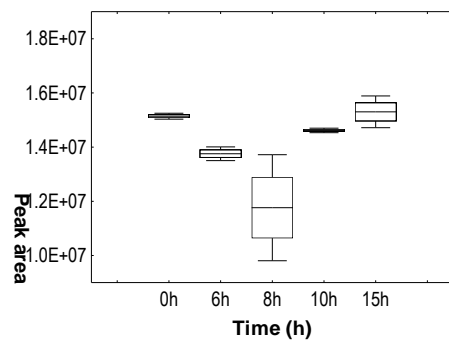
Ethylene glycol



Propylene glycol



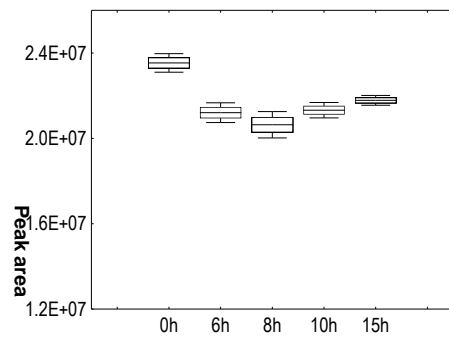
Hydroxylamine



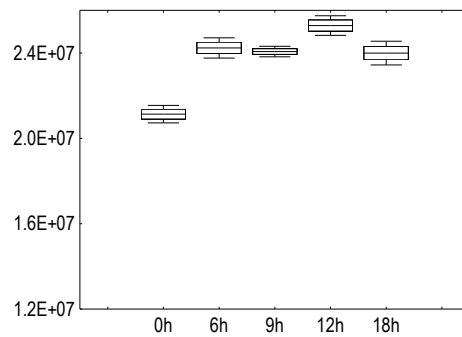
Electronic Supplementary Information

BELH04

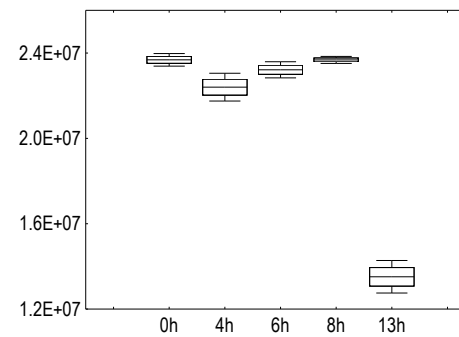
Ethanolamine



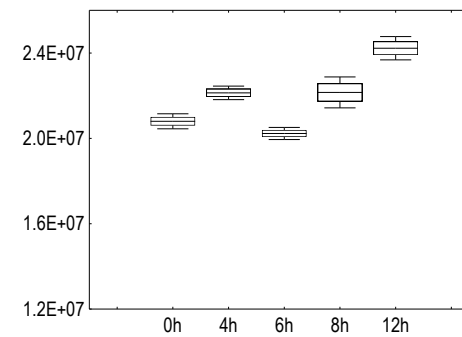
BEPC22



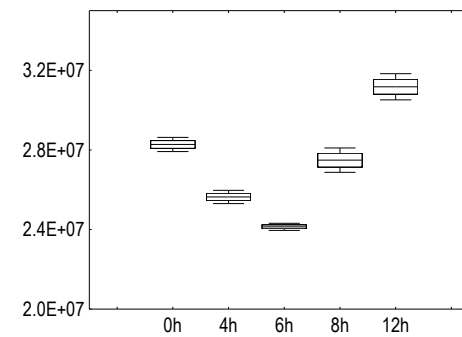
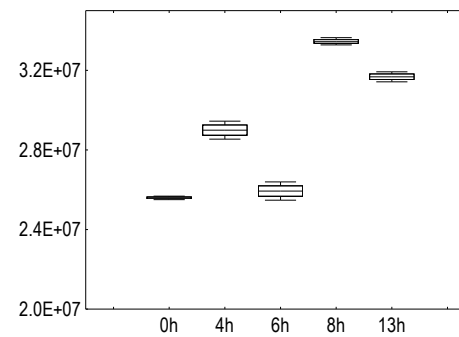
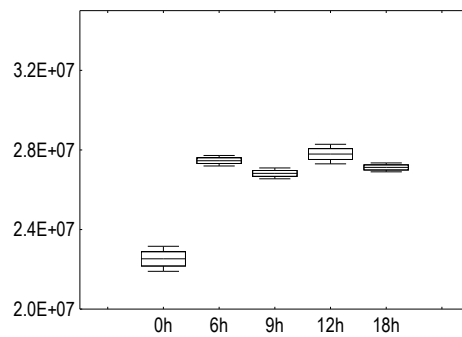
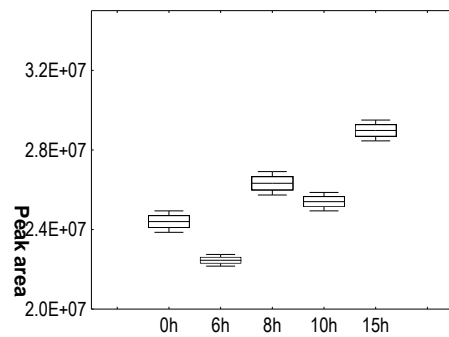
BELP53



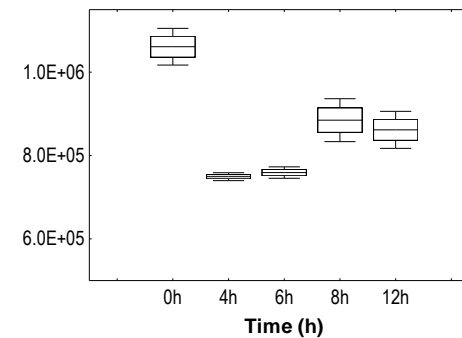
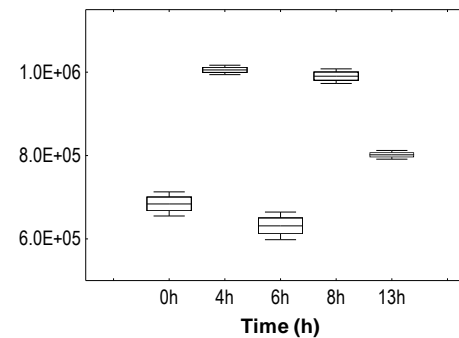
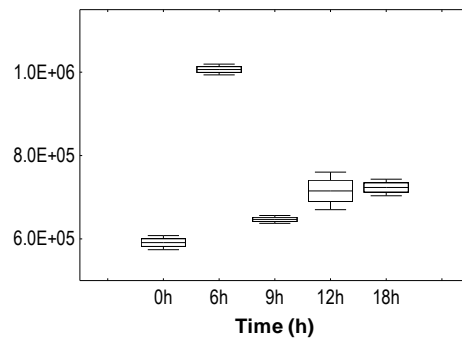
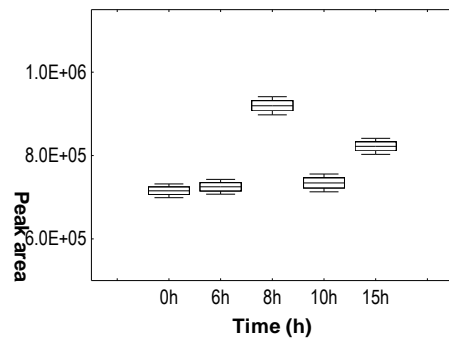
BELF01



Benzoic acid

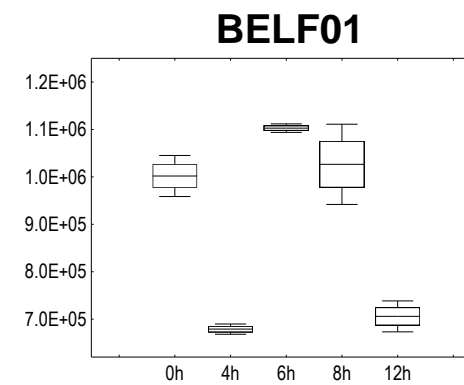
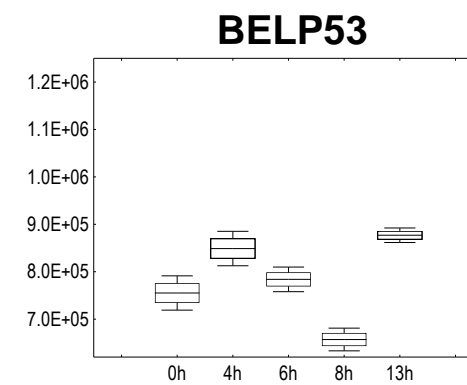
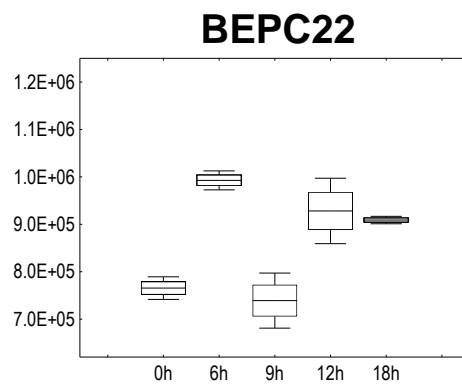
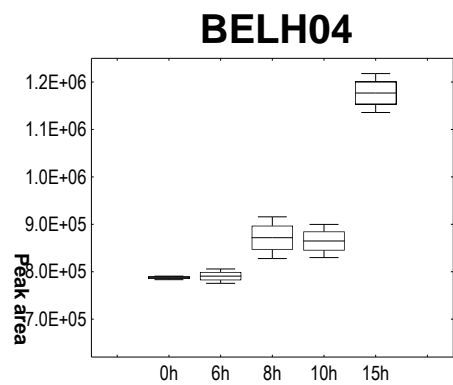


Toluic acid

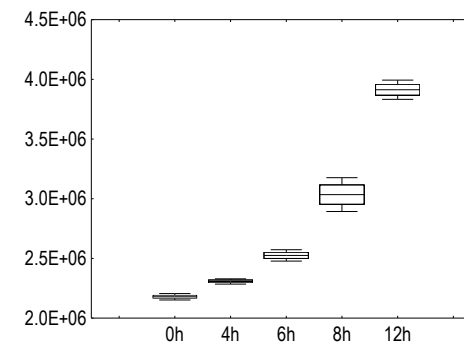
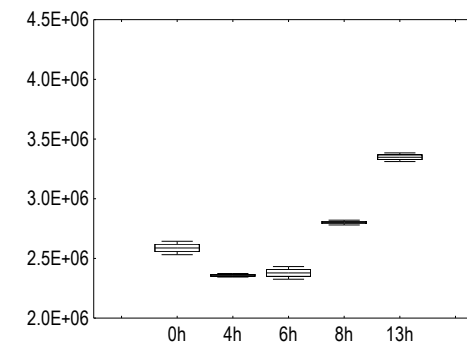
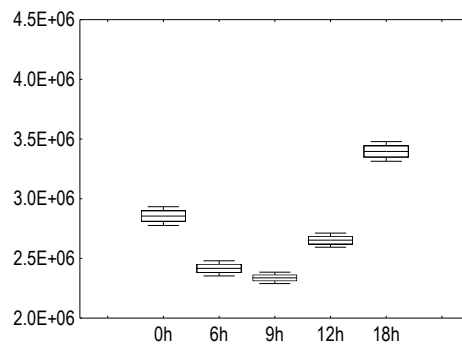
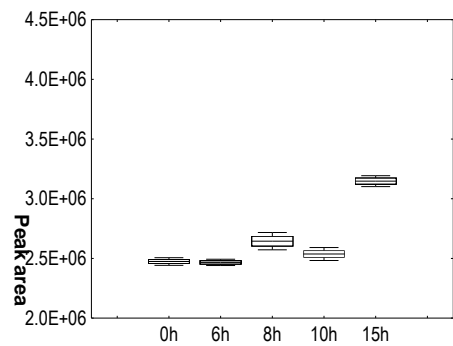


Electronic Supplementary Information

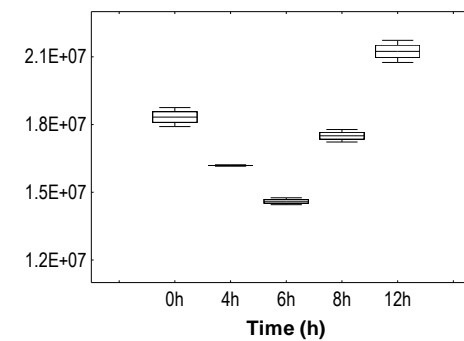
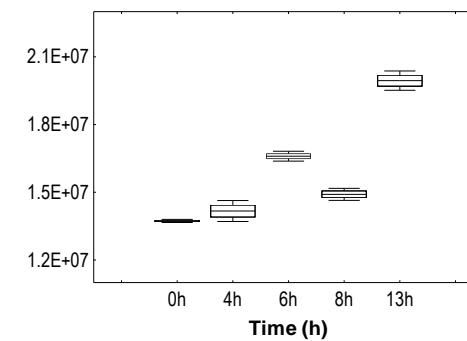
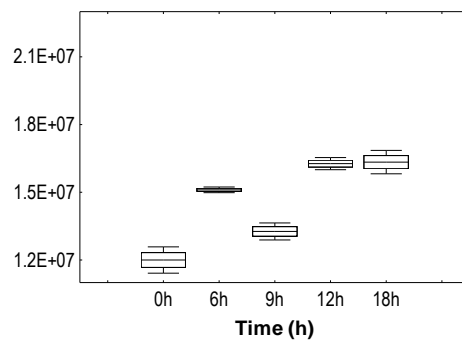
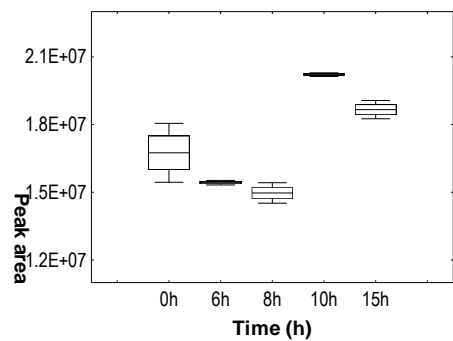
2-Naphthol



Phosphoric acid

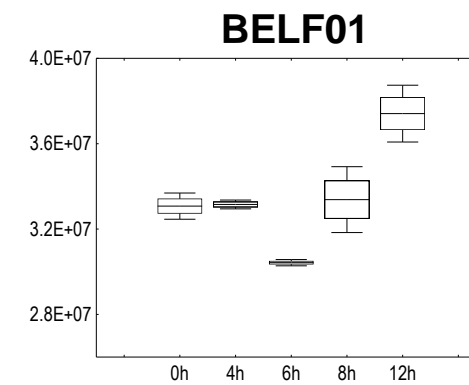
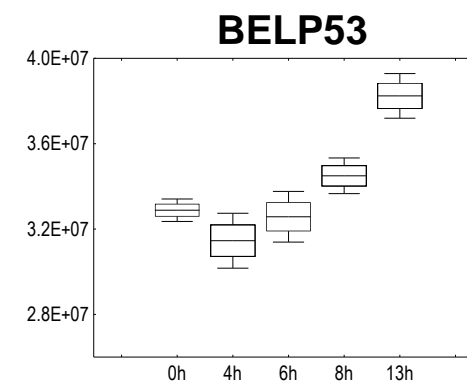
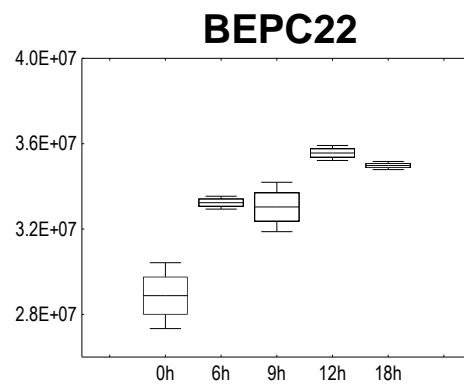
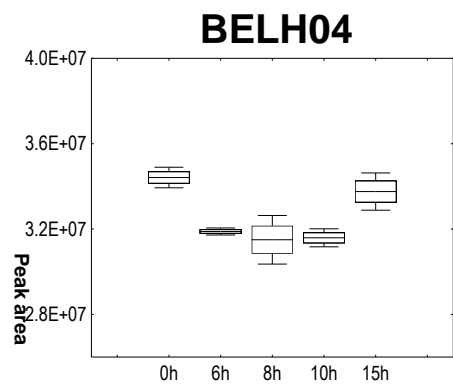


N.I.1

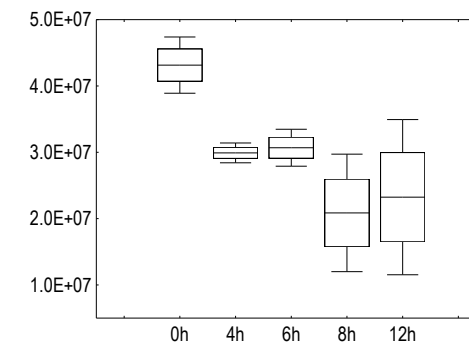
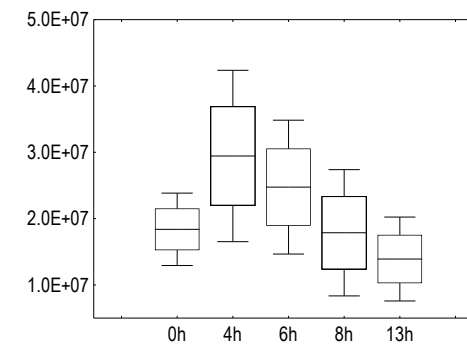
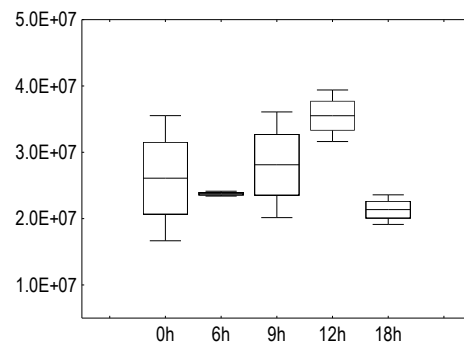
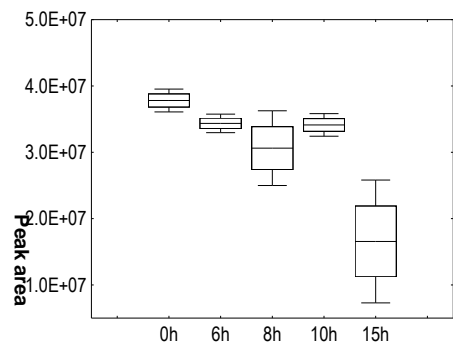


Electronic Supplementary Information

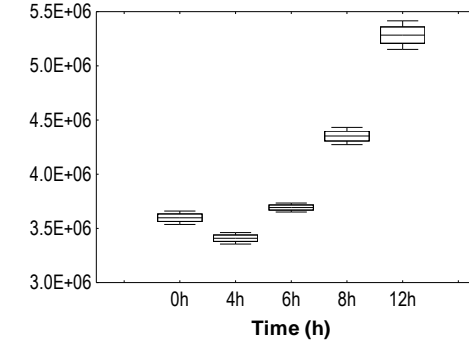
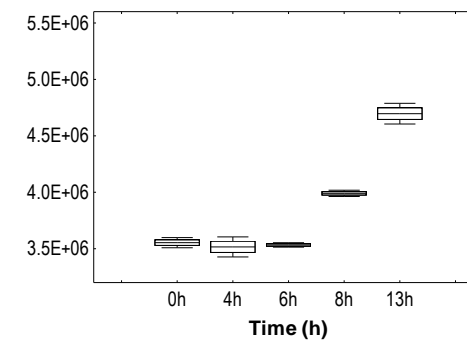
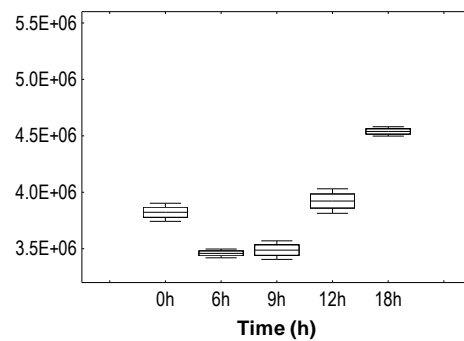
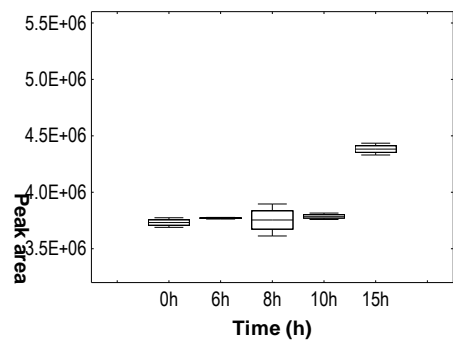
N.I.2



N.I.3

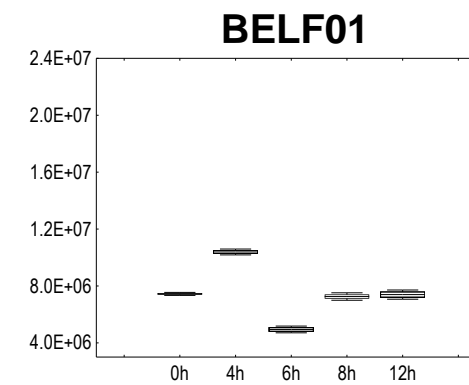
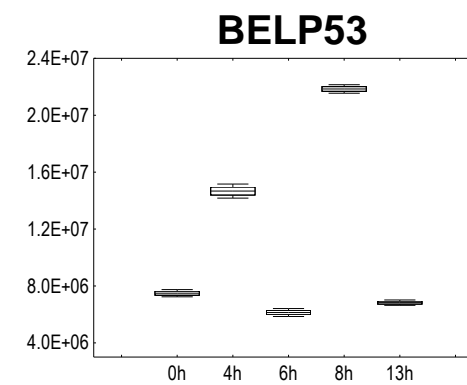
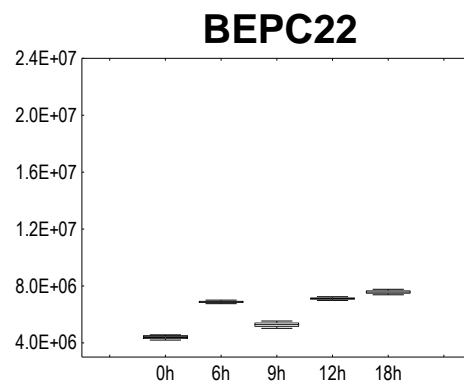
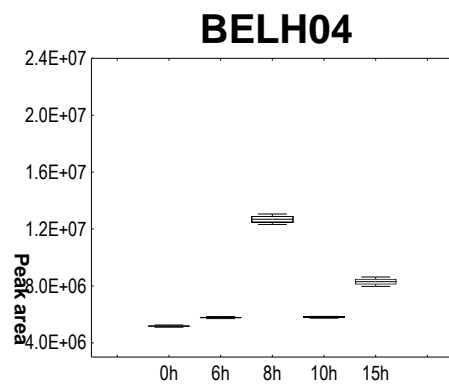


N.I.4

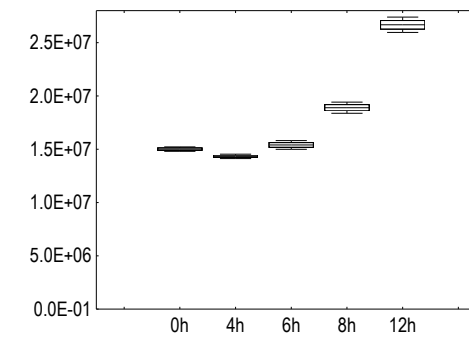
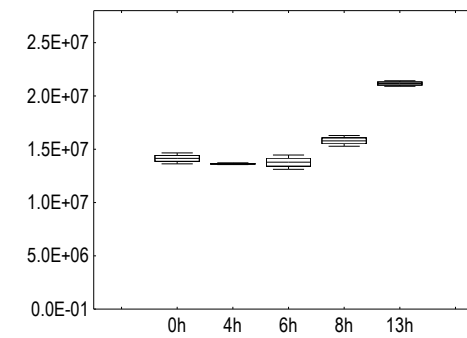
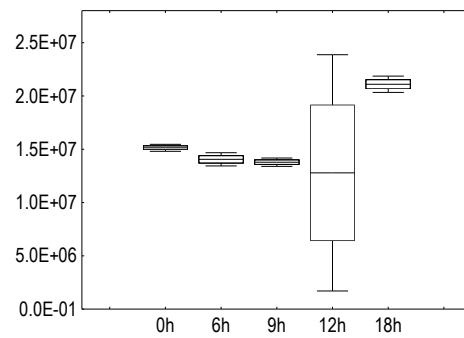
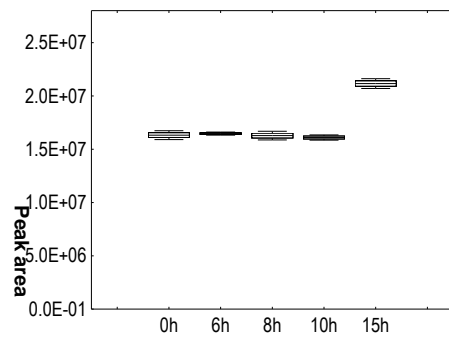


Electronic Supplementary Information

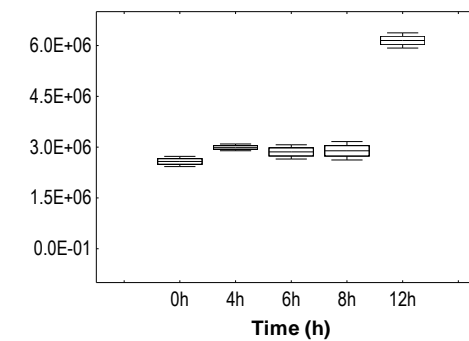
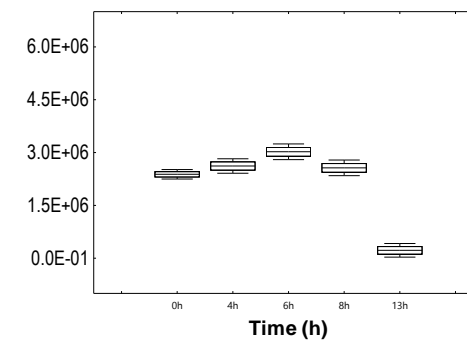
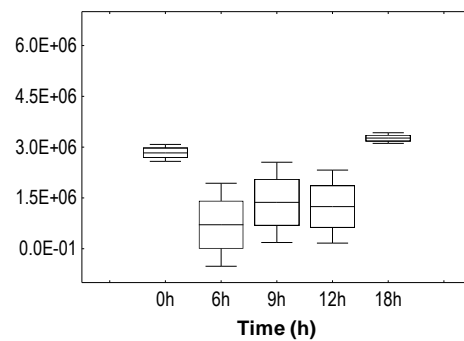
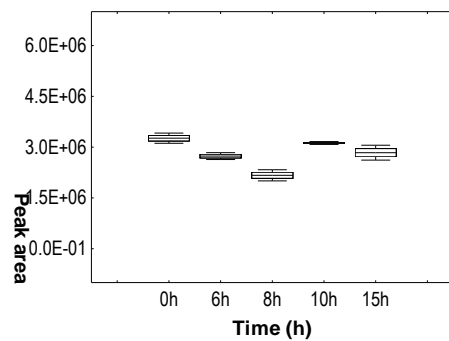
N.I.5



N.I.6

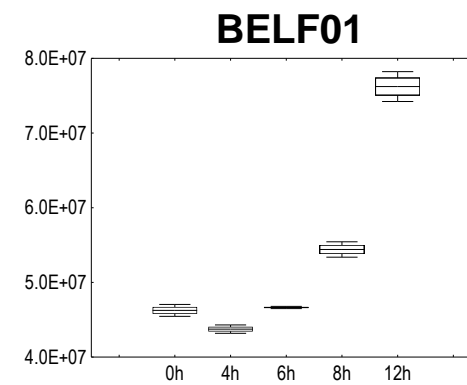
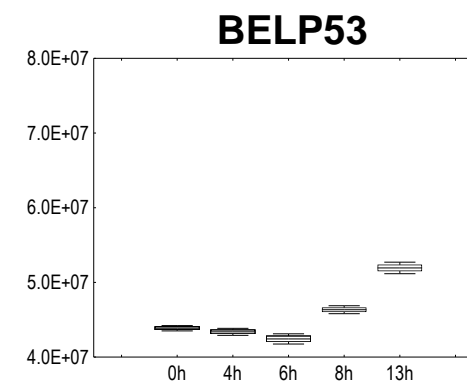
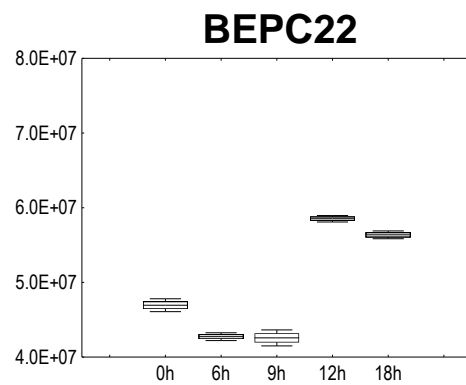
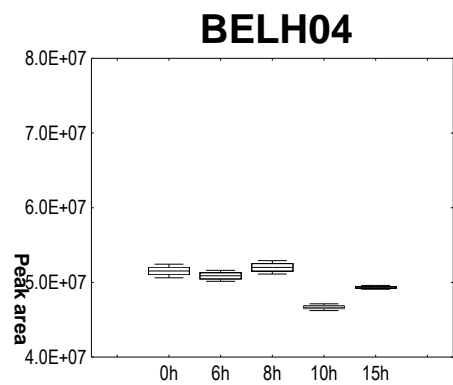


N.I.7

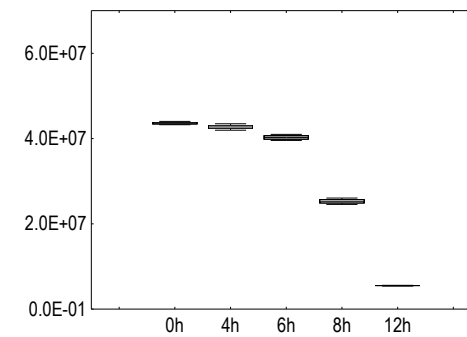
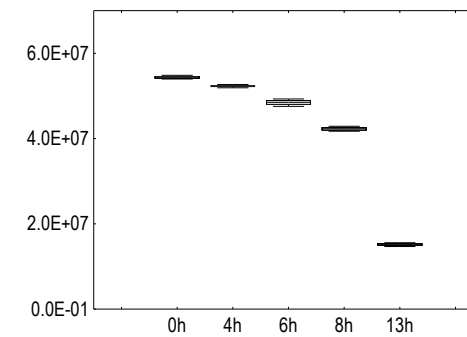
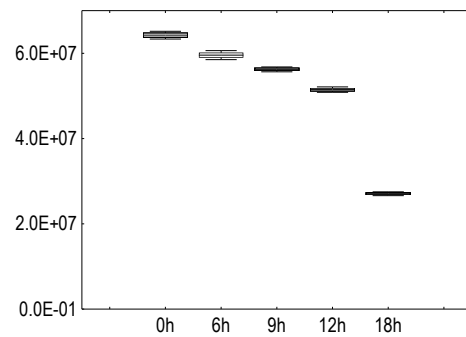
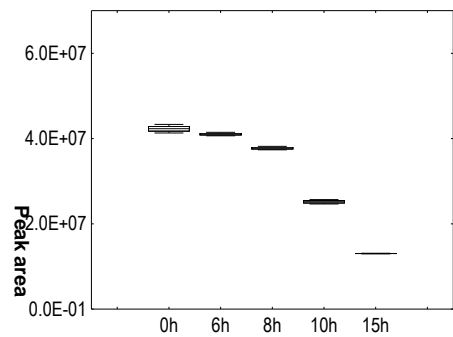


Electronic Supplementary Information

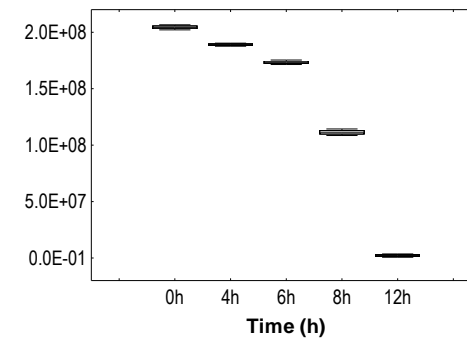
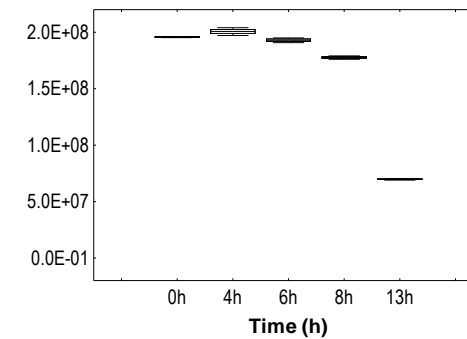
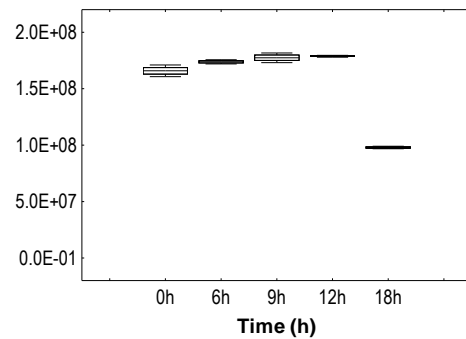
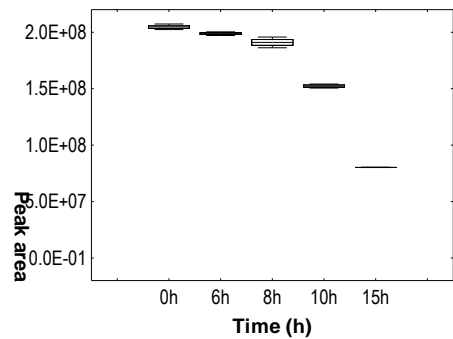
N.I.8



N.I.9

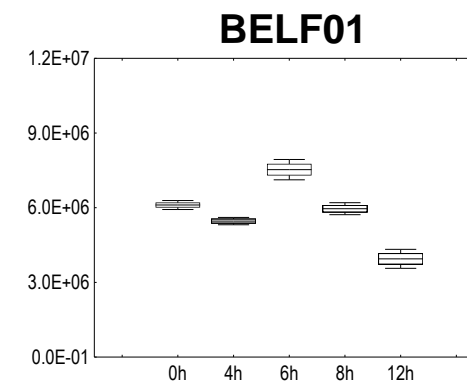
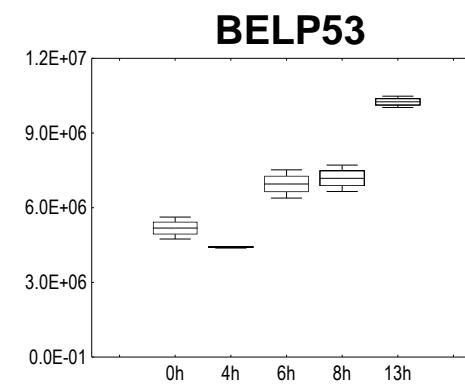
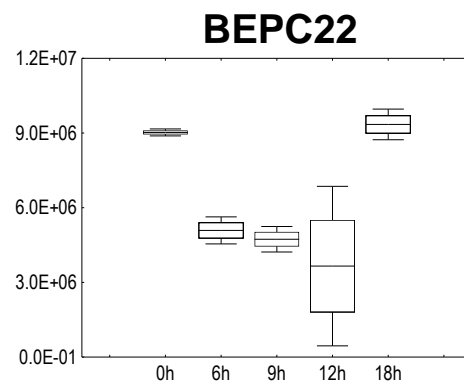
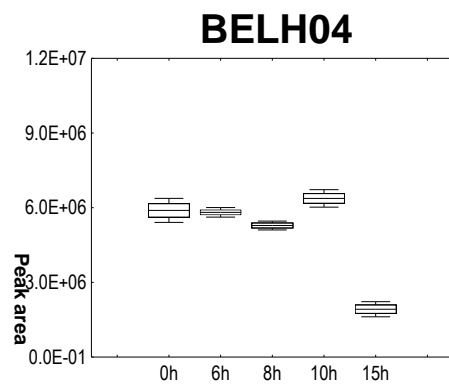


N.I.10



Electronic Supplementary Information

N.I.11



N.I.12

