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**Physical Properties and Organic Acid Concentration of Sugarcane Waste Treated with Soybean Meal Residue and Rumen Digesta**

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**Abstract**

*The study was conducted to evaluate the physical properties and Organic acid concentration of Sugarcane waste (SCW) treated with Soybean meal residue (SBMR) and Rumen digesta in vitro laboratory silos (946ml). There were four (4) treatments in a Completely Randomized Design (CRD). The treatments combinations were: 1 (30% SCW + 40% SBMR + 30% RD), 2 (40% SCW + 35% SBMR + 25% RD), 3 (50% SCW + 30% SBMR + 20% RD) and 4 (60% SCW + 25% SBMR + 15% RD) ensiled for 21 days in triplicates. At the expiration of the ensiling period, the silos were opened and the top most 5cm material was scooped off to avoid contamination with partially ensiled material. The samples were taken using forceps from each ensiled bottle for physical observation. The condition was scored for aroma and color by three independent scorers on a subjective of 1-4. Significant ( $P < 0.05$ ) differences were observed between the treatments of all parameters evaluated. The temperature of the ensiled material was determined through insertion of thermometer into the silage for 2-3 minutes and record the reading. A digital pH meter was used in measuring the pH, following standard procedures (AOAC, 2005). Furthermore, sub samples were taken from the silage and oven dried at 60<sup>o</sup>c for 48 hours for analysis. The results for physical properties showed that all the silages were adequately fermented with aroma varying from sweet to very sweet. The silages were acidic (3.85 – 4.76). All the treatments were firm in texture without moulds. The results of the organic acid concentration indicated that as the proportion of Sugarcane waste increased the concentration of the organic acids decreased. Treatment 1 had higher score of 4 in terms of colour and Aroma rating; Acetic, Butyric and Propionic acids concentration. In conclusion, ensiling of SCW with SBMR and RD at these levels enhanced the quality of the Sugarcane waste. However, treatment 1 (30% SCW + 40% SBMR + 30% RD) in treatment 1 produced the best quality silage.*

**Key words:** Silage, Silo, Aroma, Colour, Fermentation and Sugarcane waste

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**Introduction**

Nigeria has a population of 81.8m goats, 46.8m sheep and 20.6m cattle (FAO, 2019). The larger proportion of these animals are however, highly concentrated in the northern region of the country. This concentration is most likely influenced by the ecological condition of the region which is characterized by low rainfall, sandy soil and longer dry season, as well as tsetse fly infestation free zone (RIM, 1992). Sugarcane is a tropical

grass from which sugar is extracted leaving two by products which are molasses and baggase (fibrous residue). Baggase contain high fiber, low protein and are very low in digestibility (Liu and Guo, 2012). Soybean meal residue (SBMR) is a by-product of soybean after it has been processed (McDonald *et al.*, 1991). Soybean meal residue may be high in moisture for ideal silage fermentation, therefore, it would be

desirable to mix with dry material to reduce the moisture content (McDonald *et al.*, 1991).

Rumen digesta (RD) is an abattoir waste which can be obtained freely from abattoirs in Nigeria. Due to the inadequate waste disposal facilities, RD are left decaying and thus creating an unfavourable condition for human but favourable condition for proliferation of various parasites and intermediate host (Maigandi and Tukur, 2002). Majority of Nigerian ruminants are found in the Sudan and Sahelian zones, even though inadequate feeding is one of the main constraints to successful livestock production in that area (Maigandi and Nasiru, 2006). However, the problem of feed shortage is more severe in the dry season when livestock subsist on very poor quality and quantity forages and crop residues resulting in low performance (Abil, 1992). During the dry season, crop residues and grasses are dried, low in crude protein and are highly lignified, and cannot satisfy the maintenance requirement of livestock, leading to low level of production of the animals (Le Heuerou, 1990). In the rainy season, there is less problem of feed supply in areas with abundant land for pasture and grains production (Hassan *et al.*, 2014).

Nigeria has large number of livestock, therefore the use of non-conventional feed become essential in solving the problem of feeding livestock, environmental pollution and to reduce the competition between man and livestock (Dafwang *et al.*, 2001). Due to the alarming rise in the price of conventional feed ingredients used in the ration of livestock and inadequate supply of high quality pasture for ruminants throughout the year, it has become necessary for the animal nutritionist to look for alternative feed ingredients that will reduce the cost of the production. (Singh *et al.*, 2003). Ashiru *et al.* (2013) reported that sugarcane waste has low nutritive value therefore, treatment or ensiling with other

ingredients like soybean meal residue, poultry litter or urea could enhance its intake. Ensiled sugarcane waste could be used in complete diets as alternative to conventional feed for ruminant animals in the dry season (Ashiru *et al.*, 2017). Therefore, the present study was aimed at determining the pH, temperature, physical characteristics and Organic acid concentration of Sugarcane waste ensiled with Soybean meal residue and Rumen digesta.

## Materials and Methods

### Study Location

The study was conducted at the Small Ruminant Unit of Livestock Teaching and Research Farm of the Department of Animal Health and Husbandry of Audu Bako College of Agriculture (ABCOA) Dambatta, Kano State, Nigeria.

### Collection and Preparation of Experimental Materials

Sugarcane waste (SCW) was collected from selling points identified within and around ABCOA and Dambatta Market and bagged. All foreign materials (stones, irons and polythene) were removed. Soybean meal residue (SBMR) was obtained from various soybean cake (*Awara*) processing centers in and around the ABCOA campus. Rumen digesta (RD) of sheep was collected from Kano main abattoir. At least 5-10 animals brought to the abattoir for slaughter were selected for the collection. After slaughter and evisceration at least 0.5 kg of the fresh (RD) was collected from each animal. The samples were mixed thoroughly and representative samples were taken and immediately transferred to an air tight container for transportation to the experimental site.

### Ensiling Procedure

The dried sugarcane waste used for the silages was chopped into about 2-3 cm length

to make compaction easy (Ashiru *et al.*, 2013). SCW was ensiled with SBMR and RD in proportions as represented in Table 1. Plastic silos were used as laboratory silos (Ogunlolu *et al.*, 2010). The procedure of Roy

and Rangneker (2006) were followed in which 15 liters of water was sprinkled on 25 kg sugarcane waste. The silages were ensiled for 21 days. Masking tape was used to further seal the bottles.

**Table 1: Proportion (%) of Sugarcane Waste (SCW) for Ensiling with Soybean Meal Residue (SBMR) and Rumen digesta (RD).**

Treatments	SCW (%)	SBMR (%)	RD (%)	Total
1	30	40	30	100
2	40	35	25	100
3	50	30	20	100
4	60	25	15	100

At the end of the ensiling period, the silos were opened and the top most 5 cm material were scooped off to avoid contamination with partially ensiled material. The samples were taken using forceps from each ensiled bottle for physical observation. The condition was scored for aroma and color by three independent scorers on a subjective scale of 1-4 (Table 2). The temperature of the ensiled

material was determined by insertion of a thermometer into the silage for 2-3 minutes and the reading recorded. A digital pH meter was used to measure the pH, following standard procedures (AOAC, 2010). Furthermore, sub samples were taken from the silage and oven dried at 60°C for 48 hours for analysis.

**Table 2: Description of Colour and Aroma Rating used as indices of Silage Quality**

RATING	COLOUR	AROMA
1	Dark or deep brown	Putrid or rancid
2	Light brown	Pleasant
3	Pale yellow	Sweet
4	Yellowish green	Very sweet

Source: Muhammad *et al.* (2009).

### Experimental Design and Treatments

A Completely Randomized Design (CRD) was used as outlined by Steel and Torrie (1980). There were four treatments; 1 (30% SCW +40% SBMR + 30% FSD), 2 (40% SCW + 35% SBMR +25% FSD), 3 (50% SCW + 30 SBMR + 20% FSD) and 4 (60% SCW +25% SBMR +15% FSD).

### Statistical Analysis

The data collected were subjected to analysis of variance (ANOVA) using the general

linear model (GLM) procedure of SAS version 9.1 (SAS 2004). Where significant differences were observed, Duncan Multiple Range Test (DMRT) was used to separate the means. The differences between the means were considered at 5% probability level ( $P<0.05$ ).

### Results

The results for physical properties of the prepared silages are presented in Table 3. The results showed that there were significant

( $P < 0.05$ ) differences in pH values between the means of the treatments evaluated. Treatments 1 and 3 were similar ( $P > 0.05$ ) and significantly ( $P < 0.05$ ) higher than other treatments. There were no significant ( $P > 0.05$ ) differences in the temperature

values among the treatments. Furthermore, treatment 1 had higher scores of 4 in terms of colour and aroma rating compared to other treatments which had similar ( $P > 0.05$ ) ratings. All the treatments were firm in texture and without moulds.

**Table 3: pH, Temperature and Physical Properties of the ensiled sugarcane waste treated with Soybean Meal Residue and Rumen Digesta.**

Treatments			Physical properties		
	pH	Temp. ( $^{\circ}$ C)	Color	Aroma	Texture
1	4.76 <sup>a</sup>	35.40	4	4	Firm
2	3.85 <sup>b</sup>	34.20	3	3	Firm
3	4.68 <sup>a</sup>	34.38	3	3	Firm
4	4.16 <sup>b</sup>	34.79	3	3	Firm
SEM	0.124	0.487			

<sup>a, b</sup> means with different superscripts within the same column are significantly ( $P < 0.05$ ) different. SEM = Standard Error of Mean. I (30% SCW + 40% SBMR + 30% RD), II (40% SCW + 35% SBMR + 25% RD), III (50% SCW + 30% SBMR + 20% RD) and IV (60% SCW + 25% SBMR + 15% RD).

The results for organic acids production of the prepared silage are presented in Table 4. Significant ( $P < 0.05$ ) differences were observed between the treatments for all parameters evaluated. Mean acetic acid value (3.96) in treatment 1 was significantly ( $P < 0.05$ ) higher but similar to the values recorded for treatments 2 and 3, while treatment 4 had significantly ( $P < 0.05$ ) lower

value of Acetic acid (2.85). Butyric acid values were significantly ( $P > 0.05$ ) similar in treatment 1 and 2 which were significantly ( $P < 0.05$ ) higher than value recorded in treatments 3 and 4. The mean values recorded for Propionic acids were similar ( $P > 0.05$ ) in treatments 1, 2 and 3 but significantly ( $P < 0.05$ ) higher than 0.46% recorded for T<sub>4</sub>.

**Table 4 Concentration (%) Organic acid production of the ensiled sugarcane waste treated with soybean meal residue and rumen digesta.**

Parameters	Treatments				SEM
	1	2	3	4	
Acetic acid (%)	3.96 <sup>a</sup>	3.48 <sup>ab</sup>	3.15 <sup>ab</sup>	2.85 <sup>b</sup>	0.308
Butyric acid (%)	1.58 <sup>a</sup>	1.14 <sup>a</sup>	0.42 <sup>b</sup>	0.28 <sup>b</sup>	0.203
Propionic acid (%)	0.93 <sup>a</sup>	0.90 <sup>a</sup>	0.88 <sup>a</sup>	0.46 <sup>b</sup>	0.076

<sup>a, b</sup> means with different superscripts within the same column are significantly ( $P < 0.05$ ) different. SEM = Standard Error of Mean. I (30% SCW + 40% SBMR + 30% RD), II (40% SCW + 35% SBMR + 25% RD), III (50% SCW + 30% SBMR + 20% RD) and IV (60% SCW + 25% SBMR + 15% RD).

## Discussion

Generally, pH is one of the quickest and simplest way of evaluating silage quality. Silage that have been properly fermented will have much lower pH (Ashiru *et al.*, 2014). Kung and Shaver (2002) reported that a good quality silage pH value in the tropics ranged between 4.3 - 4.7. The pH values recorded in the present study (3.85 - 4.76) were in agreement with the report. However, Babayemi *et al.* (2009) reported a pH values of 3.38 – 4.61 when Cassava peels were ensiled with Albizasaman pods. The pH values of 3.58-5.05 reported by Ashiru *et al.* (2014) was in consonant with the values obtained in this study when sugarcane waste was ensiled with non-protein Nitrogen source and Soybean meal residue. A good silage must be cooled at opening or be at room temperature. This would appear to be a good operating temperature for silage fermenting organisms (Ashiru *et al.*, 2014). McDonald *et al.* (1998) stated that temperature above 30°C make silage to become dark, due to caramelization of sugars in the forage. The temperature values of the silages in the present study (34.20 - 35.40°C) were higher than 28.3 - 29.1°C and 25.0 - 27.5°C reported by Babayemi *et al.* (2009) and Akinwande *et al.* (2011) respectively. Temperature range of 29.40 -45.00°C was reported as satisfactory silo temperature (Amodu and Abubakar, 2004).

Silage quality can be assessed physically through smell, colour and texture and by chemical analysis (Wattiaux, 2000). The colours obtained in the present study were close to the original colour of the materials used for the silage. This observation coincides with finding of Oduguwa *et al.* (2007); Babayemi *et al.* (2010) and Ashiru *et al.* (2014) using similar procedure though with different feed materials. The colour obtained

in the silages of the present study ranged from pale yellow to yellowish green. This is in consonance with the work of Amodu and Abubakar (2014) who reported that good silage must present a pleasant taste; the colour should be yellowish green and must be without mould. The aroma obtained from the silages in this study ranged from sweet to very sweet. This is consistent with the findings of Muhammad *et al.* (2009) who reported that the end product of silage had a pleasant or fruity smell. Ashiru *et al.* (2014) obtained a silage with pleasant smell when sugarcane waste ensiled with non-protein Nitrogen source and Soybean meal residue. Amodu and Abubakar (2004) reported that a good silage usually has an acceptable aroma, clean and not putrid odour. All the silages in the present study were firm in texture without moulds which is also an indication of good silage. Kung and Shover (2002) reported that silages with slimy texture is an indication of spoilage or mould growth.

The results of the present study indicated that as the proportion of sugarcane waste increases the concentration of the organic acids decreases. Acetic acid controls the alcoholic fermentation in anaerobic condition by inhibiting the growth of yeast and increasing aerobic stability of the silage after opening (Taylor and Kung, 2002; Pedroso, 2003). The values of Acetic acid concentrations obtained in the present study (2.85 – 3.96%) were in line with 1.0 – 3.0% reported by Kung and Shaver (2001) for grass silage and 1.28 - 2.57% reported by Ashiru and Sani (2016) when sugarcane waste was ensiled with poultry litter. These variations may due the differences in experimental materials used. The value of butyric acid concentration obtained in the present study (0.28 – 1.5%) was higher than 0.05% obtained by Kung and Shaver (2001). Ashiru and Sani (2016) reported a higher butyric acid values of 1.51 -

2.36%. Most silages contain very low concentration of propionic acid (<0.2-0.3) and the acid is highly required by lactating animals (Kung and Shaver, 2001). The propionic concentration obtained in this study (0.46 – 0.93%) was close to 0.93 - 2.19% reported by Ashiru and Sani (2016). The propionic acid concentration of the present study decreased with the decreased in quantity of soybean meal residue. This suggestion was supported by Bill (2005) who reported that propionic acid predominates on high concentrate diets.

### Conclusion

It could be concluded that SBMR and RD enhanced the Sugarcane waste by improving the pH, temperature and physical properties of SCW. Likewise, sugarcane waste ensiled with soybean meal residue and rumen digesta from sheep can be used as ruminant feed at whatever level.

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