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EFFECTS OF GRADED LEVELS OF MOLASSES, SALT AND UREA ON PHYSIOCHEMICAL COMPONENTS OF RICE STRAW SILAGE

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ABSTRACT

An experiment was conducted to evaluate the ensiling quality of Rice straw (RS) using graded levels of Molasses, Salt and Urea as additives. Rice straw collected from the University Farm after harvest in 2016 growing season was chopped to 2 – 3 cm sizes, mixed with the three additives at 5g, 7.5g and 10g each. Nine treatments; T1 (RS + 5g Molasses), T2 (RS + 7.5g Molasses), T3 (RS + 10g Molasses), T4 (RS + 5g Salt), T5 (RS + 7.5g Salt), T6 (RS + 10g Salt), T7 (RS + 5g Urea), T8 (RS + 7.5g Urea) and T9 (RS + 10g Urea) were replicated three times and then ensiled for 21 days. The results revealed significant ($p<0.05$) difference in all parameters evaluated. The result on pH showed a linear increase with the exception of T3 (RS + 10g molasses). The pH varied from 4.04 in T3 (RS + 10g Molasses) to 7.02 in T9 (RS + 10g Urea). In terms of physiochemical characteristics T1 (RS + 5g molasses), T2 (RS + 7.5g molasses) and T3 (RS + 10g molasses) resulted in better quality silage with very sweet to sweet aroma, yellowish green to pale yellow colour, high DM (90.76 - 93.35%), OM (89.55 - 92.05%), CF (29.06 - 37.32%) and NFE (53.52 - 62.71%), with moderate %CP (6.16 - 6.56%), %EE (0.53 - 1.77%), %NDF (53.52 - 62.71%) and ash (1.21 - 1.30%) content. T4 (RS + 5g Salt), T5 (RS + 7.5g Salt) and T6 (RS + 10g Salt) results in silage with putrid to pleasant aroma, light to dark brown colour low CP (5.47 - 5.61%), %DM (88.60 - 91.93%) and Ash (0.81 - 1.85%) contents. While T7 (RS + 5g Urea), T8 (RS + 7.5g Urea) and T9 (RS + 10g Urea) had significantly ($p<0.05$) highest crude protein (9.40 - 14.18%), Ash (1.50 - 1.88%) and metabolisable energy (2143.54 - 2478.98 kcal/kg) among the treatments evaluated. Addition of additives to rice straw silage improved the silage physiochemical qualities and farmers should add molasses or urea at 7.5% for better silage production.

Keywords: Molasses, Salt, Urea, Physiochemical, Ensiling Quality and Rice straw.

INTRODUCTION

One of the limiting factors for ruminant production is the inadequate and low quality of feedstuff during the dry season in the semi-arid zone of Nigeria (Han *et al*., 2002; Abdurrahaman, 2017). Most ruminant animal rearers fed crop residues after harvest with little or no supplement. One of the most common crop residues in this zone is rice straw due to a high number of rice farmers. However, only a small proportion of rice straw is utilized as roughage due to its low feeding value, while the majority is used as fencing material, firewood, or directly burnt in the field which causes serious air pollution (Cai, 2006; Kim *et al*., 2006). Rice straw does not contain enough sugars, amino acids and minerals for efficient

microbial growth, feeding ruminants with only rice straw, without any supplementation of the other required nutrient sources, will result in poor performance of the animals (Sarnklong *et al.*, 2010). Therefore, improving the feeding quality of rice straw has become a great concern. In the past, some physical, chemical and microbial treatments were tried to improve the feeding value of rice straw in the world, but they were proven ineffective. Fermentation in the silo can be a much uncontrolled process leading to less than the optimal preservation of nutrients (Cai, 2006; Kim *et al*., 2006). Silage additives have been used to improve the ensiling process (Better energy and DM recovery) with subsequent improvements in animal performance. In most developing countries especially Southeast Asia, rice straw is used as part of feeding ingredients for the ruminants. However, due to its low protein content and high level of lignin and silica, there is a limitation to its digestibility and nutritional value. To utilize this crop residue judiciously, there is a need for improvement of its nutritive value to promote its utilization through ensiling. Additives are used to control the fermentation processes to enhance nutrient recovery and improve silage stability (Oladosu *et al*., 2016). This among other justifies the need to ensiled rice straw with additives. The study aimed to determine the effect of graded levels of molasses, urea and salt as silage additives on rice straw and the best inclusion level of the additives in rice straw silage.

MATERIALS AND METHODS

Study Area

The study was conducted at Department of Animal Science Laboratory; Federal University Dutse, Jigawa State of latitude: 11.0 °N to 13.0 °N and longitude: 8.0 °E to 10.1 °E. Dutse experience rainfall usually from June to September, with a mean of 743mm precipitation annually and an average temperature of 30 °C. The environment is conducive to different species of livestock production, such as cattle, sheep, goat, rabbits, donkeys and poultry (JARDA, 2012). However, some different species of crops are grown in the area; these crops are millet, rice, maize, sesame, cowpea, watermelon, groundnut, and soybean and so on.

Experimental design and treatments

The experiment was layout in Completely Randomized Design (CRD) with nine (9) treatments and three replications per treatment as shown in Table 1.

Table 1: Treatments Combination with Different Silage additives in Graded Levels of Inclusion

Treatments	Grass Type (500g)	Molasses Level (g)	Salt Level (g)	Urea Level (g)
T1	Rice Straw	5	-	-
T2	Rice Straw	7.5	-	-
T3	Rice Straw	10	-	-
T4	Rice Straw	-	5	-
T5	Rice Straw	-	7.5	-
T6	Rice Straw	-	10	-
T7	Rice Straw	-	-	5
T8	Rice Straw	-	-	7.5
T9	Rice Straw	-	-	10

Preparation of the Ensiled Rice Straw

Rice straw was collected from University farm at harvest time in 2016 growing season and chopped manually with a sharp cutlass to a length of 2 - 3 cm. The chopped material (4500g) was sprinkled with water and allow for three hours before adding molasses, salt and urea (in graded levels) as additives in solution based on treatments. After the application of the additives, the materials were ensiled in open-mouthed Kilner jars (Cope BS 910-8, 1000 ml). Each of the treatment combinations was then ensiled in the *invitro* silos and compressed until filled to the brim in three replicates. The lids were then greased before screwed back tightly to provide an anaerobic environment suitable for fermentation. The silos were kept at room temperature of 26 °C for 21 days' incubation period in the laboratory.

Following the 21 days incubation, the content of the silos was then examined and scored for colour by three independent professionally trained scorers. Each jar was then opened, the content from the first 5cm of the silos was scooped off to safe guide against possible contamination by the grease used as air pleasant, a pair of forceps was used to fetch samples from the middle of the bottles and the content was scored for aroma on a subjective score of 1-4 by three independent scorers as described in Table 2. Thereafter, pH in water was determined using digital pH meter model: Hanna HI9813-6. Furthermore, sub-samples were taken from the prepared silages and oven dried at 60^{o}C for 48h for proximate analysis.

Table 2: Description of colour and aroma used as indices of silage quality

Score	Colour	Aroma
1	Yellowish green	Putrid or rancid
2	Pale yellow	Pleasant
3	Light brown	Sweet
4	Dark or Deep brown	Very sweet

Source: Muhammad, *et al*., (2008).

Table 3: Proximate composition of raw rice straw before ensiling

Proximate composition	DM	CP	CF	EE	NFE
Rice straw	91.08 %	3.98 %	34.89 %	1.36 %	43.35%

DM = Dry Matter, CP = Crude Protein, CF = Crude Fibre, EE = Ether Extract and NFE= Nitrogen free extract.

Source: Vadiveloo, 2000.

Proximate analysis

Samples from each replicate of the treatment were grounded to pass 1mm screen using Tecator Cyclotec 1093 sample mill. Proximate analysis of the samples was done to determine nitrogen (N) for crude protein determination (N×6.25), crude fibre (CF), ether extract (EE), nitrogen-free extract (NFE) and ash according to AOAC (1999). Organic matter was calculated as the difference between DM and

ash. Hemicellulose was calculated as a difference between NDF and ADF, Metabolisable energy was calculated using Pauzenga, (1985).

Data analysis

The data collected were analyzed using General Linear Model of SAS (2013), differences between means were separated using Fisher's Least Significant difference (LSD) at a probability level of 0.05.

RESULTS AND DISCUSSIONS

pH, Colour and Aroma of Ensiled Rice Straw with Different Additives

Table 4 shows pH, colour and aroma of ensiled rice straw with different proportion of additive. There were significant differences ($p<0.05$) in pH values of the resultant silage. The pH obtained in this study vary from 4.04 in T3 (RS + 10g molasses) to 7.04 in T9 (RS + 10g urea). From the result with the exception of treatments with urea (T7, T8 and T9) all other treatments have pH within the recommended range of 4.22 to 4.70.

The resultant silage indicated a relationship between pH and aroma, the silage with the lowest pH (4.04) has a very sweet aroma while as the pH alkalinity increases the aroma becomes putrid.

Table 4: pH, Colour and Aroma of Rice Straw ensiled with Different levels of Additives

Treatments	pH	Colour	Aroma
T1 (RS+5gM)	4.30^{g}	2	3
T2 (RS+7.5gM)	4.41^{f}	2	3
T3 (RS+10gM)	4.04^{h}	1	4
T4 (RS+5gS)	4.40^{f}	3	2
T5 (RS+7.5gS)	4.45^{e}	3	2
T6 (RS+10gS)	4.50^{d}	4	1
T7 (RS+5gU)	5.08^{c}	2	3
T8 (RS+7.5gU)	7.02^{b}	2	3
T9 (RS+10gU)	7.04^{a}	3	2
SEM	**0.22**		

a, b, c, d Means with different superscripts along column s differ significantly at ($P < 0.05$) Colour: 1= Yellowish green, 2= Pale yellow, 3=Light brown, 4= Dark brown. Aroma: 1 = Putrid, 2 = Pleasant, 3 = Sweet, 4 = Very sweet.

Generally, pH is one of the quickest and simplest ways of evaluating silage quality. Kung and Shaver, (2002) reported that silage with pH values range between 4.3-4.7 has a good quality and aroma. Most of the pH values showed a linear increase with the inclusion of additives (molasses, salt and urea). Treatments with molasses and salt have pH values within the recommended rate. This is in line with the report of Leterme *et al.* (1992), who recorded an increase in silage pH when pressed sugar-beet pulp was ensiled with molasses and urea, laying hen excreta or soybean meal and related or attributed such increase to buffering capacity

as a result of ash and ammonia from the uric acid hydrolysis. However, treatments with urea have higher pH (5.08 to 7.04) even though Akinwande *et al.* (2011) also obtained a pH of 9.26 when Water Hyacinth was ensiled without additives. Baba *et al.* (2010) recorded a range of 5.51 – 7.21 pH when *Pennisetum pedicellatum* (Kyasuwa) hay was ensiled with varying proportions of poultry litter.

Quality of silage can also be evaluated through colour and aroma (Wattiaux, 2000). The colours obtained in this research were close to the original colour of the materials used for the silages. This observation agrees with the results of Oduguwa *et al.* (2007) and Babayemi *et al.* (2010) using similar procedure though with different feed materials.

Proximate Composition of Ensiled Rice Straw with Different Additives

Table 4 shows proximate compositions of the resultant silage with statistically significant differences (P<0.05). Dry matter obtained vary from 88.60% in the T6 (RS + 10g Salt) to 93.35% in T2 (RS + 7.5g Molasses). In terms of CP ranged from 5.47 in T5 (RS + 7.5g Salt) to 14.18 in T9 (RS + 10g Urea), the crude protein of the resultant silage treated with urea additive met the protein requirement for small ruminant production (Abdurrahaman, 2017). However, treatments with salt and molasses additive silage may require additional protein sources. The CF, EE, ASH, NFE and OM varied at different levels of additive inclusion.

Table 5: Proximate composition of ensiled Rice Straw with different Additives

Treatments	%DM	%CP	%CF	%EE	%ASH	%NFE	%OM
T1 (RS+5gM)	92.33^{bc}	6.38^{de}	29.06^{g}	0.53^{g}	1.30^{b}	62.71^{a}	91.03^{b}
T2 (RS+7.5gM)	93.35^{a}	6.56^{d}	34.42^{d}	1.43^{cd}	1.30^{b}	56.27^{c}	92.05^{a}
T3 (RS+10gM)	90.76^{d}	6.16^{e}	37.32^{a}	1.77^{b}	1.21^{b}	53.52^{e}	89.55^{c}
T4 (RS+5gS)	90.50^{de}	5.61^{f}	30.52^{f}	0.83^{f}	0.81^{c}	62.20^{a}	89.68^{c}
T5 (RS+7.5gS)	91.93^{c}	5.47^{f}	33.73^{e}	1.17^{e}	1.85^{a}	57.78^{b}	90.08^{c}
T6 (RS+10gS)	88.60^{f}	6.56^{d}	34.29^{de}	1.60^{bc}	0.81^{c}	56.72^{c}	87.78^{d}
T7 (RS+5gU)	92.61^{abc}	9.40^{c}	33.86^{de}	0.77^{f}	1.55^{ab}	54.41^{d}	91.06^{b}
T8 (RS+7.5gU)	89.83^{e}	10.68^{b}	35.61^{c}	1.27^{de}	1.88^{a}	50.55^{f}	87.95^{d}
T9 (RS+10gU)	93.01^{ab}	14.18^{a}	36.35^{b}	2.00^{a}	1.50^{b}	46.10^{g}	91.51^{ab}
SEM	**0.31**	**0.55**	**0.49**	**0.09**	**0.08**	**0.98**	**0.29**

a, b, c, d Means with different superscripts along columns differ significantly at (P < 0.05)
DM = Dry Matter, CP = Crude Protein, CF = Crude Fibre, EE = Ether Extract, ASH = Ash, NFE= Nitrogen free extract and OM = Organic matter.

Rice straw and molasses mixture silages resulted in highest %DM, %CF, %NFE and OM compared to other silage mixtures (RS + Salt and RS + urea). Addition of molasses resulted in lower %NFE with a decline in %EE contents. The result of this study regarding the fibre content was within ranges reported by Snyman *et al.* (1990) and Mciteka, (2008). While Urea mixture with rice straw silages resulted in highest %EE, %CP and %ASH compared to all silage mixed.

Fibre Composition and Energy of Ensiled Rice Straw with Different Additives

Table 5 shows fibre composition and energy of ensiled rice straw with different additives. The obtained were statistically significant ($p<0.05$) in the silage mixture. NDF and Energy have the same pattern in the resultant silage, both were highest for T9 (NDF = 51.20%; Energy = 2478.98 kcal kg^{-1}) and their lowest values were obtained for T1 (NDF = 40.14%; Energy = 1684.21 kcal kg^{-1}). All parameters evaluated were within the recommended levels for small ruminant production.

Table 6: Fibre composition and Energy content of ensiled Rice Straw with different Additives

Treatments	%NDF	%ADF	%HEM	Energy Kcal kg
T1 (RS+5gM)	40.14^{h}	28.03^{d}	12.10^{e}	1684.21^{h}
T2 (RS+7.5gM)	41.07^{g}	29.70^{c}	11.37^{f}	1796.53^{g}
T3 (RS+10gM)	44.84^{f}	26.20^{e}	18.63^{c}	1940.60^{e}
T4 (RS+5gS)	44.54^{f}	24.40^{f}	20.14^{b}	1834.42^{f}
T5 (RS+7.5gS)	$48,45^{e}$	35.57^{a}	12.88^{d}	1992.76^{d}
T6 (RS+10gS)	50.00^{c}	31.13^{b}	18.87^{c}	2122.48^{c}
T7 (RS+5gU)	49.52^{d}	21.64^{h}	27.88^{a}	2143.54^{c}
T8 (RS+7.5gU)	50.45^{b}	22.47^{g}	27.98^{a}	2263.88^{b}
T9 (RS+10gU)	51.20^{a}	22.86^{g}	28.34^{a}	2478.98^{a}
SEM	**0.86**	**0.77**	**1.13**	**46.26**

a,b,c,d Means with different superscripts along columns differ significantly at ($P < 0.05$) NDF= Nitrogen Detergent Fibre, ADF= Acid Detergent Fibre and HEM= Hemicellulose.

Rice straw and Urea mixtures resulted in silages with highest %NDF, %HEM and Energy, with an increment as the levels of urea increases. Molasses mixture with rice straw resulted in lowest NDF as compared to all mixtures. Least ADF obtained in the mixture of salt and rice straw. Alikhali *et al* (2005) concluded that molasses alone have a significant effect on reducing NDF and ADF components.

CONCLUSION

Addition of additives to rice straw silage has benefit to improve the silage physiochemical quality. The result of this research revealed that addition of molasses to rice straw as silage additive leads to better quality silage with a very sweet aroma, yellowish green colour, high DM, OM, CF and NFE, with moderate CP, EE, NDF and ASH components. The mixture of rice straw with salt results in silage with bad (putrid) aroma, dark brown colour, and low CP, DM and ASH.

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