PD-76

Effects of Extrusion Processing Conditions on the Physico-Chemical Properties of Mung Bean Extrudates

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Abstract

Mung bean is rich in starch, protein, vitamins, and the starch contains 32-35% amylose. For this purpose, mung bean is often used in the manufacturing of traditional food. Extrusion processing is a high pressure short time (HTST) technology with many advantages, including high productivity and low cost. For this purpose, extrusion processing technique would be applied to manufacture mung bean extrudates with high functional properties in this research. The domestic Tainan No.5 mung bean was used as material in this research, to produce mung bean extrudates by single screw extruder at different screw speed (20, 30, 40 rpm) and barrel temperature (90 °C, 100 °C), then the physico-chemical properties (moisture content, color, water activity, thermal property and resistant starch content) were also analyzed. The results showed that no significant difference was found in moisture content and water activity after extrusion processing and storage. As to the color, the L value decreased with the increasing of storage time. In addition, the degree of gelatinization was not affected by screw speed and barrel temperature. The resistant starch content increased with the increasing of storage time at barrel temperature 90 °C, but at barrel temperature 100 °C was not.

Keywords: Mung bean, amylose, extrusion processing, physico-chemical properties, resistant starch

Introduction

Mung bean, *Vugna radiate* (L.) Wilczek, *Leguminosae*, *Vigna*, is rich in starch, protein, vitamins, and the starch contains 35-45 % amylase (Hoover *and others*1997). The ratio of amylose and amylopectin will affect the starch pasting properties, granules morphology, set back viscosity, thermal stability, solubility, swelling power and enzymatic susceptibility other characteristics (Elessandra da Rosa Zavareze 2010). The content of amylose will affect retrogradation that is the most important factor. The resistant starch and dietary fiber are different (Nugent 2005). Resistant starch can be divided into four types: RS Ⅰ (Physically inaccessible starch), RS Ⅱ (ungelatinized starch), RS Ⅲ (retrograded starch), and RS Ⅳ (chemically modified starch). The principle of extrusion technology is the high temperature short time (HTST) processing technology (Rossen and Miller 1973). The factors that affect the quality of extruded products. Extrusion variables include process variable, system variable, target variable. In this study, we will produce mung bean extrudate by extrusion technology at different heating

temperature and screw speed, and mung bean extrudate stored at 4 ℃, and find the formation of resistant starch and change of physical and chemical properties.

Materials and Methods

In this study, a multivariate experimental design (3×2×3) was used to study effects of screw speed (20,30,40 rpm), barrel temperature (90/90/90, 100/100/100 ℃), and vacuum-packed storage at 4 ℃ (0,7,14 days).

Materials

The domestic Tainan No.5 mung bean were used as material in this research, were purchased from Tainan Chiku. Mung bean were soaked in distilled water for 14 hr at room temperature before experiment.

Sample preparation

Extrudate after stored was dried at 60 ℃ with hot air. The dried extrudate then was milled, and waited for the following analyses of the physical and chemical properties.

Moisture Content (%)

Follow the Chinese National Standards (CNS 5033 1984).

Water activity (Aw)

A water activity analyzer (Devices-CX-2, Decagon, USA) was used for this purpose. A measurement was repeated three times.

Color analysis

The color measurements were carried out in triplicate using Hunter Lab system (Hunter Lab Color Quest XE, USA).

Thermal property

According to Abdel-Aal and Rabalski (2008) modified to analyze bean extrudate gelatinization, this method is based on determination of glucose of the extrudate by Model YSI 7100, YSI Incorporate, Yellow Springs, OH, USA.

Resistant starch (RS)

The enzymatic-gravimetric assay was used to determine resistance starch modified from Chou and Lin (2008).

Result and Discussion

Moisture Content

The result shows that, 0 day-extrudate moisture content was 59.14 - 61.45%, 7 day-extrudate moisture content was 58.56 - 61.43%, and 14 day-extrudate moisture content was 58.08 - 60.70%, moisture content decreased slightly after extrusion, while the storage time and moisture content was inversely proportional.

Water activity (Aw)

After drying, the water activity was no difference. when the condition is 100 ℃, 30 rpm, storage 0 day, has the highest water activity (0.551) ($P<0.05$). And when the condition is 90 ℃, 30 rpm, storage 14 day, have a minimum water activity (0.393) ($P<0.05$).

Color analysis

When the storage time increased that L value increases with time. And b value, when the condition is 100 ℃, 40 rpm, storage 14 day have the minimum b value (9.43) ($P<0.05$).

Thermal property

There is no obvious relationship between gelatinization and screw speed, and results show that barrel temperature, screw speed and storage days, were no significant difference with ($P>0.05$).

Resistant starch (RS)

There is no obvious relationship between resistant starch content and screw speed. We can see from the Table 1, when the barrel temperature is 90 ℃, the resistant starch content increases with storage time increases. But when the barrel temperature is 100 ℃, resistant starch content decrease with storage time increases. The result shows that, when the condition is 90 ℃, 20 rpm, 14 days storage, the resistant starch content significantly higher than other condition ($P<0.05$).

Table 1. The changes of resistant starch with different storage time

BT(□)/SS(rpm)	Storage time(days)		
	0	7	14
90℃、20rpm	37.400±0.381%	38.016±0.549%	50.915±0.895%
90℃、30rpm	37.313±0.545%	40.272±0.252%	43.297±0.907%
90℃、40rpm	37.306±0.081%	37.501±0.228%	47.490±0.531%
100℃、20rpm	43.828±2.351%	46.035±1.308%	38.385±0.223%
100℃、30rpm	36.848±1.486%	38.260±0.917%	36.655±1.218%
100℃、40rpm	43.163±1.108%	42.062±0.247%	40.326±0.962%

BT= Barrel Temperature, SS= Screw Speed

Conclusions

The result show L values decreased with increasing storage time. When the barrel temperature was 90 ℃, the resistant starch content was increased along with increasing storage time. According to the results, when the extrusion condition was 90 ℃, 20 rpm, stored 14 days, the resistant starch content was the highest (50.92%) ($P<0.05$).

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