Evaluation of the economic viability of ethanol production from palm sap with low sugar concentration

Some palm saps extracted from old oil palm trunks have low sugar content due to differences in species or in plant physiology. Here, we condensed palm sap with low sugar content by flat membrane filtration, then fermented the condensed palm sap at a high temperature using the thermotolerant yeast, *Kluyveromyces marxianus*. The input energy required to concentrate the palm sap and the output energy that could be generated from the ethanol were calculated. The condensation of sugar in sap from palm trunk required for an economically viable ethanol production was evaluated.

Experiment results showed that when palm sap squeezed from oil palm trunk (MC 80%, 30kg) had 3.1% sugar content, the energy required to condense up to 9.6% by flat membrane filtration was 10.9MJ (Fig.1). The energy required for squeezing and fermentation was 5.8MJ and 0.85MJ, respectively. Total input energy for ethanol production was 17.6MJ when the energy for condensation (10.9MJ) was added (Fig 1).

When ethanol production was conducted using thermotolerant yeast, ethanol (0.0454kg/L and 0.32L) was produced from 9.6% sugar content in palm sap. The output energy from produced ethanol was 6.7MJ (Fig.2). Consequently, the energy balance between input and output was calculated and plotted. When sugar concentration in palm sap reached 6.1% or more, output energy became higher than input energy in palm sap (i.e., output energy turned to positive based on the plot between input and output energy) (Fig.3). The energy required for sugar condensation from 3.1% to 9.6% was in proportion to sugar concentration in palm sap.

A simple method to distinguish high-sugar trunk from low-sugar trunk is reported in another research highlight report. This result only provides information to get appropriate sugar content in palm sap before ethanol production. Even if sugar in palm sap is less than 6.1%, it is still possible to use heat energy from the residue after squeezing the sap. The output energy, however, is reduced when fermentation efficiency is less than 90%.

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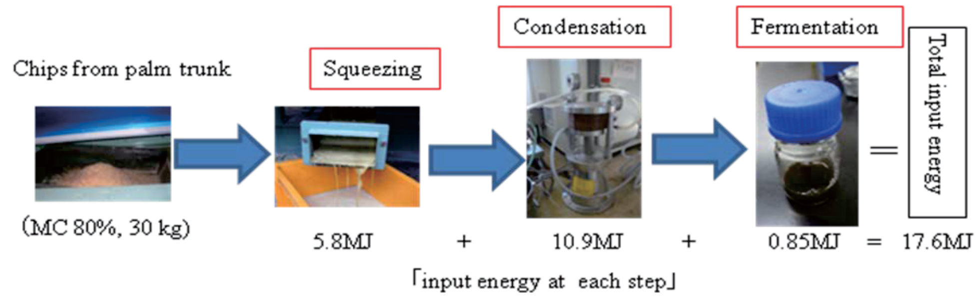

Fig. 1. Total energy required for squeezing, condensation, and fermentation from chips of oil palm trunk (17.7MJ)

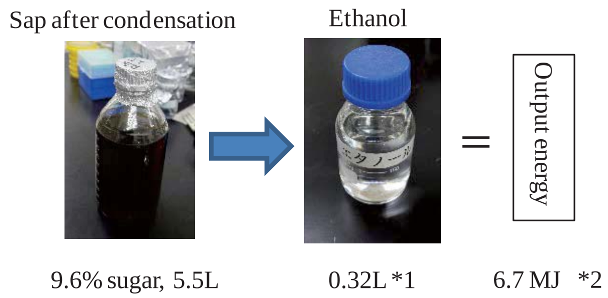

Fig. 2. Calories in ethanol from fermentation of palm sap (Output energy)
*1. Ethanol (L) produced from palm sap 5.5L was calculated from following equation: (0.0454kg/L x 5.5L)/0.789kg/L *2 calories of ethanol = 21.2MJ x 0.32L

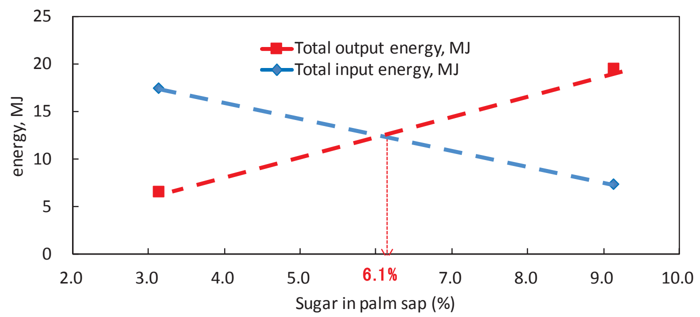

Fig. 3. The energy balance turns positive when the sugar in palm sap is more than 6.1%.

[Others]
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Term: 2013 (2011-2015)
Researchers: Yoshinori Murata, Takamitsu Arai, Akihiko Kosugi
References: 1) Y. Murata, et al. (2015) AIMS Journal 3(2):201-213