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Proximate composition of dried banana fruit peel fermented with endophytic fungi associated with bamboo

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Abstract

Seven endophytic fungi (*Cladosporium cladosporioides, Aspergillus ochraceus, Penicillium citrinum, Monascusruber, Fusarium semitectum, Fusarium* sp.1 and *Fusarium* sp. 2) associated with bamboo were tested to determine their effect on the proximate composition of banana fruit peel after 20 days of fermentation. Reduction in crude protein, ash, crude fat and crude fiber content of banana fruit peel were recorded while increment in moisture content was noted. The initial crude protein content of dried banana peel of 7.82% was reduced up to 5.66% after fermentation with *M. ruber*. Meanwhile, *C. cladosporioides* obtained highest ash content among the fungal treated banana peel of 21.55% followed by the *A. ochraceus* of 20.53%. For the moisture content, *M. ruber* and the *Fusarium sp.* 2 recorded the highest moisture content of 37.11%. Reduction of crude fat and fiber, the least of which were recorded *Fusarium* sp. 1 treated banana peel of 9.45% and 8.55%, respectively. Thus, the possible production of proteolytic enzymes, lipase and cellulolytic by the fungal endophytes.

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Introduction

Increase in production and utilization of banana fruits leads to vast amount of banana fruit peel with unpopularly known value. According to Anghwange *et al.* (2009), it contains high amount of carbohydrates, crude fiber and phytochemicals. Accordingly, Radha Khrishna *et al.* (2012) and Patel *et al.* (2012) revealed the potentiality of banana peel as substrate for microorganism for amylase, alcohol, citric acid and other enzyme production.

Endophytic fungi are group of microbial plant symbionts that live within plant tissues without causing any damage (Carroll, 1988; Carroll,1991; Petrini, 1991; Hyde & Soytong, 2008). Endophytic fungi produce extracellular enzymes such as pectinases, cellulases, lipases, laccase (Sunitha *et al.* 2013).

In this study, the effect of the fungal entophytes associated with bamboo on the proximate composition of banana fruit peel was determined.

Materials and methods

The study was done following the methodology of Simon *et al.* (2018) with some modifications.

Preparation of fungal inoculants

The cultures of entophytic fungi were the sub-cultured Potato Dextrose Agar (PDA) for seven days.

Preparation of Substrate

Banana peel were collected in San Miguel, Bulacan. The banana fruit peel was dried for 7 days and were pulverized using mortar and pestle. One hundred (100) grams of banana fruit peel was placed in a clean bottle and 100 ml of distilled covered with plastic and was sterilized at 15 psi at 121° C for 30 mins.

Solid state fermentation

The prepared substrate was inoculated with 10 mm fungal discs. Cultures were covered with plastic and allowed to acclimatize in the substrate for 20 days at room temperature. The fermented substrates were then sterilized and was air dried for seven days. Dried and pulverized samples were sent to Lipa Quality Control Center, Bocaue Bulacan, Philippines for proximate analysis of the nutritional content such as crude protein, crude fat, crude fiber, moisture and ash.

Statistical analysis

The study was laid out using Completely Randomized Design (CRD). Data was analyzed using Statistical Analysis T-test. All tests of significance were done at 5% and 1% probability levels.

Results and discussion

Shown in Table 1 is the proximate composition of the banana fruit peel as affected by entophytic fungi after solid state fermentation.

Table 1. Proximate composition of dried banana fruit peel with different fungal endophyte.

TREATMENTS	CRUDE PROTEIN (%)	MOISTURE (%)	ASH (%)	CRUDE (%)	FAT CRUDE FIBER (%)
Uninoculated Banana fruit peel	7.82	11.63	20.1	13.03	12.24
A. ochraceus + banana fruit peel	7.05^{ns}	24.72**	20.25^{ns}	11.75*	9.64**
C. cladosporioides + banana fruit peel	6.12*	34.67**	21.55^{ns}	10.46**	10.46*
M. ruber + banana fruit peel	5.66*	37.11**	10.51**	9.62**	10.06**
P. citrinum + banana fruit peel	6.26*	32.24**	12.08**	9.83**	10.94*
F. semitectum + banana fruit peel	6.17*	32.34**	11.02**	10.25**	9.41**
Fusarium sp.1 + banana fruit peel	5.84*	37.11**	18.94*	9.45**	8.55**
Fusarium sp. 2 + banana fruit peel	6.27*	33.38**	11.48**	9.94**	9.73**

ns no significant difference as compared to control; *significantly different as compared to control; **highly significantly different as compared to control.

For the crude protein, among the fungal enriched banana fruit peel, *A. ochraceus* obtained the highest CPC of 7.05% while the *M. ruber* had the least of 5.66%. Statistically, only the CPC of *A. ochraceus* + banana fruit peel is comparable to untreated banana fruit peel and the rest were significantly lower.

Similarly, the highest percentage reduction was recorded in *M. ruber* with 27.36%. Thus, the potential proteolytic enzyme production of the seven endophytic using banana fruit peel as substrate. Reduction in crude protein content is due to the carbon requirement for fungal growth and microbial metabolic activities that may cause catabolic breakdown of sugar and degradation of some amino acids (Achinewhu, 1983; Bhattcharya and Raha, 2002; Ezeand Jacob, 2005;).

Table 2. Percentage increment/reduction in the proximate composition of dried banana fruit peel with different fungal endophyte.

Treatments	Crude protein (%)	Moisture (%)	Ash (%)	Crude fat (%)	Crude fiber (%)
A. ochraceus + banana fruit peel	-9.85	+112.55	+0.752	-9.82	-21.24
C. cladosporioides + banana fruit peel	-21.74	+198.11	+0.72	-19.72	-14.54
M. ruber + banana fruit peel	-27.62	+219.09	-47.71	-26.17	-10.62
P. citrinum + banana fruit peel	-19.95	+177.21	-39.90	-24.56	-10.62
F. semitectum + banana fruit peel	-21.10	+178.07	-45.17	-21.34	-23.12
Fusarium sp.1 + banana fruit peel	-25.32	+219.09	-5.77	-27.48	-30.15
Fusarium sp. 2 + banana fruit peel	-19.82	+187.02	-42.89	-23.71	-20.51

+ increment: - reduction

Fungal proteases may degrade the protein into amino acids relative to fungal growth, bioconversion and utilization of hydrolytic products of various substrates (Gupta *et al.*, 2002; Colombatto and Beauchemin, 2009; Braaksma *et al.,* 2009;).

Accordingly, several species of filamentous fungi are potent sources of protease and banana peel also act as inducers of protease production. (UL-Haq *et al.*, 2003; Kalpana *et al.*, 2008; Kakde and Chavan, 2011). Fermentation led to increased moisture content of banana fruit peel, *M. ruber* + banana fruit peel and *Fusarium* sp. 1+ banana fruit peel obtained the highest value of 37.11%, followed by *C. cladosporioides*+ banana fruit peel of 34.67% and *Fusarium* sp. 2+ banana fruit peel of 33.38% while *A. ohraceus*+ banana fruit peel had the least of 24.72%. Statistically, they were highly significantly higher than uninoculated banana fruit peel of 11.63%.Increment in moisture content is because of the metabolic and proteolytic activity of microorganisms that release water and carbon through hydrolysis of peptides (Hammouni *et al.,* 1997; Chutmanop *et al.*, 2008).

Meanwhile for the evaluation of ash content, *C. cladosporioides*+ banana fruit peel had highest ash content of 21.55% followed by *A. ochraceus*+ banana fruit peel of 20.53%, which were comparable to the untreated banana fruit peel with a 20.13%.

Reduction in ash content which were highly significantly lower than the untreated banana fruit peel were recorded in *P. citrinum, Fusarium* sp. 2, *F. semitectum, M. ruber* + banana fruit peel with 12.08%, 11.48%, and 11.02%, respectively.

Similarly, the crude fat of the fungal enriched banana fruit peel depleted after 20 days of solid state fermentation. Statistically, the crude fat content of the uninoculated banana fruit peel of 13.03% were significantly higher to 11.75% by *A. ochraceus*+ banana fruit peel and *Fusarium* sp. 1+ banana fruit peel had a least of crude fat of 9.45%. Reduction in crude fat coincides with the reports of Khodanazary *et al.* (2013), Nasseri *et al.* (2011), Oseni and Ekperigin (2011), Kakde and Chavan (2011), that fermentation of different substrate with filamentous fungi have resulted to reduce crude fat as per secretion of enzyme lipase.

Finally the initial crude fiber content of banana fruit peel of 12.24% was also reduced, wherein, *P. citrinum*+ banana fruit peel had 10.94% followed by

C. cladosporioides+ banana fruit peel with 10.46% and the least crude fiber content of 8.41% by *Fusarium* sp 1.

Subsequently, fungal endophytes caused the reduction in crude protein, increment in moisture content and deduction in ash, crude fat and crude fiber content of the banana fruit peel. The crude protein content and ash content of banana fruit peel was reduced up to 27.62% and 47.71% by *M. ruber*, whereas crude fat and crude fiber was depleted by *Fusarium* sp 1 of up to 27.48% and 30.15, respectively. Additionally, *M .ruber* and *Fusarium* sp 1 caused a 219.09% increment in moisture content (Table 2). According to Negedu *et al.* (2014), the decrease observe in the fat content and protein of banana fruit peel can be attributed to possible high proteolytic and lipolytic activities (Agrahar and Jha, 2011). Similarly, fiber content decrease due to its elevated cellulose production and cellulolytic activity (Rubeena *et al.,* 2013).

Conclusion

Based on the results of the study it can be concluded that solid state fermentation of banana peel with fungal endophytes could influence the proximate composition of the substrates which led to reduction in crude protein, crude fiber, ash and crude fat and increased moisture content.

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