IJBPAS, August, 2017, 6(8): 1516-1524

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

NUTRITIONAL ATTRIBUTES OF FUNGAL ENDOPHYTES-PINEAPPLE PEEL (*Ananas comosus* (L.) Merr.)

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Received 30th Oct. 2016; Revised 29th Dec. 2016; Accepted 26th March 2017; Available online 1st August2017

ABSTRACT

This study is in line with the study of Agonoy et al [1] wherein the single cell protein potential of nine fungal endophytes were evaluated through its effect on the crude protein content of the fungal enriched pineapple peel. In the present study the crude fat, crude fiber, ash, and moisture content of the fermented pineapple were assessed.

Fortificationin the ash content, crude fiber and crude fat of the pineapple peel were observed.For the crude fiber content, *F. semitectum*- treated pineapple peel had the highest percentage crude fiber of 15.5%. Also, *Fusarium sp.2*- treated pineapple peel registered the highest value of crude fat content with 1.82%. And for the % ash content, *C. cladosporioides* - treated pineapple peelobtained 14.5%.Meanwhile, reduction in moisture content was observed which can be attributed to microbial growth and proliferation in the substrate. Hence, the ability of the nine fungal endophytes to enhance the nutritional attributes of the of pineapple peel.

Keywords: ash - crude fat - crude fiber – moisture - nutritional attributes

INTRODUCTION

In recent study of Agonoy *et al* [1], the single cell protein potential of fungal endophytes was revealed through the increment in crude protein content of the pineapple peel. Accordingly, several researches probed that single cell protein

production of microorganism does not only increase the crude protein of the substrate but also influences its nutritional composition. This can be attributed to the activating fungal organisms which are known as best sources of enzymes [2]. Enzyme is protein which is synthesized as intra and extra cellular compounds that catalyze biochemical reaction with high specificity and enhance the reaction rate [3]. These group of enzymes includes cellulases, pectinases, xylanases, xylosidases, phytases, amylase, amyloglucosidase, invertase, lactase and acid proteases Whereas, these enzymes could be produced by degrading and utilizing various agro industrial waste materials rich in cellulose as carbon source through solid state fermentation [4-6]. Consequently, agricultural wastes are known to support the growth of microorganism as single cell protein and enhance other nutritional attributes. Pineapple peel is one of the million tons of agricultural wastes that are left unutilized. It contains sugar and fibers which could serve as growth medium of microbial growth for the production of industrial enzymes and single cell protein [7, 8]. The study was carried out, to determine the influence of the fungal endophytes on the ash, moisture, crude fiber and crude fat content of the pineapple peel.

MATERIALS AND METHODS

Methodology was adapted from previous works of Valentino et al [9], Gabres et al[10], Paynor et al [11], Zamora et al [12] and Valentino et al [13,] as cited by Agonoy et al [1] with some modifications.

Solid State Fermentation

Seven day old fungal endophytes were counted with heamacytometer and were to 5.0 x 10^6 cells per ml with sterile distilled water. Then, 20 ml of the spore suspension were inoculated to 100 ml pre-moistened (with 200 ml distilled water) and sterilized pineapple peel. Then the cultures were allowed to acclimatize in the substrate for 20days at room temperature.

Harvesting and Analysis of Nutritional Attributes

After 20 days of solid state fermentation, the cultures were sterilized at 15 psi for one hour and was air dried for seven days. The fungal enriched pineapple peel were pulverized and were analyzed for the crude fiber, crude fat, ash content and moisture content. Percentage reduction and reduction on their nutritional attributes were also computed. The nutritional attributes of the uninoculated pineapple peel served as the initial values for the composition.

Statistical Analysis

Data were analyze using Analysis of Variance. Means were compared by Duncan's Multiple Random Test at 5% level of probability.

RESULTS AND DISCUSSION

Moisture Content

As presented on Table 1, results in moisture content revealed that the untreated pineapple peel had the highest moisture content with 12.6% followed by *A. ochraceus* -treated pineapple of 11.4%. On the other hand, *Fusarium*sp.2- treated pineapple peel had the lowest moisture content of 8.53% followed by *C. cladosporoides,* and *A. flavus*- treated pineapple peelwith 8.76% and 9.26% respectively. Statistical analysis showed that the moisture content of the fungal enriched pineapple peel was significantly lower than the untreated pineapple peel. Meanwhile, for the computed percentage decrease in the moisture content, *Fusarium sp* 2-treated pineapple peel had the highest percentage increase of 32.30%, followed by *C. cladosporioides* of 30.48%, whereas *A. niger*-treated pineapple peel had the least with 9.52%.

Findings favors the report of Santiago et al [14]. Reduction the moisture content of the substrate suggest prolific growth and nutrient assimilation of the fungal endophytes in the substrates. Also, fungal growth favors the nutrients concentration, decreases contamination and may lead to the production of specific compound [15, 16].

Ash Content

Ash content is the total mineral content of any organic material which comprise about 7% of the dry matter of the substrate. It includes potassium, sodium, calcium and magnesium. They play an important role from a physicochemical, technological and nutritional point of view [17].

Cited in Table 2 is the mean percentage of ash content of the fungal enriched pineapple peel. It is very noticeable that the initial ash content of 5.40% increased upon fermentation with the nine fungal endophytes. *C. cladosporioides*- treated pineapple peel registered the highest ash content of 14.5%, seconded by *Fusarium*sp2-treated pineapple peel of 11.8% while *P. citrinum*- treated pineapple peel had the least among the fungal enriched pineapple of 5.94%. For the computed percentage increase, *C. cladosporioides*- treated pineapple peel was able to increase the ash content to 168.52%, followed by *Fusarium* sp 2 of 118.52%. Statistical differences between the computed means were recorded.

Thus, the nine fungal endophytes were able to enhance the ash content of the pineapple peel.

Similar trends in the increment of ash content of the substrates were reported by of Santiagoet al [14] using rice straw, Salvador et al [18] with sugarcane bagasse, and Ganado et al [19] utilizing rice bran after fermentation with the same fungal endophytes. These also coincide with the findings of Souza et al [16], Sanusi et al [20], Adeyemi et al [21] Obizoba and Atti [22] and Obizoba [23]. Finally, results also suggest the biosynthetic or hydrolytic mechanisms of the microorganisms to increase the inorganic mineral elements [21, 24].

Crude Fiber Content

Crude fiber is fibrous food residues or structural carbohydrates such as cellulose and hemicellulose. Fungal endophytes influenced the increase in the percentage crude fiber of the treated pineapple peel (Table 3). *F. semitectum*- treated pineapple peel obtained the highest percentage crude fiber of 15.5%, followed by *A. flavus* and *M.ruber*- treated pineapple peel with 15.4% and 14.8%, respectively. On the other hand, untreated pineapple peel had the lowest crude fiber of 11.9%, followed by *A. ochraceus*- treated pineapple peel with 14.1%. For the percentage increase in crude fiber, *F. semitectum*, had the highest increase of 30.25%, followed by *A. niger* of 29.41%. This coincides with Santiago et al [14] upon fermentation of rice straw and rice bran by Ganado et al [19] with the same fungal endophytes.

Crude Fat Content

Crude fat or ether extract is a crude mixture of fat-soluble material. This include triglycerides, diglycerides, monoglycerides, phospholipids, steroids and free fatty acids. For the crude fat content (Table 4), results showed that the *Fusarium sp.2* contained the highest value of crude fat content which is 1.82% followed by *A. flavus, Fusarium semitectum* and *C. cladosporoides* - treated pineapple peelwith 1.81%, 1.66% and 1.65%. Meanwhile, *A.niger*- treated pineapple peel had the least fat content with 0.957% followed by *Fusarium sp.1, P. citrinum*-treated pineapple peel and untreated pineapple peel with 1.15%, 1.22% and 1.24% respectively. Results indicate a noticeable increase in the fat content treated and untreated pineapple peel except for the *P. citrinum* and *A. niger*- treated pineapple peel wherein they are statistically comparable to the untreated pineapple peel. *Fusarium*sp.2 registered the highest percentage increase of 46.77 followed by *A. flavus* of 45.97%.

Results were also in agreement with Zamora et al [12], Gabres et al [10], Paynor et al [11], Belewu [25] and Oboh and Akindahunsi [26]. This could be attributed to the ability of fungi to transform the carbohydrate to fat and to synthesize microbial oil [26, 27]. Also, some of fungal organisms are lipogenic and are capable to produce lipids in various agro industrial sources [20, 28, 29, 30]. Additionally, this could be due to extensive breakdown of large molecules of fat into simply fatty acids [31, 32].

CONCLUSION

Results clearly demonstrated the enzymatic activities of fungal endophytes enriching the ash content, crude fat and crude fiber content of pineapple peel.

Table 1: Mean percentage (%) moisture content of the fungal enriched pineapple peel

Treatments	Moisture	% decrease in moisture
Control (Uninoculated pine apple peel)	12.6[a]	0.00
Aspergillusflavus-treated pineapple peel	9.26[d]	26.50[c]
Aspergillusniger-treated pineapple peel	10.3[c]	18.25[c]
Aspergillusochraceus-treated pineapple peel	11.4[b]	9.52[d]
Cladosporiumcladosporoides-treated pineapple peel	8.76[e]	30.48[a]
Fusariumsemitectum-treated pineapple peel	9.29[d]	26.27[b]
Fusarium sp.1-treated pineapple peel	10.2[c]	19.05[c]
Fusarium sp.2-treated pineapple peel	8.53[e]	32.30[a]
Monascusruber-treated pineapple peel	10.2[c]	19.05[c]
Penicilliumcitrinum-treated pineapple peel	10.2[c]	19.05[c]

* Treatment means with the same letter are not significantly different

Table 2: Mean percentage (%) ash content of the fungal enriched pineapple peel

Treatments	Ash	% increase in ash
Control (Uninoculated pine apple peel)	5.40[f]	0.00
Aspergillusflavus-treated pineapple peel	6.29[cd]	16.48[cd]
Aspergillusniger-treated pineapple peel	6.04[de]	11.85[de]
Aspergillusochraceus-treated pineapple peel	5.95[e]	10.19[e]
Cladosporiumcladosporoides-treated pineapple peel	14.5[a]	168.52[a]
Fusariumsemitectum-treated pineapple peel	6.32[c]	17.04[c]
Fusarium sp.1-treated pineapple peel	6.08[cde]	12.59[cde]
Fusarium sp.2-treated pineapple peel	11.8[b]	118.52[b]
Monascusruber-treated pineapple peel	6.11[cde]	13.15[cde]
Penicilliumcitrinum-treated pineapple peel	5.94[de]	10.00[de]

* Treatment means with the same letter are not significantly different

Table 3: Mean percentage (%) crude fiber content of the fungal enriched pineapple peel

Treatments	Fiber	% increase in fiber
Control (Uninoculated pine apple peel)	11.9[d]	0.00
Aspergillusflavus-treated pineapple peel	15.4[a]	29.41[a]
Aspergillusniger-treated pineapple peel	14.1[c]	18.49[c]
Aspergillusochraceus-treated pineapple peel	14.1[c]	18.49[c]

***Cladosporiumcladosporoides*-treated pineapple peel**	**14.5^{bc}**	**21.85^{bc}**
***Fusariumsemitectum*-treated pineapple peel**	**15.5^{a}**	**30.25^{a}**
***Fusarium sp.1*-treated pineapple peel**	**14.4^{bc}**	**21.01^{bc}**
***Fusarium sp.2*-treated pineapple peel**	**14.55^{bc}**	**22.27^{bc}**
***Monascusruber*-treated pineapple peel**	**14.8^{b}**	**24.37^{b}**
***Penicilliumcitrinum*-treated pineapple peel**	**14.5^{bc}**	**21.85^{bc}**

*** Treatment means with the same letter are not significantly different**

Table 4: Mean percentage (%) crude fat of the fungal enriched pineapple peel

Treatments	Fat	%Increase Crude Fat
Control (Uninoculated pine apple peel)	**1.24^{dc}**	**0.00**
***Aspergillusflavus*-treated pineapple peel**	**1.81^{a}**	**45.97^{a}**
***Aspergillusniger*-treated pineapple peel**	**0.96^{d}**	**22.58^{d}**
***Aspergillusochraceus*-treated pineapple peel**	**1.54^{abc}**	**19.48^{abc}**
***Cladosporiumcladosporoides*-treated pineapple peel**	**1.65^{ab}**	**33.06^{ab}**
***Fusariumsemitectum*-treated pineapple peel**	**1.66^{ab}**	**33.87^{ab}**
***Fusarium sp.1*-treated pineapple peel**	**1.15^{a}**	**7.26^{a}**
***Fusarium sp.2*-treated pineapple peel**	**1.82^{a}**	**46.77^{a}**
***Monascusruber*-treated pineapple peel**	**1.45^{bc}**	**16.94^{bc}**
***Penicilliumcitrinum*-treated pineapple peel**	**1.23^{dc}**	**0.80^{cd}**

*** Treatment means with the same letter are not significantly different**

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