

# Improvement and application of biodegradable molded products by several agro-resources and bio-polymer

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## Introduction

To make biodegradable molded products from CGM(Corn gluten meal) based agro by-products by an injection molding system was carried out<sup>(1)</sup>. In this process, we successfully reduced the cost and obtained solid molded products for practical use by adopting the injection molding method, which has many advantages in productivity (low cost, high moldability, flexibility to make various shapes of molds). At present, we are working on evaluation of the properties of the biodegradable molded material and improvement of the materials for different purposes. So, this time, to improve the molded products properties, we tested to blend PLA ( poly lactic acid ) into CGM based ingredient agricultural by-products. And also, we investigate on the applicability of other bio-polymer such as wheat gluten and zein.

## Materials and Methods

*Materials* CGM containing 9.1% oil and 8.9% moisture (supplied from Showa Sangyo Co., LTD, Japan) was dried at 110 °C for 12h before use. Dried CGM mainly contains 69.8±0.1% zein, measured with a nitrogen/protein instrument (FP-528, LECO corporation, MI, USA). Ethanol (99.5%) , glycerol (first grade). And separated zein concentrate (95%) was supplied from Showa Sangyo Co., Ltd. Wheat gluten meal was supplied from WRRC, USDA, USA. Okara (soy bean curd refuse): dry powder type was purchased. Bamboo powder was supplied from a Japanese company. And PLA pellet was supplied from KAMIYAMA package Co., Ltd.

*Methods* The production process is shown in Fig. 1. First, we processed the materials into pellets with an extruder(TEX30FC, Japan Steel Works (JSW), Japan), and then molded the pellets into test pieces for physical properties and seedling culture pots by an injection molding machine(J85MEL, JSW, Japan).

High protein content sample such as zein did not form pellets using the twin screw extruder due to high viscosity, so we introduced the desk pelleter (DALTON, F5/11-175) to prepare the pellets(Fig.1). All the sample water contents were adjusted to 10-12%

Table 1 showed the combination of the ingredients for pellets. Molded samples were tested for the mechanical properties and microstructure by SEM.

## Results and Discussion

High protein content sample and PLA blended sample required high injection pressure and long injection time due to high viscosity, however, all the samples were converted into molded products. Molded samples from pure zein sample had quite high physical property and smooth surface like synthetic polymer based products (Fig. 2). CGM and PLA blended sample had also quite high physical property and SEM photograph showed uniform structure, and bamboo fiber may maintain the structure (Fig. 3).

The results can be utilized to design good biodegradable products for the commercialization in the future.

Table 1, Material recipes (Weight of one experiment condition (g))

Sam ple No.	Protein(g)	Fiber(g)	Glycerol (g)	Ethanol(g)	Water(g)	PLA(g)
1	CGM 500	okara 500		100	150	250
2	CGM 500	bamboo 500		100	150	375
3	zein 700	bamboo300	150		150	
4	wheat gluten 700	okara 300	200		150	

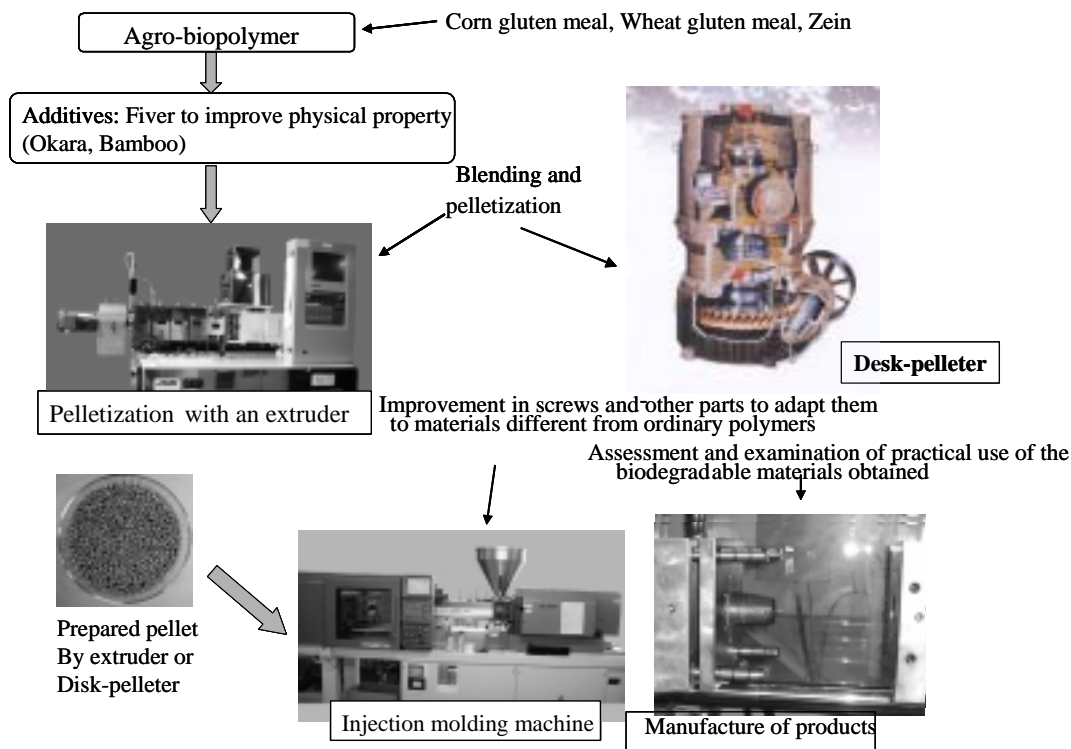


Fig.1 Experimental flow for palletizing and molding for each sample



Fig. 2  
Molded sample  
(Zein /Sample NO.3)

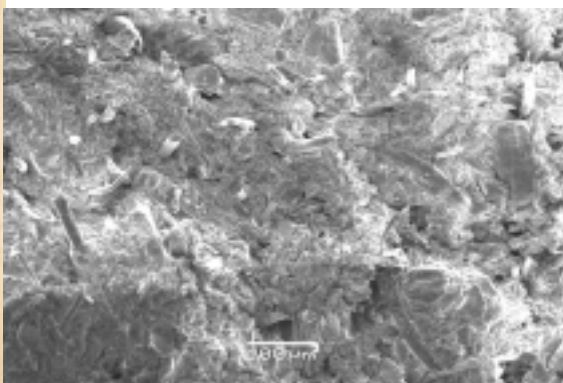


Fig 3  
Cross section view of molded sample by SEM  
(CMB, Bamboo fiber PLA/ Sample NO.2)

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**Reference**

(1) Processing and Properties of Low Cost Corn Gluten Meal/Wood Fiber Composite  
Wu, Q.; Sakabe, H.; Isobe, S.; *Ind. Eng. Chem. Res.*; (Article); 2003; 42(26); 6765-6773