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Chemical Composition of Spent Mushroom Paddy Straw (SMPS) and its Nutritive Value in Cattle

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ABSTRACT

Backgrounds: An experiment was conducted to study the chemical composition of spent mushroom (*Pleuroyus ostreatus*) paddy straw (SMPS) and its nutritive value in cattle. Samples of the SMPS were collected from various mushroom farms of Assam and were analysed for proximate principles according to the AOAC (2012) and fraction of fibre were estimated according to the Van Soest method (1991).

Methods: Three digestion trials were conducted to evaluate the nutritive value of SMPS (difference method) by using a group of six mature healthy and non-productive cows of approximately same age and similar body weight. In first trial, only para grass was fed to animals, in second trial, para grass along with GNC were fed together and in third trial, SMPS and GNC were fed together to determine the digestibility for various nutrients of the SMPS.

Result: The average chemical composition of SMPS were 42.65±1.33, 76.30±0.40, 7.23±0.24, 1.31±0.06, 21.25±0.76, 23.69±0.49, 46.51±0.57, 62.03±1.18 and 49.26±0.67 per cent of DM, OM, CP, EE, CF, TA, NFE, NDF and ADF, respectively. The DCP and TDN content of SMPS were 4.75 and 59.76 per cent, respectively. From the results obtained, it could be concluded that Spent Mushroom (*Pleurotus ostroeatus*) paddy straw had higher CP and total ash and lower CF and higher nutritive value (DCP and TDN) compared to paddy straw and could be used as a maintenance types of roughage source for feeding to cattle.

Key words: Cattle, Chemical Composition, Nutritive value, *Pleuroyus ostreatus,* Spent mushroom paddy straw.

INTRODUCTION

Spent mushroom substrate is the organic material remaining after a crop of mushrooms has been harvested (Aamlid and Landschoot, 2007). During the year 2021, mushroom production in India is 285 thousand tons with a 6 per cent increase from the previous year production that is 242 thousand tons (ICAR-DMR Annual Report 2021). According to this report, in India, mainly two types of mushrooms are produced which are button mushroom (*Agaricus bisporus*) contributes about 73 per cent followed by oyster mushroom (*Pleurotus ostreatus*) contributes about 16 per cent of total mushroom production in India. Straw is extensively used as bedding materials for cultivation of mushroom (Oei, 2003). After mushroom cultivation, the waste residue is called the spent mushroom substrate.

Fungal cultivation resulted in considerable changes in the spent straw, remaining after mushroom harvesting, leading to increased crude protein and soluble cell wall content which might be more useful than the original straw when fed to ruminants (Langer *et al*., 1982; Durrant *et al*., 1991). Due to its high mycelium content, mushroom waste compost may improve animal health by increasing antioxidant capacity. The enzymes in mushrooms have the ability to degrade readily available agricultural wastes under solid state fermentation. Due to the enzymatic conversion processes that occur during mushroom cultivation, ruminants can easily digest spent mushroom substrate (Adamoviec *et al.,* 1998). Consequently, spent mushroom straw may be an appropriate feed additive for sheep (Fazaeli and Masoodi, 2006) and Holstein steers (Ayala *et al*., 2011). This waste material can be rich in microorganisms and extra-cellular enzymes (Ball and Jackson, 1995) and contain relatively high levels of nitrogen, potassium, phosphorus, calcium and trace elements, notably iron and silicon, (Langar *et al.*, 1980; Burton *et al*., 1994) that may be used as animal feed. It will be viable alternative for the benefit of society by mushroom cultivation as protein rich food source for human beings and spent mushroom straws as alternative food source for animals. There is limited information regarding the chemical composition and nutritive value of spent mushroom paddy straw in animal nutrition. Therefore, present experiment was conducted to evaluate the chemical composition and nutritive value of spent mushroom paddy straw for cattle.

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MATERIALS AND METHODS

The study was conducted at Instructional Livestock Cattle Farm, ILF(C), College Of Veterinary Science, AAU, Khanapara, Assam, India. Spent mushroom paddy straw were collected from various places and the chemical analysis and nutritive value of spent mushroom paddy straw was evaluated. Samples of the spent mushroom paddy straw (SMPS) were collected after 60-70 days of incubation from four different mushroom farms of various places of Assam *i.e.* Mangaldoi, Nalbari, Beltola and Jorabat. There were mainly two types of oyster mushroom which predominantly produced in Assam *i.e. Pleurotus ostroeatus* and *Pleurotus florid*, out of which *Pleurotus ostroeatus* was used in this study.

For feeding trial SMPS were collected from a mushroom farm in Mangaldoi after 2 month of incubation. After collection the SMPS were dried in sunshine to reduce the moisture content to 10% level. For chemical analysis spent mushroom straw was collected and collected samples were analysed for proximate principles. The methods of proximate analysis were done according to the AOAC (2012) and neutral detergent fibre and acid detergent fibre were estimated according to the Van Soest method (1991).

The nutritive value of the spent mushroom (*Pleurotus ostroeatus)* paddy straw was determined by difference method. Three digestion trials were conducted to evaluate DCP and TDN values of the spent mushroom paddy straw. The experiment was carried out for a period of 66 days from 27th April to 30th June, 2022 in the Instructional Livestock Cattle Farm, ILF(C), College of Veterinary Science, AAU, Khanapara.

Digestion trials were conducted using a group of six mature healthy and non-productive cows of approximately same age and similar body weight. Daily feed intake and faeces voided for each cattle were recorded and representative samples for feeds and faeces were processed and preserved for proximate analysis. Initial and final body weight of each animal was recorded for the experimental period.

In first trial, para grass was fed for a period of 15 days followed by collection period of 7 days and digestibility of various nutrients were determined. In second trial, para grass along with ground nut cake (GNC) were fed together for the same period to determine the digestibility of GNC by difference method. In third trial, GNC was fed along with SMPS for a period of 15 days followed by collection period of 7 days and the digestibility for various nutrients of the SMPS was determined by difference methods. During this period, proper record of feed offered and residue left were recorded on a daily basis. Daily faeces voided by each animal were also recorded. Feed, residue and faecal samples were oven dried, ground and stored for further analysis for proximate principles (AOAC, 2012). Nutrient digestibility was calculated by applying the following formula:

$$\text{Nutrient digestibility (\%)} = \frac{\text{Nutrient intake in feed-Nutrient loss in faeces}}{\text{Nutrient intake in feed}} \times 100$$

TDN value was calculated by using the following formula:

$$\text{TDN (\%)} = \text{Digestible CP} + \text{Digestible CF} + \text{Digestible NFE} + (\text{Digestible EE} \times 2.25)$$

The experimental data was statistically analysed by using SPSS (Statistical Package for Social Science, version 20, Chicago, USA). For data analysis both way ANOVA were used.

RESULTS AND DISCUSSION

Collection and chemical analysis of spent mushroom paddy straw

Samples of the Spent mushroom (*Pleurotus ostreatus*) paddy straws were collected from different places of Assam and chemical compositions were analyzed and has been presented in Table 1. The dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fibre (CF), total ash (TA), nitrogen free extract (NFE), neutral detergent fibre (NDF) and acid detergent fibre (ADF) content of the spent mushroom paddy straw (SMPS) ranged from 38.36 to 46.23 per cent, 74.57 to 77.86 per cent, 6.94 to 7.69 per cent, 1.13 to 1.45 per cent,

Table 1: Chemical analysis of spent mushroom paddy straw from various places of Assam (% DM basis).

Attributes	Spent mushroom paddy straw				Averag value
	Mangaldoi	Nalbari	Beltola	Jorabat	
Dry matter	46.23±1.85	43.76±1.23	38.36±1.56	42.30±0.76	42.65±1.33
Organic matter	77.35±0.59	74.57±0.26	77.86±0.62	75.47±0.22	76.32±0.40
Crude protein	7.69±0.28	7.23±0.16	6.94±0.23	7.06±0.37	7.23±0.24
Ether extract	1.41±0.09	1.24±0.02	1.13±0.05	1.45±0.08	1.31±0.06
Crude fibre	19.96±0.89	21.36±0.74	22.76±0.59	20.95±0.96	21.25±0.76
Total ash	22.65±0.59	25.43±0.33	22.14±0.77	24.53±0.45	23.69±0.49
NFE	48.29±0.67	44.74±0.71	47.03±0.53	46.01±0.38	46.51±0.57
NDF	61.63±1.56	63.53±0.86	62.22±1.28	60.76±1.11	62.03±1.18
ADF	48.16±0.70	50.12±0.39	50.66±0.76	48.13±0.92	49.26±0.67

19.96 to 22.76 per cent, 22.14 to 25.43 per cent, 44.74 to 48.29 per cent, 60.76 to 63.53 and 48.13 to 50.66 with the average value of 42.65, 76.32, 7.23, 1.31, 21.25, 23.69, 46.51, 62.03 and 49.26 per cent respectively. The average value of dry matter from SMPS was 42.65±1.33 per cent. Similar findings were reported by Chang *et al.* (2016) who reported that Spent Mushroom compost (*Pleurotus ostreatus*) contain approximately 48.60 per cent dry matter. Kim *et al.* (2007) and Baek *et al.* (2017) also reported 38.70 per cent and 38.00 per cent of DM content of SMS respectively.

The average organic matter (OM) of SMPS was 76.32±0.40 per cent. The reduced OM of SMPS might be due to increase in the total ash content compared to paddy straw. In agreement with this study, Kholif *et al.* (2014) reported that spent *Pleurotus ostreatus* mushroom rice straw had 70.89 per cent organic matter. Similarly, Bakshi and Langar (1991), Fazaeli and Masoodi (2006) and Fazaeli *et al.* (2014) reported significantly lower organic matter in spent mushroom straw (SMS) compared with normal straw. In contrary, Fazaeli *et al.* (2002) reported SMS contained 92.6 per cent organic matter. The average crude protein (CP) value of SMPS of the present study was 7.23±0.24 per cent. The increased CP per centage compared to paddy straw could be due to impact of mycelium activity during mushroom cultivation or might be due to addition of nitrogenous substance and increase in microbial and fungal biomass during the whole fermentation process (Konko *et al.,* 2001; Kaul and Dhar, 2007). The results were in accordance with the findings of Kim *et al.* (2007) and Baek *et al.* (2017) who reported SMS contained approximately 7.80 per cent and 7.90 per cent CP respectively. Similarly, Bakshi and Langar (1991), Fazaeli *et al.* (2002), Deshmukh, A.S. (2019) and Fan *et al.* (2022) also reported significant increase in CP per cent in spent mushroom straw compared to untreated straw. The CP content of collected samples of SMPS of the present experiment were almost similar. The average ether extract (EE) of SMPS was 1.31±0.06 per cent. In agreement with this value, Bakshi and Langar (1991) reported 1.26 per cent EE, Kim *et al.* (2007) reported 2.1 per cent EE, Baek *et al.* (2017) reported 0.80 per cent EE and Fan *et al.* (2022) reported 0.80 per cent EE in spent mushroom substrate. The average value of crude fibre (CF) from SMPS was 21.25±0.76 per cent. The CF content of SMPS was lower than the value of paddy straw (31.48±1.18%) which might be due to the presence of cellular ligninolytic enzymes (lignin peroxidase, manganese peroxidase) and cullulolytic enzymes (cellulases) which might be responsible for the breakdown of lingo-cellulose bond during fermentation. This result showed a similar trend with the results of Baek *et al.* (2017) who reported 24.20 per cent crude fiber in spent mushroom straw. Significant reduction of CF in SMS was also reported by Bakshi and Langar (1991), Fazaeli and Masoodi (2006), Fazaeli *et al.* (2014) and Deshmukh, A.S. (2019) compared with normal straw. The average total ash (TA) value of SMPS of the present study was 23.69±0.49 per cent. The increased TA of SMPS as compared to paddy straw (16.53±0.89%) might be due to the depletion of organic matter of straw by the mushroom fungi (Martinez *et al.,* 2005). Similar findings were reported by Fazaeli and Masoodi (2006) and Fazaeli *et al.* (2014) who reported increased TA content in SMS compared to the straw. In contrary, Fazaeli *et al.* (2002) and Baek *et al.* (2017) reported 7.40 per cent and 4.40 per cent TA in SMS respectively. The average value of nitrogen free extract (NFE) of SMPS was 46.51 ± 0.57 per cent. Bakshi and Langar (1991) and Fazaeli *et al.* (2014) reported significantly lower NFE in spent mushroom straw (SMS) compared with normal straw. In contrary, Baek *et al.* (2017) reported 63.30 per cent NFE in spent mushroom (*Pleurotus ostreatus*) inoculated straw. The average concentration of neutral detergent fibre (NDF) and acid detergent fibre (ADF) in SMPS were 62.03±1.18 and 49.26±0.67 per cent. Decreased value of NDF and ADF in SMPS could be due to decrease in the organic matter during fermentation process and increased in the TA content. The results showed a similar trend with the results of Fan *et al.* (2022) who reported NDF and ADF value of SMS as 60.29 per cent and 52.30 per cent, respectively. Similarly, Bakshi and Langar (1991), Fazaeli *et al.* (2002), Fazaeli *et al.* (2014) and Baek *et al.* (2017) reported significant lowered NDF and ADF value of SMS compared to the untreated straw.

Paddy straw contained 87.30±1.79, 83.47±0.90, 3.04±0.19, 0.96±0.06, 31.48±1.18, 16.53±0.89, 47.99±0.86, 73.48±1.64 and 52.66±1.73 per cent DM, OM, CP, EE, CF, TA, NFE, NDF and ADF, respectively. SMPS contained 42.65±1.33, 77.18±0.88, 7.23±0.24, 1.11±0.08, 21.36±0.66, 22.82±0.89, 47.48±0.67, 61.44±1.85 and 50.23±1.27 per cent DM, OM, CP, EE, CF, TA, NFE, NDF and ADF, respectively.

Evaluation of nutritive value of spent mushroom paddy straw in cattle

The nutritive value of the spent mushroom (*Pleurotus ostreatus*) paddy straw was determined by difference method conducting three digestion trials and reported (Table 2).

Table 2: Digestibility of nutrients (%).

Feeds	Dry matter	Crude protein	Crude fibre	Ether extract	Nitrogen free extract
Para grass	74.58±1.18	66.14±1.06	64.66±1.43	87.73±1.39	76.52±1.22
GNC	76.66±0.89	87.50±1.23	60.01±1.02	87.14±0.63	79.25±1.07
SMPS	70.75±1.94	61.76±0.91	71.87±1.02	74.01±1.33	79.36±1.33
			DCP of SMPS= 4.75%		
			TDN of SMPS= 59.76%		

The digestibility of different nutrients of para grass as DM, CP, CF, EE and NFE were 74.58±1.18, 66.14±1.06, 64.66±1.43, 87.73±1.39 and 76.52±1.22 per cent, respectively.

The digestibility of different nutrients of ground nut cake (GNC) obtained in second trial were 76.66±0.89, 87.50±1.23, 60.01±1.02, 87.14±0.63 and 79.25±1.07 per cent, for DM, CP, CF, EE and NFE, respectively.

The digestibility coefficient of DM, CP, CF, EE and NFE for SMPS obtained in the third trial were 70.75±1.94, 61.76±0.91, 71.87±1.02, 74.01±1.33and 79.36±1.33 per cent, respectively.

The digestible crude protein (DCP) and total digestible nutrient (TDN) value of SMPS was 4.75±0.11 and 59.76 per cent, respectively.

The DCP values are lower and TDN values are higher than reported by Bakshi and Langar (1985) who reported 6.08 per cent DCP and 55 per cent TDN of spent mushroom wheat straw. The lower value of DCP and higher value of TDN observed in the present experiment might be due to the variation of the species of mushroom as well as straw used.

CONCLUSION

From the results obtained, it could be concluded that Spent Mushroom (*Pleurotus ostroeatus*) paddy straw had higher CP and total ash and lower CF and higher nutritive value (DCP and TDN) compared to paddy straw and could be used as a maintenance types of roughage source for feeding to cattle.

Conflict of interest

All authors declare that they have no conflict of interest.

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