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Biological Heat Generation by the Cultivation of *Alternaria alternata* in Rice Bran

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ABSTRACT

Biological heat generation was observed when *Alternaria alternata* was grown in rice bran. A temperature of more than 50°C was maintained for 25 d, and the maximum temperature was 56.5°C. After 30 d of cultivation, 55% of the energy of rice bran was liberated. The consumption rates of the lipids and sugar contained in rice bran increased with the increase of the maximum temperature during the cultivation of *A. alternata*.

Index Entries: Rice bran; biological heat generation; *Alternaria alternata*.

INTRODUCTION

Rice bran has a variety of nutrients, such as proteins, sugar, lipids, and many kinds of vitamins as shown in Table 1. The energy of the rice bran is 286 kcal/100 g rice bran. Rice bran is mainly used for the production of rice oil, but is overproduced. Thus, its useful application is desired. In this study, we attempted to get heat energy from rice bran with *A. alternata* as a useful application of rice bran.

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Table 1
Nutrients Contained in Rice Bran (per 100 g)

		Carbohydrate		Vitamin			
Proteins, g	Lipids, g	Sugar, g	Fiber, g	Carotene, μg	B1, mg	B2, mg	Niacin, mg
13.2	18.3	38.3	7.3	6	2.5	0.5	25

MATERIAL AND PROCEDURE

Rice bran was obtained from Asahi Chemical Industry Co., Ltd. Yeast extract and polypeptone were purchased from Difco Laboratories. Sabouraud agar medium was purchased from Nissui Pharmaceutical Co., Ltd. Other chemicals were of the highest purity available. The seed culture of *A. alternata* IFO (Institute for Fermentation, Osaka, Japan) 4026 was performed under aerobic conditions at 25°C for 14 d in 150 mL Sabouraud medium, containing glucose (3 g), yeast extract (0.51 g), and polypeptone (1.5 g). The *A. alternata* grown in 150 mL of Sabourand medium, 185 g of sterilized rice bran, and sterilized water were mixed well in a beaker. The mixture was added into the vacuum bottle. The evolved heat caused by growth of *A. alternata* was measured by the calorimeter. The energy was calculated from the rise of water temperature. The water content in the rice bran was calculated from the weight difference of rice bran by drying of rice bran at 135°C for 4 h. The sugar contained in rice bran was analyzed by the orcinol-sulfuric acid method (*3*). The nitrogen was quantified by the Kjeldahal method (*4*). The amount of lipid in rice bran was determined by the Soxhlet extraction method (*5*). The amount of nutrition in rice bran was calculated after cultivation of *A. alternaria.*

RESULTS AND DISCUSSION

Heat Generation by Growth of *A. alternata* in Rice Bran Medium

When *A. alternata* was grown in rice bran medium, heat generation was observed as shown in Fig. 1. In the case of *A. alternaria* growth in rice bran with 49% water content, the temperature of the rice bran increased to 48.3°C within 8 d after the introduction of *A. alternata*. In this case, a temperature of more than 40°C was maintained for 32 d.

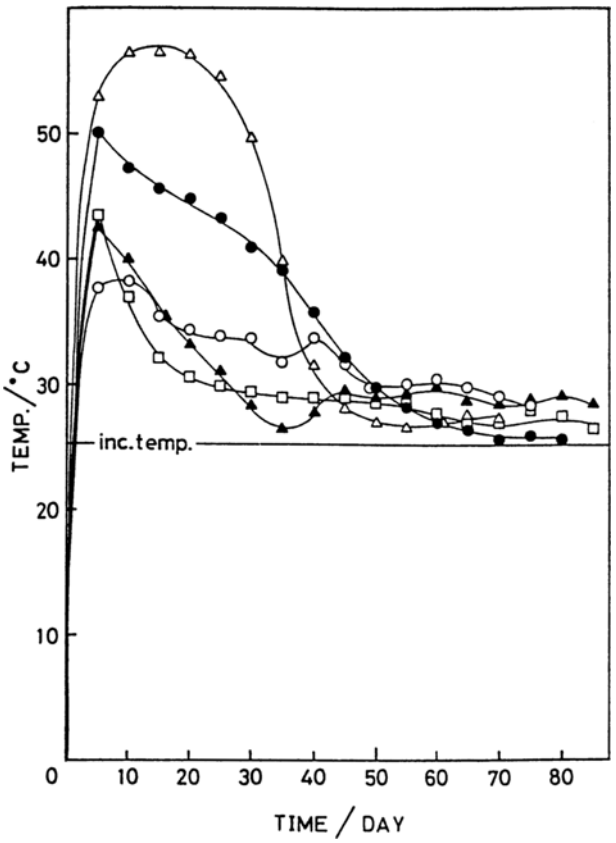

Fig. 1. Time dependence of temperature of rice bran with various water contents of *A. alternata* cultivations. The cultivations were carried out with 185 g of rice bran medium. Water content, ○: 36%, ●: 49%, △: 62%, ▲: 74%, □: 83%.

Optimum Water Content for Heat Generation

Since commercially available rice bran has a water content of between 12 and 15%, the water content of the rice bran is not enough for bacterial growth. We attempted to grow *A. alternata* in the rice bran containing various water contents by the addition of sterilized water. The highest temperature was observed when rice bran medium had 62% water content as shown in Fig. 1. In this reaction condition, the rice bran medium was kept at more than 50°C for 25 d. Figure 2 shows the relationship between the water content of rice bran and the highest temperature for the cultivation of *A. alternata*. The heat generation strongly depended on the water content of rice bran medium. At the optimum water content, the released

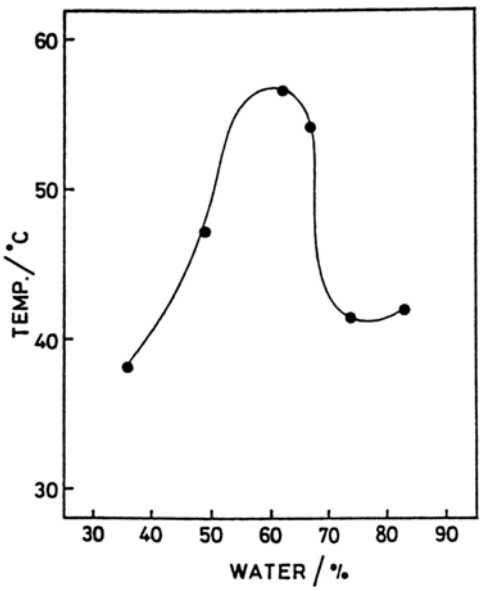

Fig. 2. Relation between the maximum temperature and the water content of rice bran. The cultivations were carried out with 185 g of rice bran medium.

energy was calculated from the rise of the temperature of water by a calorimeter. The energy generated from the rice bran after 4 d from the introduction was 196 cal/100 g of rice bran/h. Its energy shows after 33 d of cultivation that 55% of the whole energy of rice bran was released by *A. alternata* growth.

Nutrition Consumption by *A. alternata* Growing

A lipid is a higher energy source in aerobic metabolism than sugar and amino acids. We measured a relationship between nutrition consumption in rice bran and heat generation caused by *A. alternata* growth. Sugar and lipid consumption rates increased with the maximum temperature as shown in Fig. 3. In particular, the lipid consumption rate was strongly dependent on the maximum temperature during the cultivations. When the maximum temperature was 56.6°C during cultivation of *A. alternata*, 59.9% of the lipid consumption was observed. The nitrogen consumption rate was slightly increased with the increase of the maximum temperature of the cultivation. The above results show that lipid consumption plays an important role in the heat generation of rice bran during the cultivation of *A. alternata*.

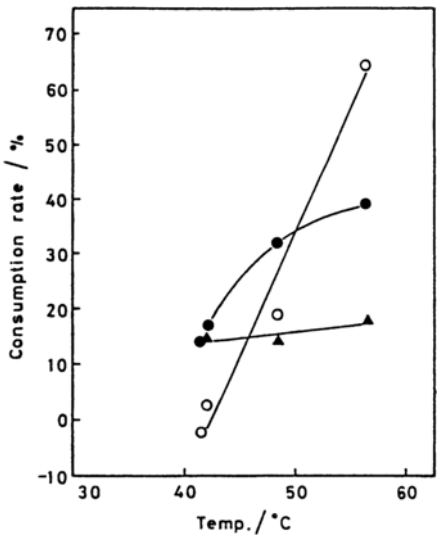

Fig. 3. Relationship between the maximum temperature and nutrition consumption rate. The cultivations of *A. alternata* were carried out with 185 g of rice bran medium of 83% water content. ○: lipid, ●: sugar, ▲: nitrogen.

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