Single Cell Oil Production

Review of genetic manipulations

for production of target lipid molecules in microorganisms.

Cx Bio

Abbreviations

ACP	Acyl Carrier Protein
CapEx	Capital expenditure
ER	Endoplasmic reticulum
FA	Fatty acid
FAS	Fatty acid synthesis
FBS	Foetal Bovine Serum
FFA	Free fatty acids
G3P	Glycerol-3-phosphate
GPAT	Glycerol-3-phosphate acyltransferase
OpEx	Operational expenditure
PA	Phosphatidic acid
PLs	Phospholipids
PUFAs	Polyunsaturated fatty acid(s)
SFE	Supercritical fluid extraction
TAG	Triacylglycerols
TE (Tes)	Thioesterase
VFA	Volatile fatty acids

Table of Contents

Introduction

Lipids are a critical component of global food supply, as they impart organoleptic properties to foods and make up a crucial ingredient in human nutrition. However, this key societal commodity has uneven global distribution, and studies estimate that there is an annual 45 million ton gap in supply compared to global need for the world population to meet its nutritional requirement (Bajželj et al., 2021). Currently 50% of fats are coming from animal sources, while plant-based oils are derived mainly from tropical plants like oil palm and coconut, or crops such as soy, rapeseed, and sunflower (Bajželj et al., 2021).

Palm oil is by far the most widely used oil, and its negative impacts on the environment are well-known (Parsons et al., 2020). Although alternative vegetable oil crops exist beyond palm oil, their cultivation tends to shift environmental burdens from one region of the world to another. This effect is amplified because palm oil has four times higher oil yield per land area compared to the next best crops, sunflower and rapeseed (Parsons et al., 2020). Therefore, meeting global nutritional lipid requirements demands novel solutions that go beyond plants and animals (Parsons et al., 2020).

One of the novel strategies for lipid production is the cultivation of lipid-rich microbes. Since microbes grow in closed systems, have high yields, and can be cultivated with renewable feedstocks, they offer several advantages over conventional crop and animal sources. Furthermore, they lend themselves well towards genetic improvements, which has been the subject of substantial scientific exploration in the last decades.

Microbial lipid production systems could be geographically flexible and help sustainably close the lipid supply gap. This research focuses on metabolic engineering literature and fermentation design for several species that are well-suited to fatty acids (FA) production from side streams in a sustainable and closed-carbon loop manner. This report is best suited for readers with a background in metabolism.