In vitro acid detergent fibre (ADF) disappearance of brewery waste incorporated paddy straw in RUSITEC

S Senthilkumar

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Abstract
An in vitro experiment was conducted to study the in vitro ADF disappearance of the following seven experimental feeds such as 1) Control feed; 2) Experimental feed (75%) + Fresh brewery waste (25%) (EFFBW); 3) Experimental feed (75%) + Dried brewery waste (25%) (EFDBW); 4) Fresh brewery waste (FBW); 5) Dried brewery waste (DBW); 6) Paddy straw (PS) and 7) Brewery waste incorporated paddy straw (BWIPS) incubated for 2, 6, 12, 24, 48 and 72 hours in Rumen Simulation Technique (RUSITEC). During initial incubation periods (2, 6, 12 and 24 hours), the control feed, EFFBW, EFDBW and FBW showed higher in vitro ADF disappearance than other experimental feeds, whereas, during later incubation periods (48 and 72 hours), the DBW, paddy straw and BWIPS showed higher in vitro ADF disappearance than other experimental feeds incubated in RUSITEC. Among the feeds experimented in RUSITEC, disappearance was more in the control feed, EFFBW and EFDBW when compared to other experimental feeds. Similarly, the disappearance was more in BWIPS compared to paddy straw. The in vitro ADF disappearance rates at all incubation periods were higher for FBW than those for DBW.

Keywords: Brewery waste, paddy straw, ADF disappearance, in vitro, RUSITEC

Introduction
Brewery waste is a by product of ethanol industry which uses cereal grains as feed stock. Distiller’s grain has a moderate content of protein and high level of crude fibre which make it an attractive ingredient to be used in ruminant feed (Rasco et al., 1989). Among the various cereal crop residues, paddy straw (Oryza sativa) is the main roughage source for majority of cattle and buffaloes reared in Indian small holdings. However, the nutrient digestibility of straw is very poor. Knowledge on disappearance / degradability of brewery waste incorporated with paddy straw would throw more light on its usefulness and would help to formulate complete feed for dairy cattle. The present study was undertaken to evaluate the in vitro ADF disappearance of brewery waste incorporated paddy straw based feeds using Rumen Simulation Technique (RUSITEC).

Materials and methods
Per cent ingredient composition of the control and experimental concentrate mixtures used are presented in Table 1. The Dry matter (DM) composition of Control feed, Experimental feed, Brewery waste, Paddy straw and Brewery waste incorporated paddy straw were carried out as per standard procedure (AOAC, 1990) and was 95.15 ± 0.56, 94.76 ± 0.26, 90.35 ± 0.81 and 78.11 ± 0.63 per cent, respectively. The ADF content of Control feed, Experimental feed, Brewery waste, Paddy straw and Brewery waste incorporated paddy straw was carried out as per AOAC (1990).

The in vitro ADF disappearance of seven experimental feeds such as control feed, experimental feed with fresh brewery waste (EFFBW), experimental feed with dried brewery waste (EFDBW), fresh brewery waste (FBW), dried brewery waste (DBW), paddy straw (PS) and brewery waste incorporated paddy straw for 3 days (BWIPS) was determined using the rumen simulation technique (RUSITEC) described by Czerkawski and Breckenridge (1977). The in vitro ADF disappearance of experimental feeds was studied at 0, 2, 6, 12, 24, 48 and 72 hours of incubation in RUSITEC and the experiment was replicated. Each RUSITEC experiment totally consisted of 7 days adaptation period followed by collection period.
Loss in weight of nylon bag after 0, 2, 6, 12, 24, 48 and 72 hours of incubation in RUSITEC followed by washing and drying was recorded to calculate in vitro ADF disappearance.

$$\text{In vitro ADF disappearance} = \frac{\text{(weight of bag with ADF before incubation) - (weight of bag with ADF after incubation)}}{\text{weight of sample}} \times 100$$

The data were analyzed statistically as per the standard statistical methods given by Snedecor and Cochran (1994) \[15\].

### Table 1: Per cent ingredient composition of the control and experimental concentrate mixtures used

| Ingredient      | Concentrate mixture (%) |
|-----------------|-------------------------|
|                 | Control | Experimental |
| Yellow Maize    | 37.00   | 40.00        |
| Groundnut Cake  | 29.00   | 21.50        |
| Wheat bran      | 30.50   | 10.00        |
| Brewery waste   | 0.00    | 25.00        |
| Mineral Mixture*| 1.00    | 1.00         |
| Salt            | 1.00    | 1.00         |
| Shell Grit      | 1.50    | 1.50         |

To every 100 kg of concentrate mixture 20 grams of Nicomix AB-D.K (Nicholas Piramal India Ltd, Mumbai) containing Vitamin A-82500 IU, Vitamin D3-12000 IU, Vitamin B2-50 mg, Vitamin K-10 mg per gram was added.

*Mineral mixture supplied by Kerala Feeds Ltd. Kerala, containing Calcium (minimum) 20 per cent, Phosphorus (minimum) 12 per cent, Magnesium (minimum) 5 per cent, Iron (minimum) 0.4 per cent, Copper (minimum) 0.1 per cent, Zinc (minimum) 0.8 per cent, Manganese (minimum) 0.12 per cent, Cobalt (minimum) 0.012 per cent, Iodine (minimum) 0.026 per cent, Sulphur 1.8-3 per cent, Arsenic (maximum) 7 ppm, Lead (maximum) 20 ppm and Fluorine (maximum) 0.07 per cent.

### Results and discussion

The ADF content of paddy straw, brewery waste and brewery waste incorporated paddy straw was 48.57 ± 0.87, 24.68 ± 0.92 and 42.60 ± 0.84 per cent, respectively on DM basis. The ADF content of brewery waste obtained in the present study is higher when compared to an average of 20 per cent as reported by Murdock et al. (1981), Davis et al. (1983), Rogers et al. (1986) and Depeters et al. (1997) \[9, 4, 12, 5\]. However, Dhiman et al. (2003) \[6\] reported higher ADF value of 27.7 per cent and Dong and Ogle (2003) \[7\] reported lower value of 17.5 per cent in brewery waste. The ADF content of Control feed, Experimental feed, Brewery waste, Paddy straw and Brewery waste incorporated paddy straw was 10.52 ± 0.23, 13.68 ± 0.57, 24.68 ± 0.92, 48.57 ± 0.87 and 42.60 ± 0.84 per cent, respectively on dry matter basis.

### Table 2: In vitro Acid Detergent Fibre (ADF) disappearance of experimental feeds at different incubation periods (h) in Rusitec, %

| Treatments                                | ADF Disappearance, % | 0h | 2h | 6h | 12h | 24h | 48h | 72h |
|-------------------------------------------|----------------------|----|----|----|-----|-----|-----|-----|
| Control feed                              |                      | 12.56 | 20.34 | 28.97 | 37.18 | 41.76 | 48.29 | 53.02 |
| Experimental feed with fresh brewery waste (25%) |                      | 10.81 | 15.46 | 22.39 | 29.06 | 37.55 | 48.99 | 51.87 |
| Experimental feed with dried brewery waste (25%) |                      | 9.70 | 14.81 | 20.71 | 27.82 | 32.89 | 48.31 | 51.09 |
| Brewery waste (fresh)                     |                      | 9.43 | 13.95 | 20.54 | 27.85 | 34.43 | 43.72 | 45.52 |
| Brewery waste (dried)                     |                      | 8.57 | 12.67 | 18.45 | 24.95 | 31.42 | 41.54 | 43.76 |
| Paddy straw                              |                      | 8.27 | 11.45 | 16.34 | 20.56 | 26.75 | 32.92 | 35.28 |
| Brewery waste incorporated paddy straw   |                      | 9.16 | 13.24 | 19.00 | 25.40 | 33.28 | 37.97 | 39.69 |

The ADF content of paddy straw, brewery waste and brewery waste incorporated paddy straw was 48.57 ± 0.87, 24.68 ± 0.92 and 42.60 ± 0.84 per cent, respectively on DM basis. The ADF content of brewery waste obtained in the present study is higher when compared to an average of 20 per cent as reported by Murdock et al. (1981), Davis et al. (1983), Rogers et al. (1986) and Depeters et al. (1997) \[9, 4, 12, 5\]. However, Dhiman et al. (2003) \[6\] reported higher ADF value of 27.7 per cent and Dong and Ogle (2003) \[7\] reported lower value of 17.5 per cent in brewery waste. The ADF content of Control feed, Experimental feed, Brewery waste, Paddy straw and Brewery waste incorporated paddy straw was 10.52 ± 0.23, 13.68 ± 0.57, 24.68 ± 0.92, 48.57 ± 0.87 and 42.60 ± 0.84 per cent, respectively on dry matter basis.

### Table 2: In vitro Acid Detergent Fibre (ADF) disappearance of experimental feeds at different incubation periods (h) in RUSITEC, %

In vitro ADF Disappearance

The percentage in vitro disappearance of ADF of control feed, experimental feed with fresh brewery waste (EFFBW), experimental feed with dried brewery waste (EFDBW), fresh brewery waste (FBW), dried brewery waste (DBW), paddy straw (PS) and brewery waste incorporated paddy straw (BWIPS) incubated for 0, 2, 6, 12, 24, 48 and 72 hours in RUSITEC are given in Table 2 and is illustrated in Fig.1. The in vitro ADF disappearance of experimental feeds such as control feed, EFFBW, EFDBW, FBW, DBW, PS and BWIPS at 2 hours of incubation in RUSITEC was 20.34, 15.46, 14.81, 13.95, 12.67, 11.45 and 13.24 per cent, respectively. The ADF disappearance at 24 hours incubation period was 41.76, 35.55, 32.89, 34.43, 31.42, 26.75 and 33.28 per cent for...
control feed, EFBW, EFDBW, FBW, DBW, PS and BWIPS, respectively. 
During 72 hours of incubation, 53.02, 51.87, 51.09, 45.52, 43.76, 35.28 and 39.69 per cent ADF disappeared from control feed, EFBW, EFDBW, FBW, DBW, PS and BWIPS, respectively. Ojowi et al. (1997) [10] reported in situ effective degradability of ADF for wet brewer’s grain and wet distiller’s grain distiller’s grain as 27.5 and 31.9 per cent, respectively. Addition of cationomycin (Ionophore) to fescue hay based pelleted diet showed increased in vitro (RUSITEC) NDF, ADF, hemicellulose and cellulose degradability (Bogaert et al., 1989) [2]. Significant improvement was observed in the in vitro (RUSITEC) NDF and ADF degradability of Vigna unguiculata when mixed with a tropical grass Brachiaria humidicola, compared to those with Leucaena leucocephala (Hess et al., 2007) [3]. Sliwinski et al. (2002) [14] found no significant difference in the 48 hour in vitro (RUSITEC) NDF, ADF and hemicellulose degradability of basal diet (containing grass silage, barley grain and grass hay) compared to those with soyabean meal based diet. The in vitro ADF disappearance values of paddy straw obtained in the present RUSITEC experiment (35.28 per cent) is in agreement with Senthilkumar et al. (2007) [13] who reported the in vitro ADF disappearance of 35.61 per cent.

Summary
Among the feeds experimented in RUSITEC, disappearance of ADF was more in the control feed, EFBW and EFDBW when compared to other experimental feeds. Similarly, the ADF disappearance was more in BWIPS compared to paddy straw. The in vitro ADF disappearance at all incubation periods was higher for FBW than the DBW. The FBW had more ADF disappearance compared to DBW. A low in vitro ADF disappearance of 35.28 per cent was recorded at 72 hours of incubation for paddy straw, whereas the BWIPS had improved in vitro ADF disappearance of 39.69 per cent at 72 hours of incubation.

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