Efficient use of unexploited agricultural and fishery resources in the Tokachi district-Focusing on research, development and commercialization

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Summary

The efficient use of biomass resources in the Tokachi district, Japan, is introduced from two viewpoints in this paper. The first is their use as food materials. New food materials were developed made from biomass resources such as kelt, residue generated from starch manufacturing plants, pumpkin fiber and seed, and residue liquid extracted in the process of making *adzuki bean* paste. The second viewpoint is the use of biomass resources such as irregular wheat and sugar beet as bio-ethanol. We introduce the results of a feasibility study of bio-ethanol conversion systems, technological development of bio-ethanol blended fuels in cold regions, and the cascade system of biomass resources with a focus on projects currently being carried out in the Tokachi district. In addition, we suggest the formation of a regionally-oriented sustainable society.

Keywords: dried salmon, potato peptide, pumpkin fiber and seed, adzuki bean, polyphenol, bio-ethanol

Introduction

Tokachi, a major agricultural and livestock district of Hokkaido, located on the northernmost island of Japan, has high potential as a future base of food production. In addition, a large amount of biomass resources from the agriculture, livestock and fishery industries are generated there compared to other districts in Japan. Currently, most biomass resources are used for making fertilizer and feed. However, due to the recent environmental problems capturing the attention of people, further efficient utilization of biomass resources should be considered for prevention of global warming, formation of a sustainable society, and further improvement in the agricultural, livestock, and fishery industries. In this paper, I would like to introduce some case study approaches of biomass utilization including commercialization taken by Hokkaido Tokachi Regional Food Processing Technology Center and suggest means of forming a regional sustainable society based on the bioethanol business.

Effective use of kelt

Salmon are one of the major fishery products in the Tokachi district. Generally, after swimming up river, the roe of female salmon are removed for incubation; but the fish bodies are not used because of the poor fat content and lack of flavor. In our project, we developed a new processed food made from such remains, called dried salmon. It is produced with the same process as that of making dried bonito, which is a major processed food in Japan. As figure 1 shows, an enzyme is injected into female salmon after removing their roe. Then, they are steamed, roasted and dried. As these processes are repeated 4~6 times, the number

of free amino acids increases. The finished dried salmon product is used for various processed foods to bring out the full flavor.

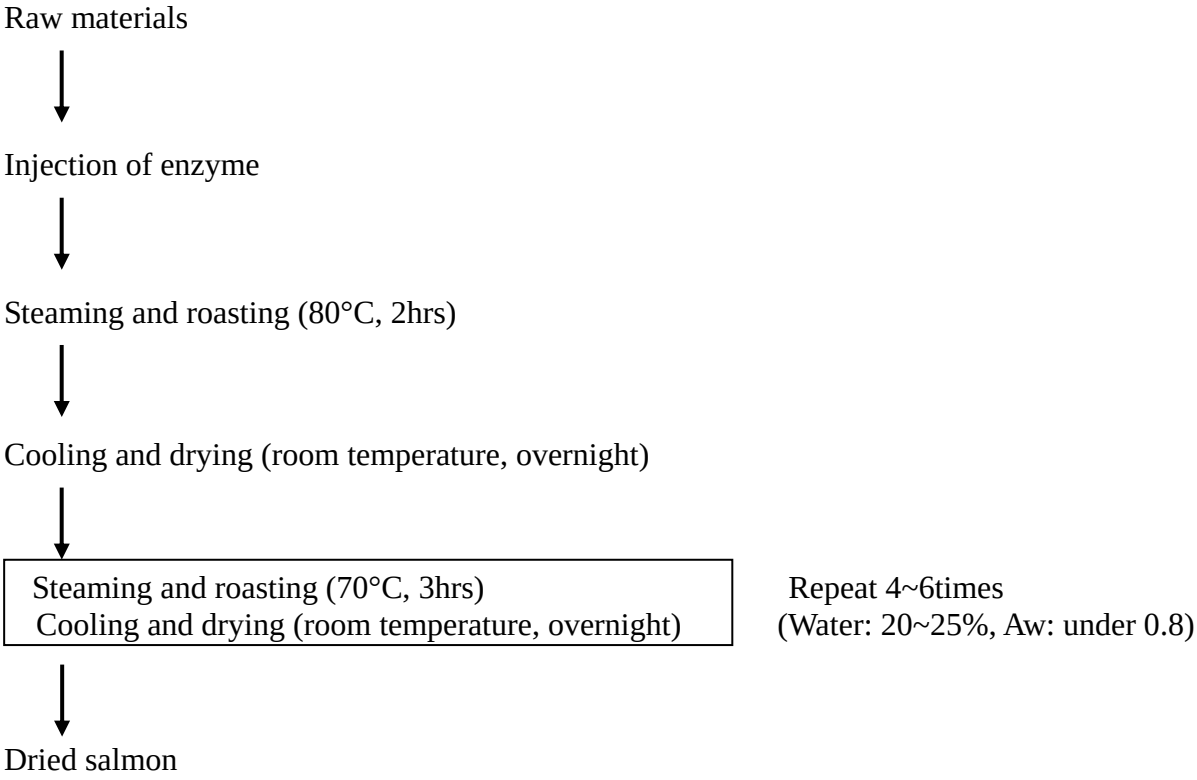

Figure 1. Process of making a dried salmon product

Efficient use of residues generated in starch manufacturing plants

The Tokachi district produces about 40 percent of the potato harvest in Hokkaido. Table 1 shows potato yield in Tokachi categorized by use. Use as a starch raw material accounts for 30 percent of the total yield. The more starch produced, the more residues and wastewater discharged by starch manufacturing plants. Such residue and wastewater were returned to the land untreated; however, since various pollution problems have occurred, most discharge is currently treated in wastewater treatment plants.

Table 1. Potato Yield by Use in the Tokachi District(in tons)

	Fresh market	Food processing	Starch raw material	Seeding
2000	258,000	325,900	247,880	89,720
2001	319,110	328,780	222,410	106,370
2002	313,720	364,320	222,640	111,320

Source: “Agriculture in Tokachi” (2001, 2002 & 2003)

Residue and wastewater generated by starch manufacturing plants contain various nutritious ingredients. Protein is contained in both the residue and wastewater, and it can be extracted as figure 2 indicates. In addition, from the extracted protein, we obtained potato peptide, whose molecular weight is between 500 to 3000, through acid precipitation and enzyme treatment. We developed a water-soluble food material flavoring which has sweetness and full flavor but does not have a bitter taste (figure 3).

Discharged materials
↓ (potato pulp and waste water)
Heating
↓ Added Sulfurous acid
Precipitation residues
↓
Enzyme treatment
↓
Filtration
↓
Dialysis
↓
Potato peptides

Figure 2. Adjustment of potato peptide *Figure 3. Potato peptide*

Efficient use of pumpkin fiber and seed

Tokachi is one of the major districts of pumpkin production in Hokkaido, and more than 1000 tons of pumpkin fiber and seed are generated from frozen-food processing plants. Currently, they are mainly used for making fertilizer; however, pumpkin seed is difficult to treat and causes problems. In our project, we used such pumpkin fiber and seed effectively. As figure 4 indicates, the fiber and seed are dried, roasted and squeezed for extracting fat. The extracted fat has a good taste and flavor and its properties are similar to that of olive oil; therefore, it is suitable for salad dressing. The residue after extracting the fat is also suitable for making fertilizer, feed and fungal culture medium.

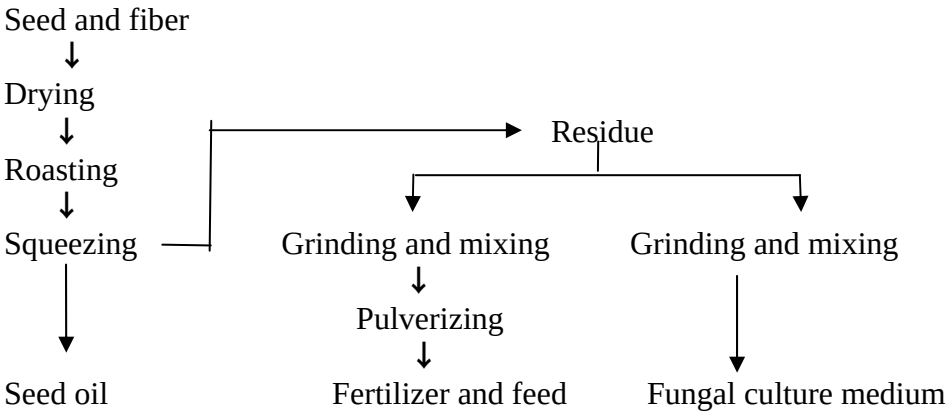

Figure 4. System of making resources from pumpkin seed and fiber

Efficient use of wastewater generated in the adzuki bean paste manufacturing process

Small red beans, called *adzuki beans* are one of the major crops in the Tokachi district. Its constituents are different from those of the soybean as it is mainly composed of starch. To make *adzuki bean* paste, called *An*, Japanese distinctive methods are used. *Adzuki beans* are boiled and mashed, and some sugar is added to the mixture; then it is mashed several times repeatedly. Since ancient times, this paste has been used for various processed foods such as Japanese confectionary.

In our project, we focused on the remaining liquid in the boiling process for making

adzuki bean paste. Until recently, it was treated as wastewater, but since a large amount of polyphenol and the pigment of Adzuki beans are transferred into the residue liquid, we have decided to collect them and use as processed food material.

In the process of figure 5, we obtained purified *adzuki bean* polyphenol fractions from *adzuki bean* broth by the processes of centrifuging and straining the supernatant liquid through an ion-exchange column. After drying the *adzuki bean* polyphenol fractions, we obtained pigments which contain 10 percent polyphenol. In addition, the pigment shows radical and super oxide elimination activity. The effects of activation are two times greater than that of Vitamin C.

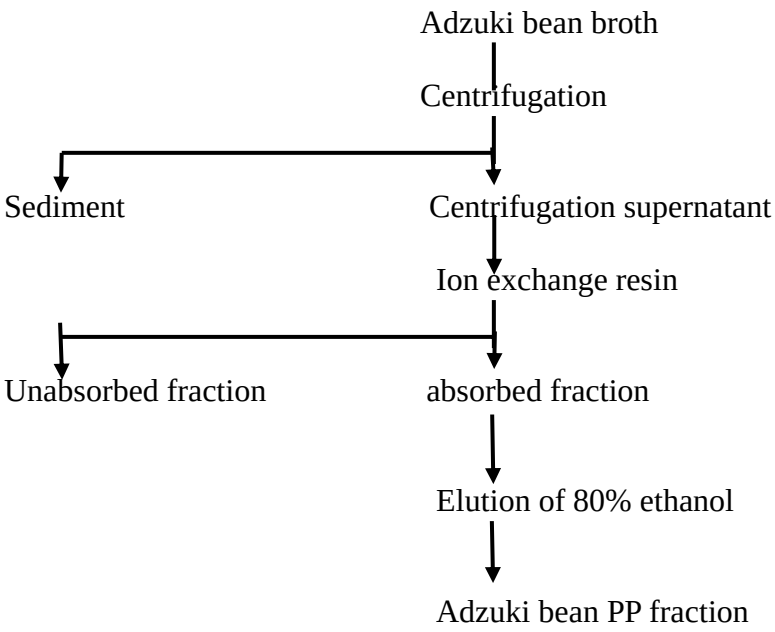

Figure 5. Preparation method of Adzuki bean Polyphenol fraction

Treatment of residue generated in food processing plants as biomass resources

For food processing plants, residue treatment will be one of the critical issues in years to come. In particular, because of the enforcement of the Food Recycling Law, the situation will become stricter. So far, we have carried out various experimental research focused on residue use and the various treatments mentioned above. However, there is little prospect of treating all residue under such a limited situation, and some drastic solutions should be implemented. Fortunately, there are many public research institutions in the Tokachi district, centered on Obihiro University of Agriculture and Veterinary Medicine, so it is very important to strengthen the network among research institutions and build up networks with government, industry, and other educational institutions as well.

Bio-ethanol projects implemented in the Tokachi district

Bio-ethanol is produced by yeast fermentation using various biomass resources whose main constituent is glucose. Ethanol is divided into two groups depending on usage: drinking and industrial purposes. Here, in the Tokachi district, we produce ethanol for industrial purposes and blend it with petrol. The blend consists of 3 percent bio-ethanol and 97 percent petrol, and is known as E3 fuel. Even though countries around the world such as the USA, Brazil, European countries, India and China have already initiated the utilization of bio-ethanol, in Japan, it is still on trial and its real use has not started yet.

Nowadays, global warming has caused serious environmental problems. We have been under pressure to reduce the greenhouse gas emissions to solve those problems on a global scale. In the case of Japan, according to the Kyoto Protocol held in 1997, the target rate of 6 percent to reduce carbon dioxide emission was set. However, because the amount of total carbon dioxide emissions in Japan has been increasing rapidly, Japan needs to reduce emissions more than the targeted rate of 6%.

In terms of carbon dioxide emissions, transport and other sectors occupy 18% and 15% respectively, and the amount is increasing rapidly. In addition, since liquid fossil fuels are used as a source of power and heat in both sectors, it is possible to substitute fuels emitting a tiny amount of carbon dioxide for those liquid fossil fuels.

On the one hand, Tokachi is one of the major agricultural areas in Japan producing flour and sugar beet; and irregular agricultural products and residue from agricultural food processing plants are generated as well. Recently, the possible availability of energy source materials from biomass resources has been discussed to introduce a new energy source, in particular, bio-ethanol has captured attention in some areas in Japan.

In the case of the utilization of bio-ethanol for industrial purposes in Japan, 3 percent of ethanol-blended gasoline was permitted according to the revision of the law for “a warranty on volatile oil” in August, 2003. It led to the first driving experiment using E3 fueled vehicles conducted in Shinjo, Yamagata Prefecture. Around the same time, projects to develop bioethanol manufacturing technology were launched in Okinawa, Okayama and Osaka Prefectures. In addition, here, in the Tokachi district, driving experiments for E3-fueled vehicles in cold regions started in April, 2004. As a part of a Japanese government project, 6 gas stations in various areas throughout Japan have experimented with the transport system and the provision of E3 fuel since January, 2005.

Next, I would like to explain bio-ethanol projects specifically in the Tokachi district. Table 2 shows projects in progress as of August, 2005. In April, 2004, we conducted a feasibility assessment study of bio-ethanol conversion systems using irregular agricultural products and residue in the Tokachi district, Hokkaido. In addition, there is another project focused on the technological development of the ethanol-blended fuel to introduce in cold regions.

Table 2. Projects implemented in Tokachi

Feasibility assessment survey of a bioethanol conversion system using substandard agricultural products and agricultural processing residue in the Tokachi region, Hokkaido (FY 2004 : FS project, Hokkaido Bureau of Economy, Trade and Industry)
Technological development on the introduction of bioethanol-blended fuel in cold regions (FY 2004-2005 : Project for Global Warming Countermeasures, Ministry of the Environment)
Agricultural, Forestry and Fishery Bio-recycling Project (FY 2005-2006 : Ministry of Agriculture, Forestry and Fisheries)

In our survey of bio-ethanol conversion systems, we searched for the amount of biomass which is not in use in the Tokachi District, collecting and transport systems, and conversion efficiency and estimated cost of bio-ethanol. Results show there are prospects of operation using irregular wheat and sugar beet for bio-ethanol under the technical and economic conditions. However, at the same time, there are various issues we need to consider such as the cost reduction of purchasing raw materials including transport charges, the promotion of residue use after fermentation as feed, and the need for sequential use using extracted active ingredients from wheat. The study also shows the need for further discussion about pricing

in the case of spreading to the general public.

Under the project called “Promotion of technology development for the introduction of ethanol-blended fuel in cold regions”, we investigated fuel supply, combustion technology of vehicles and terminal effects on E3 fuel supply facilities and conducted driving experiments on the public roads. Results proved E3 fueled vehicles have the same fuel consumption, starting quality, and accelerating quality compared with regular petrol fueled cars. However, when we stored the E3 fuel in petrol supply equipment, shape changes and abnormalities in packing and o-shaped rings occurred. We need to discuss them and remaining issues such as the phase separation in contact with moisture at low temperature as well in the near future.

In addition, in the Tokachi district, a two-year research project called Agricultural, Forestry and Fishery Bio-recycling Project has been conducted since April, 2005 aiming at the formulation of multistage utilization systems of upland field crops. The project is to find out various useful materials and usage of irregular wheat, sugar beet and potato pulp generated in potato starch manufacturing plants for producing bio-ethanol. Currently, the ways of extracting various materials such as useful protein, fat, water-soluble polysaccharide, feed and bio-ethanol, have been examined systematically.

Conclusion

In this paper, the utilization of biomass resources as food materials and bio-ethanol has been introduced. The materials introduced in this paper occupy only a tiny part of the biomass resources, but there are prospects of discovering other raw materials that could be utilized in Hokkaido. In addition, various institutes including Obihiro University of Agriculture and Veterinary Medicine conduct projects involved in the treatment of animal manure and development of wood pellets. Especially, in the Tokachi district, the effective utilization of biomass resources should be tackled by not only individual institutes but also the whole region on a cooperative basis. In order to survive as an agricultural area, recycle systems for biomass energy should be established quickly.

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