Research Article

Preparation and Evaluation of Cattle Feed by Ensiling Wet Rice Straw, Market Fish Waste and Molasses

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Abstract | The research was intended to produce cattle feed with wet rice straw processed with market fish wastes (MFW) and fermented with 5% molasses to enhance the storage quality and nutrients of rice straw. Feeds were placed in plastic drums and sealed properly. The preparation was completed under room temperature following T_0 (0% MFW), T_1 (5% MFW), T_2 (10% MFW), and T_3 (15% MFW) to examine the physical qualities, metabolizable Energy (ME), in vitro organic matter digestibility (OMD) and other nutritional properties, at different intervals (0, 30, 45, and 60 days). The organoleptic and physical characteristics (smell, color, and hardness) of feeds were improved in treatments with market fish wastes up to 60 days but after 45 days, in T_3, fungi and some bad smells were obtained. The pH, dry matter (DM), crude fiber (CF) were reduced and the crude protein (CP), ether extract (EE), ash, ME, OMD were elevated significantly with MFW and ensiling time ($P<0.05$). Comparing the parameters, T_2 and T_3 were preferable to prepare silages as cattle feed. Finally, it can be summed up that market fish waste is a valuable resource for the preservation of rice straw which provides farmers with cheap and environmentally friendly cattle feed.

Keywords | Environmental pollution, Silage, Metabolizable energy, Organic matter digestibility, Physical properties

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INTRODUCTION

Bangladesh is currently placed 2nd in freshwater fish production and 5th in fish culture worldwide. In 2017-18, the fish production totaled 4.27 million metric tons (MMT) and it contributed 3.57% to the national GDP and 25.30% to the agricultural GDP, and 1.5% to the foreign exchange income through the export of fish and fish products (DoF, 2019). More than 50% of the production heals from sea fishing. Around 70% of fish is fully or partially processed before selling, resulting in 20-80% of fish wastes varying according to fish type and processing level (FAO, 2018).

Fish is an animal source protein that is purchased and consumed in a great quantity by all classes of people but the produced fish wastes in markets and households are disposed of randomly here and there, sometimes in nearby drains or open dustbins, mainly rivers or ponds, by the roadsides, etc. The aerobic bacteria present in the water body causes organic matter breakdown, leading to a considerable reduction of oxygen in the water. There are also the overloads of phosphorous, nitrogen, and ammonia, which lower the pH, increase water turbidity, resulting in algae decomposition in the water (Ghaly et al., 2013). The decline of O_2 in water creates an anaerobic state that releases some foul gases such as organic acids, ammonia, hydrogen sulfide, and greenhouse gases such as methane and carbon dioxide. These produced gases are directly responsible for the air pollution and global warming that are threatening our very existence. Moreover, the wastes are hazardous to other environmental elements like water, and soil. These spread and transmit diseases to animals, humans, and even birds (Tchoukanova et al., 2003). Among all factors, aimed at minimizing pollution, proper disposal of fish wastes is becoming a new challenge. Fish wastes can be disposed of in many ways but one of the most efficient and easiest solutions to this problem is to use the waste for livestock feeding by ensiling it with poor quality roughage. As we know, many animals in Bangladesh suffer from a shortage of feeds in both quality and quantity. The roughage and concentrate available in Bangladesh can only cover 50% and 10%, of the feed requirement in the livestock sector (Haque et al., 2007). On the other hand, fish waste contains 1% crude fiber, 58% crude protein, 22% ash, and 19% ether extract (Esteban et al., 2007). In this context, the proper use of market fish wastes as livestock feed is an efficient solution as the nutrient contents in market fish wastes are higher.

Rice straw is considered a negligible by-product after the rice harvests as it is low in protein. Our farmers feed their buffalo and cattle rice straw as the sole feed throughout the year (Islam and Khan, 2021). It consists predominantly of cell walls, comprising of hemicellulose, lignin, and cellulose which is only poorly digestible by animals (Oladosu et al., 2016; Binod et al., 2010). The biological treatment can improve its digestibility and quality by enhancing its protein level (Malik et al., 2015). Ensiling of rice straw together with fish waste and molasses can produce high-quality silage with the desired palatability, nutritional contents, and digestibility through the production of lactic acid bacteria (Yitbarek and Tamir, 2014).

Silage processing with fish wastes, rice straw, and molasses for cattle feed has not yet been carried out in Bangladesh. Since fish wastes are widely available in Bangladesh, there is an opportunity to utilize fish waste for ensiling rice straw with molasses, which can increase crude protein and other nutritional values of the diet and also reduce the environmental hazards. Therefore, the experiment was conducted to determine the nutritional values of silages and to find out the optimal amount of fish waste for the preparation of inexpensive good quality silage.

MATERIALS AND METHODS

Experimental Location

The experiment was undertaken in the Goat and Sheep farm, Department of Animal Science, Bangladesh Agricultural University, Mymensingh from December 21, 2020 to February 22, 2021. The laboratory analysis of the silage was completed in the Animal Nutrition and Animal Science laboratory under the Department of Animal Nutrition and Animal Science, respectively, Bangladesh Agricultural University, Mymensingh.

Collection And Preparation Of Materials

Market fish wastes were collected from nearby fish markets, Bangladesh Agricultural University (BAU), and rice straw was received from Agronomy Field, BAU. Molasses and plastic drums (size 30L) were purchased from the local dye market and labeled for different treatments.

Rice straws were sun-dried and ground to pass through a 40 mm mesh screen. Market fish wastes were blended properly. Fresh samples of market fish wastes and rice straw were then assigned for the analysis of dry matter (DM), crude fiber (CF), crude protein (CP), ether extract (EE), and total ash (TA) following AOAC (2004) (Table 1).

Table 1: Chemical composition of market fish wastes and rice straw

Chemical composition (g/100 g DM)	Ingredients	
	Market fish wastes	Rice straw
DM (Fresh basis)	37.91	89.31
CP	15.20	3.01
CF	15.21	31.84
EE	4.03	4.47
NFE	0.38	30.50
Ash	3.30	18.22

Experimental Design And Treatments

A 4×4 Factorial Design with 3 replications for individual treatment was performed. The treatments followed under the study based on DM were: T_0 = 0% market fish wastes+ 95% rice straw+ 5% molasses, T_1 = 5% market fish wastes+ 90% rice straw+ 5% molasses, T_2 = 10% market fish wastes+ 85% rice straw+ 5% molasses, T_3 = 15% market fish wastes+ 80% rice straw+ 5% molasses

Silage Preparation

Rice straws were crushed to a size of 2cm and market fish wastes were blended with help of a blender. Then silage was prepared by mixing molasses with blended fish wastes and then with rice straw according to the treatment. Rice straw, market fish wastes, and molasses were properly mixed by hand. The mixed materials were placed in the designated sealed plastic drums according to the treatment number. These plastic drums were finally stored in a clean room for 60-day for successful ensiling.

Observation Of Physical Parameters Of Silages

The samplings were done at 0, 30, 45, and 60-day in order to observe the physical characteristics of silages. The texture (hardness), color, and smell of samples were investigated and recorded properly. Cattle acceptance of silages were also tested to follow up the palatability. The procedures of determining the physical attributes of the sample were conducted according to the Haque et al. (2022), Ritu et al. (2021), Sarkar et al. (2018) and Sultana et al. (2020). At least 3 students were the panelists who assessed the parameters.

PH Determination And Proximate Analysis

For pH, 2-gram of silage sample was removed from each treatment, followed by the addition of 50 ml of distilled water and mixed thoroughly with vigorous stirring. The extracts were collected through the filter papers and the pH of the silage samples was determined with a laboratory pH meter (ino Lab, Germany). The dry samples were assigned to determine proximate components such as dry matter (DM), ash, crude fiber (CF), crude protein (CP), and ether extract (EE), following AOAC (2004). ME and IVOMD of silages were completed according to Menke et al. (1979).

Statistical Analysis

The statistical model for this experiment was:

$Y_{ijk} = \mu + A_i + B_j + (AB)_{ij} + \varepsilon_{ijk}$ i = 1….a; j = 1…b; k = 1…n

Where, Yijk = Observation k in level i of factor A and level j of factor B, μ = the overall mean, Ai = the effect of level i of factor A, Bj = the effect of level j of factor B

The data were analyzed with SAS Software, North Carolina State, USA, and the differences among the means of the treatments were determined by Duncan's Multiple Range Test (DMRT) with 5% significance level.

RESULTS AND DISCUSSION

Physical Parameters And Ph Of Silage

The physical characteristics of silages are presented in Table 2. After 60-day of ensiling, the straw color, the light brownish, and the brown color of silages were observed. The color has been enhanced by adding market fish wastes in rice straws. All treatments had good silage color in different ensiling periods. Among the treatments, T_1 and T_2 had a vinegar-like pleasant odor and T_3 had a pungent taste after 60 days of ensiling. A pleasant aroma and color were obtained in the ensiling fish wastes (Gullu et al., 2015). The color of silages differs from light green to light brown color depending on silage materials but a black color is not preferable (Toruk and Gonulol, 2011). After silage has been processed, silage appears brownish in color and dry in appearance (Kung et al., 2018). When ensiling, sugars and proteins bind and react at high temperatures, and O_2 traps in the silage materials to stimulate the respiration and the metabolic activity of aerobic microorganisms and to produce heat. In this process, the smell is rather slightly vinegar, which is highly desirable in the final silage (Kung et al., 2018). In this study, market fish wastes and molasses were the elements of protein and sugar that bind and react with each other, resulting in the formation of a vinegar-like smell, the most desirable and pleasant odor in silage production.

All treatments softened after 60-day of ensiling and fungus multiplication was only observed in T_3 after 45-day of ensiling. The softness in silage materials happens due to the digestion of ingredients by producing the lactic acid bacteria in silage (Kung et al., 2018). Aerobically unstable silages may also present a moldy or musty smell and may have visible mold and fungal growth. Moldy or fungal silage should be discarded because it could be contaminated with mycotoxins (Kung et al., 2018).

The pH is shown in Figure 1. After ensiling, T_3 had the minimum pH followed by T_2, T_1 and T_0 and they showed significant differences ($p<0.05$) among them. The reason for reducing pH in silage was to add market fish wastes and molasses as silage materials. The lower the pH in silage indicates good fermentation quality due to the presence of water-soluble carbohydrates and protein which enhance the production of lactic acid bacteria (Kung et al., 2018). Borreani et al. (2018) indicated that silage should reach a pH of 4.3 to 4.7.

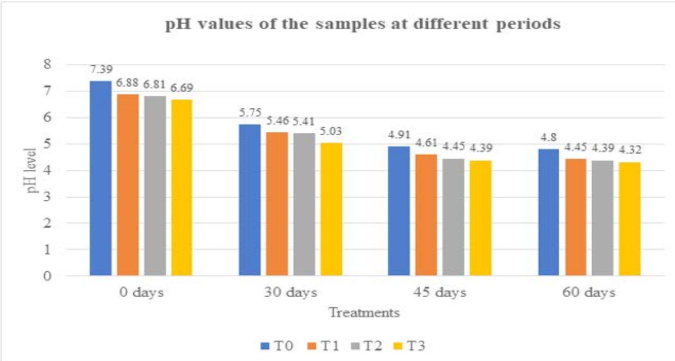

Figure 1: pH values of the samples at different periods

Nutritional Evaluation Of Silage

Dry Matter

The dry matters of silages are shown in Table 3. The dry matter (DM) varies significantly ($p<0.05$) with the treatments and decreases with the increase in ensiling time from 0 to 60 days. The DM was minimal in T_3 followed by T_2, T_1, and T_0. The reason for the decrease in DM in the study may be in the decomposition and fermentation process. Man and Wiktorson (2003) found a similar result where DM was lessened from 28.0% to 26.4%, after 4 months ensiling. Furthermore, DM losses may arise from oxidation, runoff, and evaporation of volatile compounds (Borreani et al., 2018).

Crude Protein

The crude Proteins (CP) of silages are shown in Table 4. The highest (17.95%) and the lowest (6.68%) CP were observed in T_3 and T_0, respectively. The CP levels improved

Table 2: Physical parameters of silages at different treatments and ensiling period

Characteristics	Observation	Treatment T_0	T_1	T_2	T_3
Color	0 Day	Straw color	Straw color	Light Brown	Light Brown
	30 Days	Light Brown	Light Brown	Brown	Brown
	45 Days	Light Brown	Brown	Brown	Brown
	60 Days	Brown	Brown	Dark Brown	Dark Brown
Smell	0 Day	Straw	Straw	Fish	Fish
	30 Days	Straw	Straw	Vinegary	Vinegary
	45 Days	Straw	Light vinegary	Vinegary	Vinegary
	60 Days	Light Vinegary	Vinegary	Vinegary	Pungent smell
Softness	0 Day	Hard	Hard	Hard	Hard
	30 Days	Hard	Hard	Moderate Soft	Soft
	45 Days	Moderate soft	Moderate soft	Soft	Soft
	60 Days	Soft	Soft	Very soft	Very soft
Fungus	0 Day	Absent	Absent	Absent	Absent
	30 Days	Absent	Absent	Absent	Absent
	45 Days	Absent	Absent	Absent	Absent
	60 Days	Absent	Absent	Absent	Present

T_0 = 0% MFW+ 95%RS + 5% molasses; T_1 = 5% MFW+ 90%RS + 5% molasses; T_2 = 10% MFW + 85%RS + 5% molasses; T_3 = 15% MFW+ 80%RS+ 5% molasses
*MFW=Market fish waste and RS= Rice straw

Table 3: Dry matter (%) of silages at different treatments and ensiling period

Ensiling Days (D)	Treatments (T) T_0	T_1	T_2	T_3	Mean	SEM	P Value T	D	T*D
0	57.70±0.02	50.51±0.37	42.88±0.35	34.39±0.47	46.37[a]±0.30	5.01	<.0001	<.0001	<.0001
30	49.17±0.58	41.70±0.59	37.59±0.15	31.78±0.36	40.06[b]±0.42	3.66			
45	46.79±0.27	37.87±0.35	35.51±0.04	32.17±0.37	38.08[c]±0.26	3.13			
60	47.02±0.01	33.80±0.39	33.27±0.03	30.84±0.38	36.23[d]±0.20	3.65			
Mean	50.17[a] ±0.22	40.97[b]±0.43	37.31[c]±0.14	32.29[d]±0.39					
SEM	2.57	3.57	2.05	0.75					

*Means (three replicates in each treatment) with different superscripts within row and column are significantly different (P<0.05), T_0 = 0% MFW+ 95%RS + 5% molasses; T_1 = 5% MFW+ 90%RS + 5% molasses; T_2 = 10% MFW + 85% RS + 5% molasses; T_3 = 15% MFW+ 80% RS+ 5% molasses MFW=Market fish waste and RS= Rice straw

Table 4: Crude protein (%) of silages at different treatments and ensiling time

Ensiling Days (D)	Treatments (T) T_0	T_1	T_2	T_3	Mean	SEM	P Value T	D	T*D
0	4.736±0.08	6.40±0.09	9.50±0.16	15.79±0.11	9.11[d]±0.11	2.44	<.0001	<.0001	<.0001
30	6.34±0.16	8.45±0.06	11.71±0.14	16.73±0.09	10.80[c]±0.11	2.26			
45	7.32±0.16	9.73±0.09	13.80 ±0.03	18.61±0.05	12.36 [b]±0.08	2.47			
60	8.33±0.16	11.62±0.10	15.40±0.09	20.69±0.13	14.01[a] ±0.12	2.65			
Mean	6.68[d] ± 0.14	9.05[c] ± 0.09	12.60[b]±0.11	17.95[a] ±0.09					
SEM	0.77	1.10	1.28	1.08					

*Means (three replicates in each treatment) with different superscripts within row and column are significantly different (P<0.05), T_0 = 0% MFW+ 95% RS + 5% molasses; T_1 = 5% MFW+ 90% RS + 5% molasses; T_2 = 10% MFW + 85% RS + 5% molasses; T_3 = 15% MFW+ 80% RS+ 5% molasses
MFW=Market fish waste and RS= Rice straw

Links Researchers

Table 5: Crude fiber (%) of silages at different treatments and ensiling time

Ensiling Days (D)	Treatments (T)				Mean	SEM	P Value		
	T_0	T_1	T_2	T_3			T	D	T*D
0	25.92±1.01	22.90±1.93	25.10±0.11	24.62±0.30	24.64^a±0.83	0.64	<.0001	0.0420	0.0083
30	25.43±0.23	23.73±0.26	23.42±0.19	22.11±0.35	23.67^{ab}±0.26	0.68			
45	25.85±0.48	21.65±0.86	22.55±0.38	23.37±0.03	23.35^b±0.43	0.90			
60	25.53±0.25	25.60±0.38	23.33±0.45	22.39±0.20	24.21^{ab}±0.32	0.80			
Mean	25.68^a±0.49	23.47^b± 0.71	23.60^b± 0.28	23.12^b±0.22					
SEM	0.12	0.83	0.54	0.57					

*Means (three replicates in each treatment) with different superscripts within row and column are significantly different (P<0.05), T_0 = 0% MFW+ 95%RS + 5% molasses; T_1 = 5% MFW+ 90%RS + 5% molasses; T_2 = 10% MFW + 85% RS + 5% molasses; T_3 = 15% MFW+ 80% RS+ 5% molasses

MFW=Market fish waste and RS= Rice straw

Table 6: Ether extract (%) of silages at different treatments and ensiling time

Ensiling Days (D)	Treatments (T)				Mean	SEM	P Value		
	T_0	T_1	T_2	T_3			T	D	T*D
0	1.07±0.06	2.07±0.02	3.26±0.02	4.48±0.01	4.23^a±0.03	0.74	<.0001	<.0001	0.0105
30	0.96±0.02	1.93±0.02	3.02±0.01	4.24±0.02	2.72^b± 0.02	0.71			
45	0.87±0.01	1.81±0.01	2.91±0.01	4.17±0.01	2.53^c±0.01	0.71			
60	0.84±0.03	1.73±0.01	2.94±0.02	4.04±0.02	2.44^d±0.02	0.70			
Mean	0.93^d±0.03	1.89^c±0.02	3.03^b ±0.02	4.23^a ± 0.2					
SEM	0.05	0.07	0.08	0.09					

*Means (three replicates in each treatment) with different superscripts within row and column are significantly different (P<0.05), T_0 = 0% MFW+ 95%RS + 5% molasses; T_1 = 5% MFW+ 90%RS + 5% molasses; T_2 = 10% MFW + 85% RS + 5% molasses; T_3 = 15% MFW+ 80% RS+ 5% molasses

MFW=Market fish waste and RS= Rice straw

Table 7: Ash (%) of silages at different treatments and ensiling time

Ensiling Days (D)	Treatments (T)				Mean	SEM	P Value		
	T_0	T_1	T_2	T_3			T	D	T*D
0	8.32±0.01	10.21±0.02	12.06±0.03	14.25±0.13	11.21^a±0.05	1.27	<.0001	<.0001	<.0001
30	7.38±0.07	9.26±0.13	11.18±0.06	13.33±0.09	10.29^b±0.09	1.28			
45	7.07 ±0.03	8.30±0.15	10.15±0.05	12.11±0.04	9.41^c±0.07	1.10			
60	6.27±0.12	7.18±0.06	9.20±0.15	11.09±0.07	8.44^d±0.10	1.08			
Mean	7.26^d ±0.06	8.74^c± 0.09	10.65^b±0.07	12.69^a± 0.08					
SEM	0.42	0.65	0.62	0.69					

*Means (three replicates in each treatment) with different superscripts within row and column are significantly different (P<0.05), T_0 = 0% MFW+ 95%RS + 5% molasses; T_1 = 5% MFW+ 90%RS + 5% molasses; T_2 = 10% MFW + 85% RS + 5% molasses; T_3 = 15% MFW+ 80% RS+ 5% molasses

MFW=Market fish waste and RS= Rice straw

Table 8: *In vitro* organic matter digestibility (%) at different treatments and ensiling period

Ensiling Days(D)	Treatments (T)				Mean	SEM	P Value		
	T_0	T_1	T_2	T_3			T	D	T*D
0	48.38±0.47	48.54±0.23	52.06±0.08	49.72±0.38	49.67^c±0.29	0.85	<.0001	<.0001	<.0001
30	53.01±0.34	48.61 ±0.30	53.49±0.13	48.78±0.36	50.97^b± 0.28	1.32			
45	53.17 ±0.20	49.28±0.22	53.31±0.25	49.78±0.38	51.39^b±0.26	1.08			
60	53.67±0.24	49.95±0.05	54.29±0.50	51.11±0.15	52.25^a± 0.24	1.03			
Mean	52.06^b± 0.31	49.09^d±0.20	53.29^a±0.24	49.85^c± 0.32					

SEM	1.23	0.33	0.46	0.48

*Means (three replicates in each treatment) with different superscripts within row and column are significantly different (P<0.05)
T_0 = 0% MFW+ 95% RS + 5% molasses; T_1 = 5% MFW+ 90% RS + 5% molasses; T_2 = 10% MFW + 85% RS + 5% molasses; T_3 = 15% MFW+ 80% RS+ 5% molasses
MFW=Market fish waste and RS= Rice straw

Table 9: Metabolizable energy (MJ/Kg DM) at different treatment and ensiling period

Ensiling Days (D)	Treatments (T)				Mean	SEM	P Value		
	T_0	T_1	T_2	T_3			T	D	T*D
0	6.94±0.07	7.11^c± 0.06	7.46±0.08	7.46±0.05	7.11^c± 0.06	0.15	<.0001	<.0001	<.0001
30	7.64±0.05	7.31^b ± 0.04	7.68±0.02	7.68±0.05	7.31^b ± 0.04	0.18			
45	7.66±0.02	7.37^b± 0.04	7.65±0.04	7.65±0.06	7.37^b± 0.04	0.15			
60	7.74±0.03	7.50^a± 0.03	7.80±0.07	7.80±0.02	7.50^a± 0.03	0.15			
Mean	7.49^b± 0.04	7.03^d ±0.03	7.65^a± 0.05	7.11^c± 0.05					
SEM	0.19	0.05	0.07	0.07					

*Means (three replicates in each treatment) with different superscripts within row and column are significantly different (P<0.05)
T_0 = 0% MFW+ 95% RS + 5% molasses; T_1 = 5% MFW+ 90% RS + 5% molasses; T_2 = 10% MFW + 85% RS + 5% molasses; T_3 = 15% MFW+ 80% RS+ 5% molasses
MFW=Market fish waste and RS= Rice straw

due to the enhancement of market fish wastes and ensiling time in the treatments (p<0.05). CP content increased when market fish wastes were ensiled in Gullu et al. (2015). The result was also supported by Shabani et al. (2018), who stated that CP improved with the ensiling period.

Crude Fiber

The Crude Fiber (CF) contents of silages are listed in Table 5. The CF in the treatments (T_0, T_1, T_2 and T_3) of silages was slowly declining from 25.68% to 23.12% due to adding market fish wastes at 60-day of ensiling. The reasons for CF decrease may be due to the addition of market fish wastes which contain lower CF than rice straw and also indicate the higher decomposition of silage materials.

On the other hand, a high inclusion level of fish wastes improves the digestibility of dry matters (Carmen et al., 2018; Soe Htet et al., 2021).

Ether Extract

The Ether Extracts (EE) of silages are shown in Table 6. EE was improved by including market fish wastes in the treatments and the differences in EE of silages were significant (p>0.05). It was observed that EE was decreased significantly (p<0.05) from 4.23 to 2.44% over the time from 0 to 60 days. The result of this study is similar to Gullu et al. (2015) who reported that when market fish waste was ensiled, EE declined with time. Carmen et al. (2018) stated a similar finding that EE improved with the upper addition of fish wastes in the silages.

ASH

The ash contents are shown in Table 7. The ash contents were significantly enhanced (P<0.05) taking into account the percentage of market fish wastes and ensiling time (0 to 60 days). From Table 7, it can be revealed that the highest (12.69%) ash content was found in T_3 and the lowest (7.26%) one was found in T_0. The ash contents of silages at different times (0, 30, 45, and 60 days) were 11.21, 10.29, 9.41, 8.44%, respectively. It was observed that the ash content was decreased from 11.21% to 8.44% over the time. Jalč et al. (2009) reported that bacterial inoculation during ensiling did not affect the ash content of grass and corn silages. Kim et al. (2014), indicated that the ash content of silage increases up to 28 days of ensiling. Carmen et al. (2018) supported the result that ash improved with the upper addition of fish wastes in the silage materials.

In Vitro Organic Matter Digestibility

The organic matter digestibility (OMD) is shown in Table 8. The OMD for the treatments (T_0, T_1, T_2 and T_3) of silages was 52.06%, 49.09%, 53.29%, and 49.85%, respectively. The highest in vitro OMD was observed in T_2 and the lowest was in T_1. The OMD in different treatments differed significantly (P<0.05) due to different levels of market fish wastes. The result of this study is similar to De Boever et al. (2013) reported that in *vitro* organic matter digestibility of ensiled grass improved from 82.3% to 83.9% from 0 to 150 days of ensiling respectively. The protein hydrolysis occurring during the fermentation increased the digestibility of fish silage (69 to 81.6%) (Ramírez et al., 2013).

Metabolizable Energy

The ME content (MJ/Kg DM) is shown in Table 9. The ME improved with the ensiling period from 7.49 to 7.11 MJ/Kg DM. The highest (7.78 MJ) ME content was found in T_2. The lowest (7.03) ME content was found in treatment T_1. In this study, T_3 showed the highest CP and lowest ME contents. Wittayakun et al. (2019) stated the same scenario that the ME contents reduced with the improvement of CP content.

CONCLUSION

The use of market fish wastes as a feed ingredient will not only reduce waste disposal and pollution problems but will also provide low-cost feed components for cattle. Ensiling can destroy pathogenic microorganisms and render palatable feed to livestock by altering the chemical nature of some unusable materials. Silage is a nutritious product and can be incorporated as a staple diet or as a concentrate type supplement to forage or other roughages. Taking the parameters into account, T_2 to 60 days and T_3 to 45 days were acceptable to prepare silages. Finally, it can be summed up that market fish waste is a valuable resource for the preservation of rice straw which provides farmers with cheap and environmentally friendly cattle feed.

ACKNOWLEDGEMENTS

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CONFLICT OF INTEREST

The authors have declared no conflict of interest.

NOVELTY STATEMENT

The utilization of fish by-products is a crucial matter in Bangladesh. The study was designed to focus on the conversion of these wastes into valuable products as ruminant feed.

AUTHORS CONTRIBUTION

Avijite Sarker completed the whole research work. Sharemen Islam assisted in research, wrote and edited the manuscript, Md. Rokibul Islam Khan supervised the research. Md. Mukhlesur Rahman reviewed the work.

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