Effects of drying on germinated mung bean by fluidization technique

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Abstract

Germinated mung bean (GMB) can be used as a raw material to produce many food products. After being germinated, high-moisture GMB must be dried to appropriate moisture content to prolong its storage life. Fluidization technique is widely used to dry GMB at high-temperature. The purpose of this research was to study the effect of drying on the qualities of GMB, i.e. 2,2-diphenyl-1-picrythydrazyl radical (DPPH*), total phenolic content (TPC) and γ-anminobutyric acid (GABA) were investigated. The experiments were set up at the material initial moisture content of 110% dry basis (d.b.), drying temperatures of 110–150°C, velocity of 3.9 m/s and bed depths of 10 cm. The experimental result showed that the drying temperatures affect the drying rate and some quality attributes of GMB. The drying temperatures in the range of 110–150°C did not significantly affect DPPH*, TPC and the GABA content.

Keywords: drying, hot-air, legume, quality

Introduction

Mung bean is important crop of Thailand for a long time. The most production of mung bean for direct consumption and processed into products such as sprouts, vermicelli. Mung beans are rich in protein and fat (Zhang et al. 2013). Extracts of mung beans can also be used as a medicine to relieve the symptoms of diabetes (Randhir and Shetty 2007; Perez-Jimenez and Saura-Calixto 2005), antibiotics (Randhir and Shetty 2007), inhibit cancer cells (Li et al. 2012) and antioxidants (Chaieb et al. 2011). In addition, the seed germination process to increase the nutritional value, especially GABA content. Because these conditions cause cell stress. The enzymes glutamate decarboxylase being urged to change glutamate to GABA increased (Bown and Shelp 1997). However, the moisture content inside the seed germination process is high. Although there are a number of dryers that could possibly be used to dry crop, fluidized bed dryer may be the most appropriate one since it can provide good mixing (Jaiboon et al. 2009) and reduce moisture rapidly and keep the quality of seed (Swasdisevi et al. 2010). Therefore, the aim of this research was to study the effect of fluidized bed drying temperature on GMB quality and drying kinetic The GMB quality was considered in terms of DPPH*, TPC and the GABA content.

Methodology

Preparation of GMB and drying
Mung bean "*ChaiNat 72*" was provided by Chai-Nat Field Crops Research Center and Phetchabun Field Crops Research Center, Thailand. It was soaked in water at room temperature for 5 h and germinated in air of 3 h. By this time, it appeared a small bud at seed germ with length about of 2-5 mm. The GMB had an initial moisture content of 110 % d.b. The GMB was divided into two groups. The first group was prepared for reference GMB

which was dried in shade. The remaining group was dried in a fluidized bed dryer. A batch of GMB was dried in hot-air fluidized bed dryer (Figure 1). The hot air fluidized-bed dryer consists of stainless steel cylindrical drying chamber of 15 cm diameter and 150 cm height, a 12 kW heater with a PID controller with an accuracy of ±1°C, a backward curved blade centrifugal fan driven by a 1.5 kW motor. The drying was carried out at temperatures of 110 – 150°C.The desired moisture content of the mung bean after fluidized bed drying was 15 - 25 % d.b., the sample was taken from the dryer. After that it was ventilated using ambient air until the moisture content of the sample reached 16% d.b. The samples were kept in cold room at 4-5°C before quality test. The quality of dried GMB was compared with the reference GMB quality.

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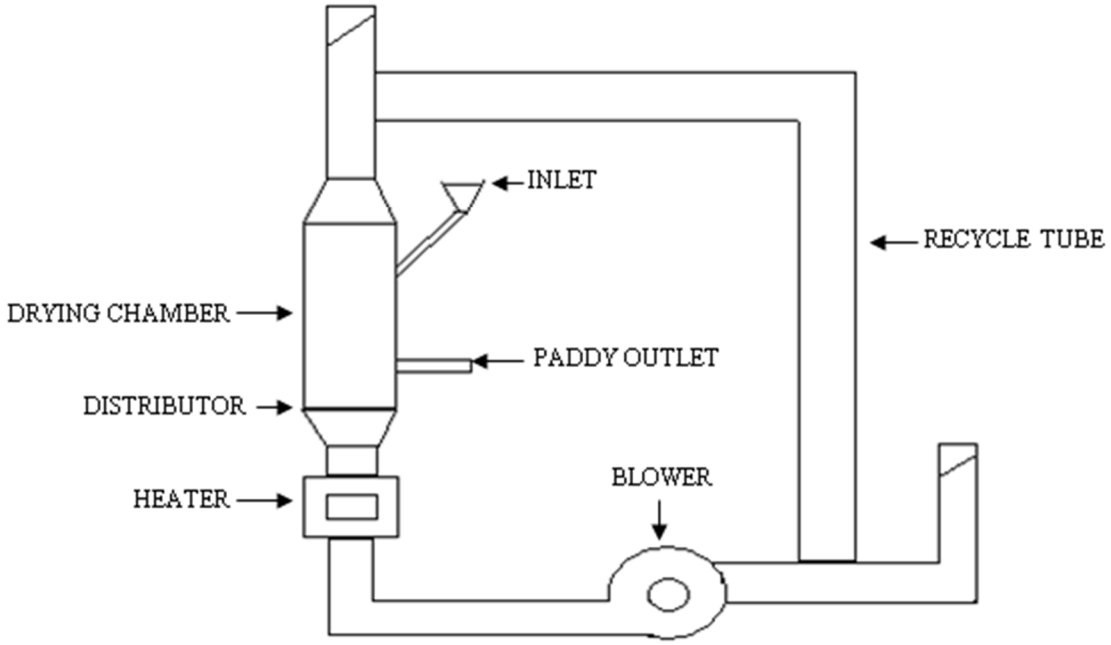

Figure 1 Schematic diagram of a fluidized bed dryer

Extraction procedure to determine the antioxidant properties

Each mung bean flour (5 g) was weight accurately and extracted at room temperature with 70% ethanol 25 ml under agitation using a magnetic stirrer for 30 min. Then, the mixtures were centrifuged at 4000g for 10 min and supernatants were collected. The residues were re-extracted under the same conditions, resulting finally in 50 ml crude extract. All extracts were used as they were after centrifugation to determine TPC, DPPH* and GABA.

Chemical analysis

Samples were collected and analyzed for the moisture content by the method 44-15.02 of AACC (1990).

Determination of total phenolic contents and DPPH•

The total phenolic content (TPC) was determined using the Folin-ciocalteu method (Singleton et al. 1999). The DPPH• radical scavenging capacity of each extract was evaluated according to the procedure of Brand-Williams et al. (1995).

Determination of GABA content

The content of GABA was determined by using HPLC method described by Khuhawar and Rajper (2003). The HPLC system (Shimadzu, Kyoto, Japan) consisted LC-20AD pump and SPD-20A DAD detector. Chromatographic separation was archived on Inertsil ODS-3 column (4.6 mm x 250 mm, 5 µm, GL Sciences, Japan). The mobile phase was a mixture of methanol: H2O with 0.1% v/v Trifluoroacetic acid (40:60 v/v) at a flow rate of 1.5 ml/min and GABA was monitored at 330 nm. Calibration curve was constructed with the external standard.

Statistical analysis

All data were subjected to the analysis of variance (ANOVA) using SPSS software and are presented as mean values with standard deviations. Differences between mean values were established using Duncan's multiple range test. Statistical significance was considered at level of 95%.

Results and Discussion

Drying Kinetics

Figure 2 shows the drying curves of GMB undergoing fluidized bed drying at various temperatures. As expected, the moisture removal rate was enhanced at higher drying temperatures. Drying rate increased with increasing drying temperature.. The required drying time to reach the desired moisture content range of 20 - 26 % d.b. was about 12-20 min. This moisture content was not safe for storage. However, a further decrease in the moisture content at this stage would cause a crack of seed.

TPC

The total phenolic content of dried GMB determined by Folin-ciocalteu method were in a range of 1062.35 – 1081.58 mg GAE / 100 g seed and mung bean (reference) of 1378.81 mg GAE / 100 g seed (Table 1). The results showed that TPC decreased with drying but drying temperature did not affect the phenolic content of the GMB. Because of the high temperatures during drying can affect the phenolic compounds to break down into smaller molecules and vaporize. This result was in accordance with that reported by Mausour and Khaili (2000), reported that the decrease of total poly-phenolic compounds in the extracts from ginger is dependent on drying temperature and drying time. Drying resulted in the increasing of the hardness of bean. Thus, when the extraction solvent penetration into the seeds can be difficult and the solvent was less, resulting in the release of phenolic compounds in mung beans in the form of soluble (soluble phenolic) out at least.

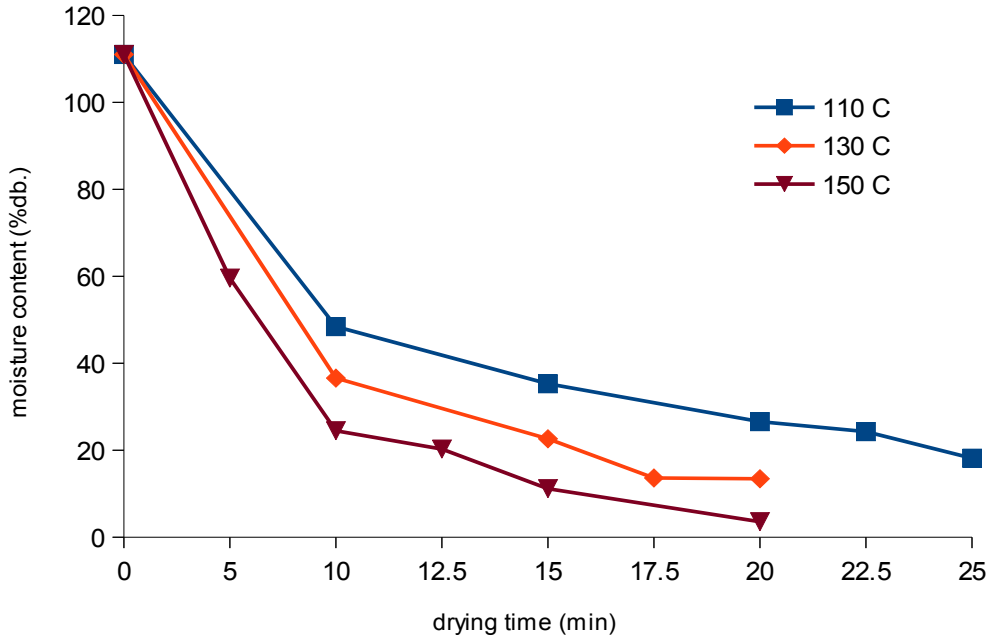

Figure 2 Drying curves of GMB dried by a fluidized bed dryer

DPPH radical scavenging activity

The free-radical scavenging activity of the extracts of mung bean after processing was evaluated using the DPPH assay (Table 1). The inhibition (%) of DPPH radical for GMB were varied from 45.07 % to 46.09 % and mung bean (reference) of 55.01 %. The results showed that drying process did affect the DPPH radical scavenging activity which was in accordance with the total phenolic content.

Table 1 Total phenolic content, %inhibition DPPH radical of GMB

Drying Temperature (°C)	Total phenolic content (mg GAE / 100 g seed)	Inhibition %DPPH
Mung bean (reference)	1378.81 ± 8.78^{a}	55.01 ± 2.11^{a}
GMB (shade drying)	1063.36 ± 49.10^{b}	45.92 ± 0.72^{b}
110 °C	1076.46 ± 27.83^{b}	45.07 ± 0.34^{b}
130 °C	1081.58 ± 23.12^{b}	45.76 ± 0.80^{b}
150 °C	1062.35 ± 38.32^{b}	46.09 ± 2.31^{b}

Different superscripts in the same column mean that the values are significantly different ($p \leq 0.05$)

GABA content

Table 2 shows the GABA content of mung bean and GMB after drying from the HPLC analysis. The GABA content increased from 0.22 mg/100 g for the mung bean (reference) to 15.60 mg/100 g for GMB (shade drying). The increase of GABA content was due to the change of component in grain during the germination process (Komatsuzaki et al. 2007). After drying, GABA contents were not significantly influenced by drying temperature. This result

Table 2 GABA content of mung bean and dried GMB

Drying Temperature (°C)	GABA content (mg GABA / 100 g seed)
Mung bean (reference)	$0.22 + 0.04^{b}$
GMB (shade drying)	$15.60 + 0.54^{a}$
110 °C	$15.40 + 0.90^{a}$
130 °C	$15.31 + 0.17^{a}$
150 °C	$15.00 + 0.20^{a}$

Different superscripts in the same column mean that the values are significantly different ($p \leq 0.05$)

Conclusion

It was found that the drying of GMB by fluidization technique led to the decreases of the total phenolic content and %inhibition DPPH radical.The GABA content increased with the germination process. Total phenolic content, %inhibition DPPH radical and GABA contents were not significantly influenced by drying temperatures (110-150°C). Thus, fluidization technique was an efficient process for preparation of GMB.

Acknowledgements

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