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Quality Assessment of the Physical Characteristics and Chemical Composition (Proximate and Fibre Fractions) of Rice Straw Ensiled with Processed Soya bean Meal

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Abstract:
Background: Due to the fact that rice straw is available especially in the northern part of Nigeria, feeding only rice straw does not provide enough nutrients to the ruminant animals to maintain high production levels due to the low nutritive value of this highly lignified material. Therefore, ensiling rice straw with processed soybean meal will be helpful to improve the nutritive value of the straw for better nutrient intake and weight gain in animal feeding. The objectives of the study was to determine the quality addition of the physical characteristics and chemical composition of rice straw ensiled with processed soybean meal.
Methods: The dried rice straw was chopped (2-3 cm length) using forage chopper to allow easy compaction. Five rubber plastic silos (One thousand litres capacity) were used in which 70% of the chopped rice straw was mixed up with 30% soybean meal each. Unprocessed soybean meal was designated as treatment A (control), 12hrs and 24hrs soaking of soybean meal in water serves as treatments B and C respectively. Roasting for 15 minutes of soybean meal serves as treatment D while cooking at 70^0C for 15 minutes serves as treatment E. Polythene sheets were also used inside the silos to ensure airtight condition.. Fifty (50) litres of water was sprinkled to each silo (Containing 70kg rice straw and 30kg soybean meal mixture). Silos were properly sealed to facilitate rapid fermentation under anaerobic condition. The ensiling process lasted 21 days.
Results: The physical characteristics of the ensiled diets has shown that Diet A, B and C was light brown with pleasant aroma and rated as 2nd, while diet D and E were pale yellow with sweet aroma and rated as 3rd. The pH values for treatments A to E where 4.60, 4.63, 5.00, 4.83 and 4.49 respectively. The dry matter (DM) value was higher in treatment C (80%) and lower in treatment B (77.90%). Crude protein (CP) content values of the diets was higher in treatment C (12.60%) and lower in treatment D (11.88%). Crude fibre (CF) was higher in treatment C (32.47%) and lower in treatment B (31.60 %). EE was higher (3.47%) in treatment A and lower (2.91%) in treatment B. Ash content was high in treatment A(9.60%). Nitrogen free extracts (NFE) value was high in treatment A (45.03).Acid detergent fibre (ADF) was high in treatment A (32.21%) and lower in treatment E (28.72%) while the neutral detergent fibre (NDF) was high in treatment A (42.16%) and lower in treatment E (32.69%).
Conclusion: Silages from a processed soya bean meal by soaking in water, boiling and heating (by optimizing the heating processes and protection of soybean meal protein) improved the pH, color and aroma and could be recommended for feeding sheep.
Key words: Rice straw - soya bean meal – ensiling - physical characteristics - chemical compositions

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I. Introduction

Due to the fact that rice straw is available especially in the northern part of Nigeria, feeding only rice straw does not provide enough nutrients to the ruminant animals to maintain high production levels due to the low nutritive value of this highly lignified material. Therefore, treating rice straw with urea or calcium hydroxide or by supplementing rice straw with protein- based feed such as soya bean will be helpful to improve the nutrient intake.

Soya bean meal is an excellent feed for livestock. It is very palatable, highly digestible and contains a high amount of digestible energy and as such relatively consistent source of protein. Soya bean is therefore an important source of protein used to supplement low nutritive and highly lignified roughages for both production and maintenance.

Ensiling is a technique that ensures a controlled microbial fermentation to improve the nutritive value of livestock feeds and allows effective preservation without deterioration (Gerald and Thomas, 2006). Therefore, the palatability and feeding value of roughages could be enhanced by ensiling processes to increase

their physical characteristics and chemical composition. The present study was carried out to determine the physical characteristics and chemical composition of rice straw ensiled with raw and processed soya bean meal.

Inadequate feeding constitutes a major constraint to successful 1ivestock production (Olaloku, 1985) in Nigeria, especially in the semi-arid part of the country. The problem is more severe during the long dry season (about 8 months in a year) during which the livestock feeds are scarce and animals subsist on very poor quality forages, leading to very low level of performance (Steinbach, 1997). At this time, availability of conventional grazing forages are inadequate, pastures are dried and highly lignified, therefore cannot satisfy even the maintenance requirements of livestock (Le Houerou, 1980). In view of that, the animals sometimes scavenge on dump refuse and other dangerous materials. The scavenging nature of ruminant animals cannot be relied upon to providing adequate nutrition for optimum livestock production (Adebowale and Taiwo, 1996).

Every sector of the livestock industry is having serious setbacks mostly due to escalating price of feeds which normally constitute 60-80% of production cost depending on species (Odeyinka and Ajayi, 2004). Proper management and disease control can be achieved with an adequate plane of nutrition (Ali-Balogun *et al.,* 2003). According to Federal Department of Livestock and Pest Control Services (FDLPCS, 1992), inadequate feeding is the major constraint militating against successful livestock production in the semi-arid zone of northern Nigeria which is the natural habitat for a large number of the national ruminant livestock. These and other factors such as rise in the price of the conventional feeds and feed ingredients limited the productivity of livestock in Nigeria. It therefore becomes imperative to 1ook for other sources of feeds in order to maximize livestock performance (Gerald and Thomas, 2006). One of the sources is the ensiling of rice straw with soya bean (Ahmad,*et.al.,* 2001).

II. Materials and Method

Description of the study area

The study was conducted at the Ruminant Unit of the Teaching and Research Farm of Bayero University, Kano. Kano State lies partly in the Sudan and Northern Guinea Vegetative Zone (Olofin, 1985; KNARDA, 2001) between Longitudes 9^0 30' and 12^0 30' North and Latitudes 9^0 30' and 8^0 42' East. The area is characterized by tropical wet and dry climate (Olofin, 1987), a wet season (May-September) and dry season (October-April). Annual rainfall and temperature ranges between 787mm and 960 and 21^oC and 39^0C, respectively (KNARDA, 2001).

Experimental materials

Rice straw was purchased from local rice farmers while soya bean grains were obtained from Dawanau Market in Kano metropolitan. The dried rice straw was chopped (2-3 cm length) using forage chopper to allow easy compaction. Materials were ensiled in plastic silos (1000 litres capacity) each silo contained a mixture of 70% of the chopped rice straw and 30% of the processed soya bean meal. Polythene sheets were used inside the silos to ensure airtight condition. Fifty (50) litres of water was sprinkled to each silo (containing 70 kg rice straw and 30 kg soya bean meal mixture). Silos were properly sealed to facilitate rapid fermentation under anaerobic condition. The ensiling process lasted 21 days. Each silo was well labeled using masking tape for easy identification. Finished silages were later dried up until ready for subsequent use.

Experimental treatments

The rice straw was ensiled with raw (unprocessed) and processed soya bean meal. The unprocessed soya bean meal was designated as treatment A (control), 12 h and 24 h soaking of soya bean in water served as treatments B and C, respectively. Roasting of the soya bean for 15 minutes served as treatment D while cooking at 70^0C for 17 minutes served as treatment E. The rice straw and raw or processed soya bean meal were included at ratio of 70:30 in 100 kg of the ensiled material.

Data collection and rating

The physical characteristics of the finished silage were scored by the panel of three for colours while the aroma descriptions was rated using the indices of silage quality (Table 1) according to Muhammad *et al.* (2009). pH level of the silage was determined using a pH meter.

III. Results and Discussion

Physical characteristics of the ensiled diets

Physical characteristics of the ensiled diets as shown in Table 2 indicated that Treatments A (rice straw ensiled with raw soya bean meal), B (rice straw ensiled with 12 h soaking of soya bean meal in water) and C (rice straw ensiled with 24 h soaking of soya bean in water) were light brown with pleasant aroma and rated as 2^{nd}, while treatments D (rice straw ensiled with roasting of soya bean meal for 15 minutes) and E (rice straw ensiled with soya bean meal cooking at 70^0 C for 15 minutes) were pale yellow with sweet aroma and rated as

3rd. The pH values for treatments A to E were 4.60, 4.63, 5.00, 4.83 and 4.49, respectively. Good silage usually preserves the original color of the pasture or forage (Mannatje, 1999) and the reported colour of the ensiled material (Table 2) indicated that treatments D and E had a pale yellow with sweet aroma, thus preserving the original color of forage and termed "good silage" as reported by Oduguwa *et al.* (2007). Treatments A, B and C were light brown in color with pleasant aroma. These are in agreement with the finding of Kung and Shaver (2002) who inferred that light brown color signified good silage. pH is one of the criteria for evaluating the silage quality as reported by Menesses *et al*. (2007). The pH of 4.00-5.00 obtained in this study was closely related to the values reported by Titterton *et al.* (2002). Well fermented silage will have a lower pH (more acidic) than the original forage as reported by Kung *et al*. (2002) and however, interpreted the silage pH values of 4.3- 4.7 in the tropics as good and an indication of good quality silage.

Proximate composition of the experimental diets

The chemical composition of the experimental diets were presented in Table 3. The dry matter (DM) value was higher in treatment C (80%) and lower in treatment B (77.90%). The lowest value of 11.88% crude protein (CP) was obtained in treatment D while treatment C gave the highest (12.6%) value. Crude fibre (CF) value was higher in treatment C (32.47%) and lower in treatment B (31.60 %). Ether extract (EE) was higher (3.47%) in treatment A and lower (2.91%) in treatment B. Ash content was lower (8.26%) in treatment B and higher (9.60%)in treatment A. Nitrogen free extracts (NFE) values was lower (42.22%) in treatment A and higher (45.03%) in treatment B. Acid detergent fibre (ADF) values was lower (28.72%) in treatment E and higher (32.21%) in treatment A. similarly, the neutral detergent fibre (NDF) values was lower (32.69%) in treatment E and higher (42.16%) in treatment A. The high dry matter obtained in the present study could be due to drying of the ensiled materials before feeding and this is in agreement with National Research Council (1994). The CP levels obtained could be due to the inclusion of soya bean meal in the silage. However, the values were lower than the range of 16-18% recommended by Norton (2003) for growing sheep and goats but higher than 6-8% recommended by NRC (1985) for ruminants in the tropics. The CF and EE values obtained were in agreement with the values reported by Goto (1995) for ammoniation of barley straw. The present finding is also in agreement with the result of Kiangi *et al*. (1981) who reported a decrease in CF when urea was added to ensiled straw. Ether extract (EE) content in treatment A was consistent with 3.40 - 4.5% reported by Maigandi and Tukur (2002) when fed fore-stomach digesta (FSD) as unconventional feed ingredient. The Acid Detergent Fibre (ADF) and Neutral Detergent Fibre (NDF) were lower when compared to the values reported by Alam *et al.* (2013) who fed rice straw supplemented with soya bean meal to sheep. Khan *et al*. (1999) also stated that incorporation of soya bean meal and jack bean meal along with urea treated straw was effective in reducing ADF. The lower values in ADF could be due to incorporation of soybean meal in the treatments in accordance with the report of Khan *et al*. (1999).

IV. Conclusion and Recommendations

In the present study, fermentation of rice straw with soya bean meal processed by heating, boiling and soaking in water improved the pH, colour and aroma of the silage.

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Table 1: Description of color and aroma rating using indices of silage quality

Rate	Color	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)

Table 2: Physical characteristics and pH value of the rated ensiled diets

Treatment	Color	Aroma	Rate	pH value
A	Light Brown	Pleasant	2	4.60
B	Light Brown	Pleasant	2	4.63
C	Light Brown	Pleasant	2	5.00
D	Pale Yellow	Sweet	3	4.83
E	Pale Yellow	Sweet	3	4.49

A= rice straw ensiled with raw (unprocessed) soya bean meal B= rice straw ensiled 12 h soaking of soya bean meal in water C= = rice straw ensiled 24 h soaking of soya bean meal in water D=rice straw ensiled 15 minutes roasting soya bean meal E=rice straw ensiled cooking at 70^0C for 15 minutes of soya bean meal

Table 3: Proximate composition of the experimental diets

Parameter (%)	Diet/treatment				
	A	B	C	D	E
Dry matter	78.36	77.90	80.00	79.20	78.30
Crude protein	12.31	12.20	12.60	11.88	12.10
Crude fibre	32.40	31.60	32.47	31.80	32.20
Ether extract	03.47	2.91	3.09	3.20	2.96
Ash	9.60	8.26	9.30	8.80	8.70
NFE	42.22	45.03	42.54	44.32	44.04
ADF	32.21	32.12	30.02	29.67	28.72
NDF	42.16	38.21	40.21	38.68	32.69

NFE-Nitrogen Free Extracts ADF-Acid Detergent Fibre NDF- Neutral Detergent Fibre Treatments A= rice straw ensiled with raw (unprocessed) soya bean meal B= rice straw ensiled 12 h soaking of soya bean meal in water C= rice straw ensiled 24 h soaking of soya bean meal in water D=rice straw ensiled 15 minutes roasting of soya bean meal E=rice straw ensiled cooking at 70^0C for 15 minutes of soya bean meal

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