**Supplement information**

**RQ-guided calculation model**

Metabolic flux analysis shows that during the sophorolipid synthesis stage, the carbon source is primarily directed towards sophorolipid biosynthesis, along with a small amount of byproducts and carbon dioxide. Glucose and oleic acid serve as substrates for oxidative metabolism, which provides the energy needed for sophorolipid biosynthesis. The processes could be established in reactions (1-3):

(1)

(2)

2CH3CO-S-COA + + 2HS-COA (3)

According to the above three reactions, oxygen utilization can be mainly divided into three parts: glucose oxidation, fatty acid oxidation, and sophorolipid synthesis. The oxygen uptake rate (OUR) during the fermentation process can be expressed as equation (4):

(4)

where OUR1, OUR2, and OUR3 (mmol/L/h) represent the oxygen consumption rates in the pathway of glucose oxidation, fatty acid oxidation, and SLs biosynthesis, respectively. Since the SLs biosynthesis process does not produce carbon dioxide, it mainly comes from the oxidation of glucose and fatty acids. Therefore, the carbon dioxide production rate (CER) can be expressed as formula (5):

(5)

where CER1 and CER2 (mmol/L/h) represent the rates of carbon dioxide production from glucose oxidation and fatty acid oxidation. In the process of glucose oxidation, the rate of oxygen consumption (OUR1) is equivalent to the rate of carbon dioxide production (CER1). On the other hand, during oleic acid oxidation, approximately 0.71 mol of carbon dioxide is generated per 1 mol of oxygen consumed. The rate of sorbitol lipid synthesis is equivalent to its rate of oxygen consumption (OUR3). The formula for calculating the respiratory quotient (RQ) during fermentation is given by equation (6):

(6)

Therefore, the calculation formula can be further expressed in relation to substrate consumption as equation (7):

where, *a* represents the glucose consumption rate (mmol/L/h), *b* represents the fatty acid consumption rate (mmol/L/h), and *c* represents the SLs biosynthesis rate (mmol/L/h).