Production and Sales of the Ethanol for the Vehicle Fuel Using the Biomass in Mie Prefecture

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Abstract— **The abandoned cultivated land is in the agricultural land district in Mie Prefecture and there is 1,085ha (As of 08 years) now. This is an area of 26th place in the whole country. Moreover, there is an economic discrepancy in Mie Prefecture in the northern part, central part, and the southern part. The northern part develops the commerce and industry and is lively. On the other hand, the southern part is a center the primary industry, and has declined economically. Then, whether it sold it making the product that made local crops a raw material to attempt regional revitalization was examined. Whether manufacturing the ethanol was possible from the sweet sorghum that was able to be grown in Mie Prefecture was verified. Moreover, whether the business that sold the ethanol as an automotive fuel was possible was verified.**

Keywords— **Sweet sorghum, alcoholic fermentation, MF21 yeast**

I. Introduction

In this study, we considered whether the local activation model of Mie Prefecture (shown in Figure 1) where agriculture had cooperated with industry and the regional society can be realized. In this model, the farmers in Mie Prefecture grow a sweet sorghum as a raw material to produce the ethanol for the vehicle fuel. The local populace buys it as an automotive fuel. The farmers could earn the money from sale of sweet sorghum, a local enterprise also could earn the money from sale of bio-ethanol, and as a result, it is useful for the environmental preservation of the regional society.

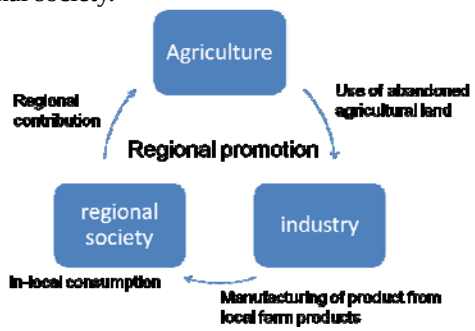

Fig.1 The local revitalization model of Mie Prefecture

The main question of our study is to verify whether the achievement by the cycle that becomes this regional contribution and promotion is possible. In our plan, it can be understood that the possibility of achievement of the society rises if MIE TOYOTA buys the ethanol. Moreover, the problems that should be solved to achieve by the model cycle were identified from the consideration in this study.

II. Materials and Methods

A. *Cultivation experiment of sweet sorghum in Mie Prefecture*

The cultivation experiment of a sweet sorghum was done in Mie Prefecture Ise City Obata-cho in 2009. The seeds used in this study were “high sugar sorgo” which was purchased from Snow Brand Seed. The area of cultivation was 6m^2. The herbicide and manure were scattered at the same time. Afterwards, anything did not add the hand. A sweet sorghum grew up well. The cultivation was conducted for 72 days. The plant height reached to 220cm (Figure 2). The diameter of plant stalk was 18mm. The total quantity of crop was 1250kg per 10Are (=100m^2), which was converted from the actual results.

Fig.2 Sweet sorghum

B. *Collection experiment of a soup of sweet sorghum*

The leaves of the harvested sweet sorghums were taken from their stalks. The stalks were squeezed (Figure 3), and soup was extracted. It took three hours to gather 500mL by 2 persons (Figure 4).

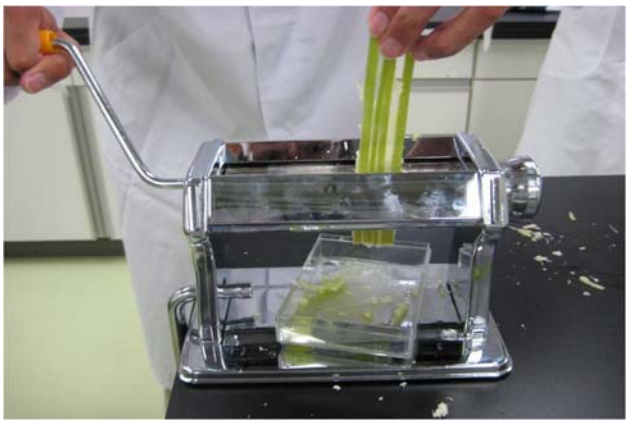

Fig.3 Squeezing of stalks

Fig.4 Collected soup from sweet sorghum

According to the mass balance of between soup and stalk, which was calculated from experimental results, the ratio of soup was 39%. The sugar concentration of the soup was measured by the phenol-sulfuric acid method (Figure 5). According to the results, the sugar concentration was 7.7%.

C. *Alcoholic fermentation experiment from the soup*

The alcoholic fermentation from sweet sorghum extract was done by three patterns. First, Kyokai No.7 yeast was used as a catalyst for fermentation and the soup was not preprocessed. In the second experiment, the soup was adjusted by adding sulfuric acid to pH 2.5, and MF21 yeast, which shows high resistance to acid, was used. In third experiment, MF21 of yeast and the soup of pH 2.5 adjusted by sulfuric acid were also used for the alcoholic fermentation was conducted for 5 days.

Fig.5 The phenol-sulfuric acid method

III. Results and Discussion

A. *Production experiment of ethanol from sweet sorghum*

In the alcoholic fermentation by MF21 yeast and the pH 2.5 adjusted sweet sorghum extract for 5 days, the alcohol density and the ethanol conversion rate reached to 5% and 97.5%, respectively (Figure 6).

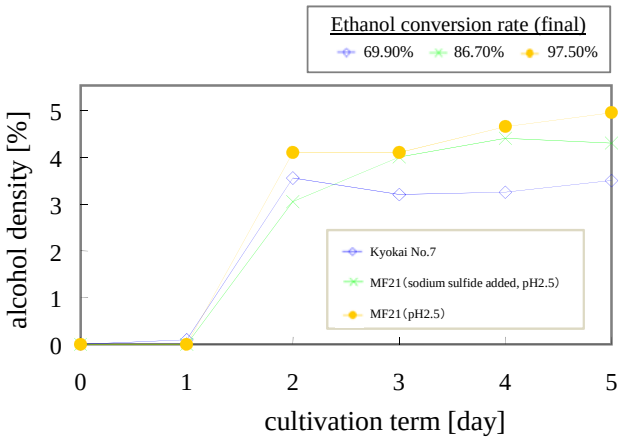

Fig.6 The alcoholic Fermentation

According to the calculation from experimental results, it appeared that the ethanol of 25kg (30.8L) per each 10a could be generated by the fermentation of sweet sorghum. The fermentation time was not shortened by addition of yeast extract and Polypepton to the fermentation soup. As a result of this experiment, it was indicated that the alcoholic fermentation using MF21 yeast does not need heating or pressurizing of soup for sterilization. This property will

decrease the production energy of ethanol fermentation. It is an advantage by usage of MF21 yeast in alcoholic fermentation. Moreover, the medium component of yeast need not be added to the soup of a sweet sorghum. This is also advantage for the improvement of fermentation and lowering the cost.

A sweet sorghum can be grown in Mie Prefecture. The production of ethanols by the alcoholic fermentation is also possible from the soup made by extraction of sweet sorghum. The low-cost alcoholic fermentation could be conducted by use of MF21 which was isolated in Mie University.

B. *Consideration from juridical view point*

It can be sold to mix the ethanol with gasoline up to 3% as an automotive fuel in the law of Japan. The fuel that mixes the ethanol with this gasoline by 3% is called E3. Moreover, a benzine tax and a local benzine tax are reduced to E3 by the benzine tax method.

C. *Consideration from manufacturing side*

MIE TOYOTA has used the gasoline of 349,480L (in 2009) a year for the business vehicle. Therefore, if gasoline would be changed to E3 at MIE TOYOTA, a necessary ethanol becomes 10,484L. According to the calculation from the result of the cultivation experiment and the alcoholic fermentation experiment, a necessary area for the cultivation of sweet sorghum becomes 34ha. Moreover, the trouble is suppressed to the minimum when the car breaks down because the sales are limited in MIE TOYOTA. The running data of the car using E3 can be gathered during the subscription period to MIE TOYOTA.

D. *Consideration from farmer side*

The abandoned cultivated land in Mie Prefecture is 1,085ha (the data in 2008) and these land area can be used as a cropland of a sweet sorghum. The income of the farmer when rice is grown is 30,000 yen per 10a. A sweet sorghum grows up even if nothing is done after the seeding, addition of fertilizer and the scattering of herbicide. On the other hand, it is not necessary to give a lot of care like rice farm. Therefore, if the same income as the case to grow rice is obtained, the profit will be enough for a farmer. Moreover, there is an advantage of not becoming a problem in the Food problem, because a sweet sorghum does not compete to a food crop.

E. *Verification from Mie Toyota*

Because all business vehicles of MIE TOYOTA are the correspondences of E10, E3 can be used at once. The purchasing price of gasoline at August in 2010 is 113.4 yen/L. If the purchase price of E3 is same or low than gasoline, it is unquestionable that MIE TOYOTA will switch gasoline to E3 by the reason of Eco. Moreover, even if these cars break down while doing business, it will be possible to repair in-house. The maximum advantage for MIE TOYOTA is to be able to show the contribution on the carbon dioxide reduction for the global warming issue. It can also appeal that MIE TOYOTA contributes to the region by the viewpoint of local production for local consumption. Other dealers cannot mimic it. If the sticker is pasted on the business vehicle, it becomes good advertisement, it is expected that other enterprises buy E3.

F. *The overall estimation*

The potential ability for purchase of E3 by MIE TOYOTA per year is estimated as 1,188,885 yen by the following equation.

113.4 [yen/L of gasoline] × 10,484 [L of consumed by MIE TOYOTA/year] = 1,188,885 yen/year

The sweet sorghum crop area necessary for manufacturing the ethanol is 34ha, and the income per 10a of the farmer becomes 3,497 yen.

10,484L ÷ 30.8L/10a ＝ 34ha
113.4 yen/L × 30.8L/10a ＝ 3,497 yen/10a

According to statistics of the Mie Prefecture Livestock Research Institute, the average production of a sweet sorghum in Mie prefecture including the second grasses harvested is up to 8,500kg per 10a. Therefore, the production of sweet sorghum may be able to increase up to 6.8 times higher than the result amount in this study. The sugar concentration of the soup extracted from harvested sweet sorghum was 7.7% which is lower than the prefecture average of 12%. Therefore, the sugar concentration of the soup can be raised up till 1.55 times. The productivity of the ethanol per 10a can be also raised up till 10.54 times (6.8x1.55=10.54) from these statistics. In that case, the raw material cost becomes 92.4 yen/L.

30.86L/10a × 10.54 time = 324.6L/10a
30,000yen/10a ÷ 324.6L/10a = 92.4yen/L

Therefore, an amount in which the raw material cost is pulled from the upper bound of the sales price to MIE TOYOTA becomes 21yen/L.

113.4 yen/L － 92.4yen/L = 21yen/L

This amount changes according to the volume of sales of the ethanol. In a word, it is thought that the profit as the business can be taken if the outlay cost and administrative expenses can be covered within the range of this total.

The base for the feasibility at the local revitalization model of Mie Prefecture where agriculture had cooperated with industry and the regional society was able to be confirmed. Moreover, because MIE TOYOTA buys it, the

achievement becomes more possible. Other points that should be confirmed are being examined now.

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