Significance of *Chaetomium cupreum* for ruminant nutrition improvement through biodegradation

Suphalucksana, Wichai[1] and Soytong, Kasem[2*]

[1]Department of Animal Production Technology, Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang (KMITL), Bangkok 10520, Thailand
[2]Department of Plant Pest Management Technology, Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang (KMITL), Bangkok 10520, Thailand

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Results showed that ascospores of *Chaetomium cupreum* An 102 growing in rice straw and para-grass, the mainly feed for ruminants may possible to develop as biological animal feed for ruminant. The study revealed that sterilized rice straw and para-grass were rapidly degraded by applying the specific strain of *C. cupreum* for one month. The feed composition analyses revealed that *Chaetomium* treated with those organic substances gave the highest potential to degrade cellulose and followed by hemicellulose and crude fibre, respectively, which significantly different when compared to the non-treated one. Moreover, *Chaetomium* treated in sterilized para-grass gave significantly higher nitrogen free extract (NFE) than non-sterilized para-grass which indicated that *C. cupreum* AN102. It is indicated that *C. cupreum* An 102 could be used to improve the ruminant nutrition through biodegradation.

Keywords: *Chaetomium cupreum*, ruminant nutrition, biodegradation

Introduction

Forage crops or roughage are mainly important feed for ruminants. The most of farmers provided forage crops in nature to their animals (Supraraksana and Soytong, 1995). In general, the forage crops have lower quality in the tropic than temperate zone depending on various kinds of forage crop, age and geology (Suksrinygm, 1979). The quantity of fibre in forage crop in tropical zone has higher than temperate zone and the digestibility in the tropic has lower than temperate zone, then it causes a lower production because of different quantity of fibre (Smith *et al*., 1988). The fibre, protein and digestibility reduced in mature forage crop (Moo Yong *et al*., 1983). Although, ruminants are able to utilize roughage because of microorganism produce

*Corresponding author: Kasem Soytong; e-mail: kskasem@kmitl.ac.th

enzymes to digest cellulose and hemicellulose (Wangni, 1985). Moreover, Supraraksana and Soytong (1995) reported that a new strain of *Chaetomium globosum* could act as cellulolytic and lignolytic activities to degrade organic substances. The improvement of roughage quality to highly nutrition value can be introduced by microorganisms that produces enzymes (Wangni, 1985). Thus, the animal could completely utilized the forage crops for their growth. Our research finding is to study the potential of *C. cupreum* An 102 to degrade cellulosic materials in forage crops, to improve the quality of para-grass (*Brachiaria mutica*) and rice straw (*Oryza sativa*) and to investigate the nutrition value changes of treated forage crops with *C. cupreum* An102.

Materials and methods

Culture of *C. cupreum* An 102 was provided from Culture Collection of Biocontrol Research Unit and Mycology Section, Department of Plant Pest Management Technology, Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang (KMITL), Bangkok, Thailand. It was grown in potato dextrose agar (PDA) for 30 days before transfer to cellulosic materials, dried Para-grass and rice straw. The ascospore suspension of 1.5×10^6 spore/ml was adjusted by Haemacytometer under compound microscope. Para-grass and rice straw were put into heat tolerant plastic bags, 500 g for each bag, then sterilized in autoclave for 30 minutes, 15 lbs/inch^2 for 2 consecutive times. The 10 ml of ascospore suspension was transferred into sterilized and non-sterilized of para-grass and rice straw for each treatment, then incubated at room temperature (25^{O}c) and humidity was 60 % for 30 days. Data were collected as nutritive value changes after inoculation the fungus for 30 days and analysed by using proximate analysis (A.O.A.C., 1972), and the fiber analysis was also examined by using Van Soest's Method (Van Soest, 1963). The experiments were designed by using two factor factorial in Completely Randomized Design (CRD) with four replications, both in para-grass and rice straw, which were as follows :-Factor A: A_1 = sterilized cellulosic materials, A_2 = non-sterilized cellulosic materials, Factor B: B_1 = treated with *C. cupreum* An 102, and B_2 = non-treated one. The experiments were repeated two times. Data were then computed analysis of variance, treatment means were compared with Duncan's Multiple Range Test (DMRT) at P=0.05 and P=0.01.

Results and Discussion

Changes in Chemical Composition of Rice Straw

Results showed that the nutritive value of rice straw by proximate analysis which applied *C. cupreum* strain An 102 could improve a quality of rice straw both in sterilized and non-sterilized rice straw which significantly increased in dry matter, protein, fat, fibre, NFE (higher nitrogen free extract), calcium and phosphorus as seen in Table 1. With this, Sterilized rice straw treated with *C. cupreum* gave significantly higher dry matter (93.43%) than the non-treated sterilized rice straw (91.97%) and non-sterilized rice straw treated with *C. cupreum* also gave significantly higher dry matter (90.87%) than non-sterilized rice straw without *C. cupreum* (89.32%). The sterilized rice straw treated with *C. cupreum* gave significantly higher protein (3.07%) than the non-treated sterilized rice straw (3.21%) and non-sterilized rice straw treated with *C. cupreum.* The sterilized rice straw treated with *C. cupreum* also gave significantly higher protein (4.16%) than non-sterilized rice straw without *C. cupreum* (3.91%). The result was similar to the work of Viesturs *et al*. (1981) which stated that *Chaetomium cellulolyticum*, *Trichoderma lignolum* and *Candida lipolytica* treated to rice straw could be increased quantity of protein.

In our study, the sterilized rice straw treated with *C. cupreum* gave significantly higher fat (2.18%) than the non-treated sterilized rice straw (1.35%), but it was not significantly difference in non-sterilized rice straw treated with *C. cupreum* and non-sterilized rice straw without *C. cupreum*. Sterilized rice straw treated with *C. cupreum* gave significantly lower fibre (27.35%) than non-treated sterilized rice straw (38.42%), and non-sterilized rice straw treated with *C. cupreum.*

The sterilized rice straw treated with *C. cupreum* also gave significantly lower fibre (27.50%) than non-sterilized rice straw without *C. cupreum* (30.72%). It was not significantly different in ash percentage in sterilized rice straw treated with *C. cupreum* and non-treated sterilized rice straw, non-sterilized rice straw treated with *C. cupreum* and non-sterilized rice straw without *C. cupreum*. Moreover, the sterilized rice straw treated with *C. cupreum* gave significantly higher NFE (49.00%) than the non-treated sterilized rice straw (37.77%) and non-sterilized rice straw treated with *C. cupreum.* The sterilized rice straw treated with *C. cupreum* also gave significantly higher NFE (42.15%) than sterilized rice straw without *C. cupreum* (38.24%). Sterilized rice straw treated with *C. cupreum* gave significantly lower calcium (0.11%) than the non-treated sterilized rice straw (0.25%), but it was not significantly difference in calcium between non-sterilized rice straw treated with *C. cupreum* (0.21%) and non-sterilized rice straw without *C. cupreum* (0.18%). The work was similar resulted to Supraraksana and Soytong (1992) that applied the mycelia of *Volvarierella volvacea* to improve rice straw for animal feed.

The sterilized rice straw treated with *C. cupreum* gave significantly lower phosphorus (0.01%) than the non-treated sterilized rice straw (0.06%), but it was not significantly difference in calcium between non-sterilized rice straw treated with *C. cupreum* (0.04%) and sterilized rice straw without *C. cupreum* (0.06%). It is observed that there are some factors may not suitable for growth of fungus (*C. cupreum*) inoculated to the tested materials such as pH, moisture and temperature etc. (Smith *et al*., 1988).

The fibre analysis in rice straw using Van Soest had revealed that fibre digestion of rice straw treated with *C. cupreum* gave significantly higher degraded cellulose than lignin as seen in Table 2. It is demonstrated that *C. cupreum* may produce cellulose and ligninase, then released outside cell. As Wangni (1985) stated that the digestion of organic substances such as cellulose, hemicellulose, polysaccharide and other substances usually occur enzymatic production before pass through cell wall to degrade organic materials (Wangni, 1985).

With this, the sterilized rice straw treated with *C. cupreum* gave significantly lower cellulose (9.11%) than the non-treated sterilized rice straw (38.25%) and non-sterilized rice straw treated with *C. cupreum.*

The sterilized rice straw treated with *C. cupreum* also gave significantly lower cellulose (12.91%) than non-sterilized rice straw without *C. cupreum* (32.78%). It revealed that *C. cupreum* could produce cellulose to degrade cellulose in rice straw as similar reported by Soytong (1992) that *C. cupreum* and *C. globosum* had good potential to degrade cellulose.

However, it was not significantly difference in both sterilized and non-sterilized rice straw inoculated with or without *C. cupreum* for NDF, ADF, and hemicellulose in fiber analysis. It revealed that the tested fungus has no potential for NDF, ADF and could not produce hemicellulase.

It was noticed that sterilized rice straw treated with *C. cupreum* gave significantly higher lignin (8.07%) than the non-treated sterilized rice straw (4.4.99%) and non-sterilized rice straw treated with *C. cupreum.* The sterilized rice straw treated with *C. cupreum* also gave significantly lower lignin (7.57%) than non-sterilized rice straw without *C. cupreum* (5.67%). This may be correlated with cellulose chain degradable and remaining lignin in the tested organic materials (Wangni, 1985). Moreover, Soytong and Supraraksana (1994) reported that a new strain of *C. globosum* acts as cellulolytic and lignolytic fungi which possible producing cellulose and ligninase, but in this study revealed that *C. cupreum* was not produced ligninase.

Change in Chemical Composition of Para-Grass

The nutritive value of para-grass applied *C. cupreum* An 102 could improve a quality of para-grass both in sterilized and non-sterilized rice straw treated with *C. cupreum* as seen in Table 3. With this, sterilized para-grass treated with C. cupreum gave significantly higher dry matter (92.76%) than the non-treated sterilized para grass (91.38%) and non-sterilized para grass treated with *C. cupreum*.

The sterilized para-grass treated with *C. cupreum* also gave significantly higher dry matter (89.18%) than non-sterilized para-grass without *C. cupreum* (88.01%). Sterilized para-grass treated with *C. cupreum* gave non-significantly difference in protein (5.69%) when compared to the non-treated sterilized para-grass (5.64%) and non-sterilized para-grass treated with *C. cupreum*.

Sterilized para-grass treated with *C. cupreum* also gave non-significantly in protein (8.93%) when compared to the non-sterilized para grass without C. cupreum (9.21%). According to the work of Viesturs *et al*. (1981) reported that *C. cellulolyticum*, *T. lignolum* and *C. lipolytica* treated to rice straw could be increased quantity of protein.

The work is also similar to Moo-Yong *et al*. (1983) reported that *C. cellulolyticum* could be increased protein in corn cob.

The sterilized para-grass treated with *C. cupreum* gave significantly lower fat (1.31%) than the non-treated sterilized para-grass (2.89%), but it was not significantly difference in non-sterilized para-grass treated with *C. cupreum* and non-sterilized rice straw without *C. cupreum*. This may possible related to the contamination on non-sterilized para-grass.

Sterilized para-grass treated with *C. cupreum* gave significantly lower fibre (25.04%) than non-treated sterilized para-grass (37.52%), and non-sterilized para-grass treated with *C. cupreum*.

Sterilized para-grass treated with *C. cupreum* also gave significantly lower fibre (19.29%) than non-sterilized para-grass without *C. cupreum* (43.22%). It was not significantly different in ash percentage in sterilized para-grass treated with *C. cupreum* and non-treated sterilized para-grass, but it was significantly lower ash percentage of non-sterilized para grass treated with *C. cupreum* (17.34%) than non-sterilized para-grass without *C. cupreum* (17.52%). Sterilized para-grass treated with *C. cupreum* gave significantly higher NFE (50.97%) than the non-treated sterilized para-grass (37.99%) and non-sterilized para-grass treated with *C. cupreum* also gave significantly higher NFE (42.30%) than non-sterilized para-grass without *C. cupreum* (18.09%).

In this study, it was not significant different in calcium percentage of sterilized para-grass treated with *C. cupreum* (0.20%), non-treated sterilized para-grass (0.26%), non-sterilized para-grass treated with *C. cupreum* (0.24%)

and non-sterilized para-grass without *C. cupreum* (0.16%). The result gave different from previous experiment that *C. cupreum* could lower calcium percentage in sterilized rice straw. It was not significantly different in phophorus percentage in sterilized para-grass treated with *C. cupreum*, (0.26%) when compared to the non-treated one (0.21%), but it was significantly difference in phosphorous percentage between non-sterilized para-grass treated with *C. cupreum* (0.34%) when compared to non-sterilized para-grass without *C. cupreum* (0.76%).

The fibre analysis in para-grass demonstrated that the fibre digestion of para-grass treated with *C. cupreum* could degrade cellulose, but not hemicellulose and lignin as seen in Table 4. Sterilized para-grass treated with *C. cupreum* gave significantly lower cellulose (4.11%) than the non-treated sterilized para grass (32.18%) and non-sterilized para grass treated with *C. cupreum*. It was also gave significantly lower cellulose (8.34%) than non-sterilized para grass without *C. cupreum* (27.18%). With this, Soytong (1992) that *C. cupreum* and *C. globosum* may possible to produce cellulose to degrade cellulose. But, it was noticed that sterilized para-grass treated with *C. cupreum* gave non-significantly different in hemicellulose when compared to the non-treated sterilized para-grass, non-sterilized para grass treated with *C. cupreum*, and non-sterilized para-grass without *C. cupreum*.

Sterilized para-grass treated with *C. cupreum* gave non-significantly in lignin percentage when compared to the non-treated sterilized para-grass, but it was significantly higher lignin in non-sterilized para-grass treated with *C. cupreum* (8.18%) than non-sterilized para grass without *C. cupreum* (4.83%). It was also showed the quantity of cellulose could degrade by *C. cupreum*. The cellulose had better degraded than hemicellulose and lignin.

It is explained that *Chaetomium* spp. are cellulolytic fungi that could easily degrade cellulose (Soytong, 1992; Supraraksana, 1997.) However, Suksrinygm (1979) stated that microorganism including fungi and bacteria may possible to release different kinds of enzymes to outside cell for digesting the dead organic substances from crop residue, firstly digesting sugar, some protein, starch, fat, cellulose, hemicellulose and finally lignin which was difficult to digest (Suksrinygm, 1979). From the experiment, *Chaetomium cupreum* An 102 could possible develop to be a biological animal feed for ruminant nutrition as biodegradation. *C. cupreum* An 102 gave high efficiency to improve the nutrition value of para-grass better than rice straw. It was observed that inoculated para-grass gave the highest potential to degrade cellulose and followed by hemicellulose and crude fiber.

Conclusion

It is concluded that the sterilized rice straw and para-grass were rapidly degraded when applying the specific strain of *C. cupreum* for one month. Feed composition analyses revealed that *Chaetomium* treated those organic substances gave the highest potential to degrade cellulose and followed by hemicellulose and crude fibre, respectively, which highly significantly different when compared with the non-treated one. It was not significant different in term of dry matter, ash, fat, crude fibre, crude protein, calcium and phosphorus both in treated with *C. cupreum* and non-treated one. It is indicated that *C. cupreum* may possible to improve for the animal nutrition of ruminants.

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