Supplementary Materials

The details of the required energy and cost calculations are presented below. The values of the coefficients used in the calculations are listed in Table S1.

E_f was calculated as follows, assuming a power of 9.4 kWh for the nonwoven filter separator and a throughput of 100 kg/h.

$$E_f = 9.4/100 = 0.094 \text{ (kWh)}$$

E_{ex} was calculated as follows, under conditions in which 0.500 L of hexane and 0.167 L of ethanol (mixing ratio 3:1) per kg of emulsified solution were used for extraction.

$$\begin{aligned} E_{ex} = \sum \Big[& [(\text{solvent usage}) \times (\text{specific gravity of solvent}) \\ & \times \{(\text{boiling point}) - (\text{room temperature})\} \times (\text{specific heat}) \\ & + (\text{solvent usage}) \times (\text{specific gravity of solvent}) \\ & \times (\text{latent heat of evaporation}) \times 2] \times (\text{calorific-power coefficient}) \\ & + (\text{solvent usage}) \times (\text{power of extractor}) \Big] \end{aligned}$$

$$\begin{aligned} = & \{(0.500 \times 0.654 \times (68.74 - 20) \times 2.304 + 0.5 \times 0.654 \times 366.45 \times 2)\} \times 0.000278 + 0.5 \times 0.001 \\ & + \{0.167 \times 0.789 \times (78.34 - 20) \times 3.38 + 0.167 \times 0.789 \times 948.24 \times 2\} \times 0.000278 + 0.167 \times 0.001 \\ & \fallingdotseq 0.154 \text{ (kWh)} \end{aligned}$$

E_{ex}' was calculated as follows, under conditions where 0.667 L of hexane per kg of culture solution were used for extraction.

$$\begin{aligned} E_{ex}' = & [(\text{solvent usage}) \times (\text{specific gravity of solvent}) \\ & \times \{(\text{boiling point}) - (\text{room temperature})\} \times (\text{specific heat}) \\ & + (\text{solvent usage}) \times (\text{specific gravity of solvent}) \\ & \times (\text{latent heat of evaporation}) \times 2] \times (\text{calorific-power coefficient}) \\ & + (\text{solvent usage}) \times (\text{power of extractor}) \end{aligned}$$

$$\begin{aligned} = & \{0.667 \times 0.654 \times (68.74 - 20) \times 2.304 + 0.667 \times 0.654 \times 366.45 \times 2\} \times 0.000278 + 0.667 \times 0.001 \\ & \fallingdotseq 0.103 \text{ (kWh)} \end{aligned}$$

$E_{pf} + E_d$ was calculated as follows, using a freezing machine power of 1.5 kWh, a pre-freezing time of 0.01 hr/kg, a vacuum dryer power of 12 kWh, and a vacuum dryer throughput of 15 kg/hr.

$$\begin{aligned} E_{\mathrm{pf}} + E_{\mathrm{d}} = & (\text{freezing machine power}) \times (\text{pre-freezing time}) \\ & + (\text{vacuum dryer power})/(\text{vacuum dryer throughput}) \\ & = 1.5 * 0.01 + 12/15 = 0.82 \text{ (kWh)} \end{aligned}$$

C_m was calculated using a nonwoven cost per area of 370 yen/m² and a throughput of 500 kg/m², as follows:

$$C_m = 370/500 = 0.74 \text{ (yen)}$$

C_o and C_o' were calculated as follows, under the condition where the conventional method requires 0.667 L of hexane per 1 kg of culture, and the new method requires 0.5 L of hexane and 0.167 L of ethanol per 1 kg of culture, and the solvent recovery ratio is 98%.

$$C_o = \sum \left(\text{solvent usage}\right) \times \text{(solvent cost)} \times \left\{100 - \left(\text{solvent recovery rate}\right)\right\}/100$$
$$= 0.5 \times 33.1 \times (100 - 98)/100 + 0.167 \times 84 \times (100 - 98)/100 = 0.61 \left(\text{yen}\right)$$

$$C_o' = \left(\text{solvent usage}\right) \times \text{(solvent cost)} \times \left\{100 - \left(\text{solvent recovery rate}\right)\right\}/100$$
$$= 0.667 \times 33.1 \times (100 - 98)/100 = 0.44 \left(\text{yen}\right)$$

C_{ex} and C_{ex}' was calculated using the following equations:

$$C_{ex} = E_{ex} \times \alpha = 0.154 \times 18 \fallingdotseq 2.8 \text{ (yen)}$$

$$C_{ex}' = E_{ex}' \times \alpha = 0.103 \times 18 \fallingdotseq 1.9 \text{ (yen)}$$

Thus, the required processing energy (*RPE*, *RPE'*) and cost (*RPC*, *RPC'*) were calculated as follows:

$$RPE = E_f + E_{ex} = 0.094 + 0.154 \fallingdotseq 0.24 \text{ (kWh)}$$
$$RPE' = E_{pf} + E_d + E_{ex}' = 0.82 + 0.103 = 0.92 \text{ (kWh)}$$
$$RPC = C_m + E_f \cdot \alpha + C_o + C_{ex} = 0.74 + 0.094 \times 18 + 0.61 + 2.8 \fallingdotseq 5.8 \text{ (yen)}$$
$$RPC' = \left(E_{pf} + E_d\right) \cdot \alpha + C_o' + C_{ex}' = 0.82 \times 18 + 0.44 + 1.9 \fallingdotseq 17 \text{ (yen)}$$

Table S1. The coefficients and input values.

Coefficient used for calculation	Value	Unit
power-calorific coefficient	0.000278	kJ/kWh
electric cost-power coefficient (α)	18	yen/kWh
solvent recovery rate	98	- (%)
power of extractor	0.001	kWh/L
room temperature	20	°C
hexane boiling point	68.74	°C
hexane evaporation latent heat	366.45	J/g
hexane specific gravity	0.654	-
hexane specific heat	2.304	J/g°C
hexane cost	50.6	yen/L
ethanol boiling point	78.34	°C
ethanol evaporation latent heat	948.24	J/g
ethanol specific gravity	0.789	-
ethanol specific heat	3.38	J/g°C
ethanol cost	84	yen/L