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CHEMICAL COMPOSITION, PHYSICO-CHEMICAL PARAMETERS AND ACCEPTABILITY OF CABBAGE LEAVES ENSILED WITH PINEAPPLE PEELS BY WEST AFRICAN DWARF (WAD) GOATS

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Abstract
A study was conducted to investigate the chemical composition, silage quality and acceptability of cabbage leaves (CL) ensiled with graded levels of Pineapple peels (PP) by West African Dwarf (WAD) goats. Four different silage diets were made with graded levels of PP inclusion and designated as T1, T2, T3 and T4 where T1= 100% Cabbage leaves (without additives; T2 = 90% Cabbage leaves + 10% Pineapple peels; T3 = 80% Cabbage leaves + 20% Pineapple peels; T4 = 70% Cabbage leaves + 30% Pineapple peels. An acceptability trial was conducted using 10 WAD goats in a cafeteria experiment. Results showed that dry matter (%) of silage diets ranged between 37.30 (T4) and 45.00 (T1). Crude protein (CP) content of diets differed significantly ($P<0.05$), with values increasing as PP increased in diets. Crude protein (CP) values (%) ranged from between 16.48 (T1) and 20.13 (T4). The colour, odour and texture of silages in T2 - T4 had acceptable physical attributes while pH values ranged from 5.88 (T3 and T4) – 6.01 (T1). The order of preference for diets by WAD goats was T3 >T2 > T4 > T1. The Coefficient of preference (CoP) values obtained for T2 and T3 were above Unity (1) hence conferring acceptable status on them. Diets T1 and T4 were rejected. It is concluded that silages made from CL and PP have potential as feed for ruminants with acceptable physical attributes particularly when PP is included at 10-20%

Keywords: Acceptability, Cabbage leaves, Goats, Pineapple peels, Silage.

INTRODUCTION
The competition for food between man and his livestock has been a major concern to nutritionists (Odedire and Abegunde, 2014). This problem can be adequately alleviated through the use of modern feeding techniques and the production of silage, which are cheaper alternatives (Chah and Igbokwe, 2011). The use of agricultural by-products as feed resources have long been a practice among livestock farmers however, a lot more other farm products which are considered waste with a lot of feeding potential have not been investigated. One of such agricultural products is cabbage (*Brassiccaoleraceae*). Discarded Brassica vegetables are frequently used in practice as part of ruminant diets in temperate agricultural systems (Duncan and Milne, 1992) and developing countries (Nkosi *et al.*, 2016), although information on their nutritive value is limited. Furthermore, high moisture content of cabbage predisposes it to spoilage. Silage production helps to preserve forage with high moisture content by controlled fermentation (Mathur and Mathur, 2000) so that it is available to animals all year round. The leaves of cabbage are readily available as products of dressing and trimming in markets where they are sold. Exploitation of pineapple wastes by converting them into value-added products such as manure or animal feed is increasingly gaining attention as an innovative solution to their disposal challenges. Based on the high level of fermentable sugars in the peels, they are excellent resource that can act as additive in ensiling cabbage leaves. Literature is scanty on silage quality assessment of cabbage leaves ensiled with graded levels of pineapple peels. This study was therefore designed to investigate the silage quality and acceptability of ensiled cabbage leaves and pineapple peels by WAD goats.

Materials and methods

Experimental site
The experiments were conducted at the Poultry Meat Research Laboratory, Department of Animal Sciences and the Sheep and Goat Unit, Obafemi Awolowo University (OAU) Teaching and Research farm, Ile-Ife, Osun

State, Nigeria. Ile-Ife, Osun state is located at about latitude 7.4905°N and longitude 4.5521° E with an average annual temperature of 23.3 – 27.3° C and annual rainfall averages 1,509 mm. (Climate-data, 2021)

Experimental materials and diets

Materials for silage preparation included wilted and chopped cabbage leaves waste, fresh pineapple peels, ten growing WAD goats were used for the acceptability trial. Cabbage leaves and Pineapple peels were sourced from a nearby market. The peels were chopped into smaller sizes of about 10 cm for ease of drying and compaction. The cabbage leaves were also chopped and air-dried for 5 days. Four diets were prepared in the following proportions: Diet 1: 100% Cabbage leaves without Pineapple peels, Diet 2: 90% Cabbage leaves ensiled with 10% Pineapple peels, Diet 3: 80% Cabbage leaves ensiled with 20% Pineapple peels, Diet 4: 70% Cabbage leaves ensiled with 30% Pineapple peels.

Proximate components

Samples were opened on the 21st day and taken and oven-dried at 65 ^{0}C until constant weight was obtained for dry matter determination after which they were milled and kept in cellophane bags until analysis. Ether extract, crude fibre, crude protein, ash and nitrogen free extract of the diets were determined according to the standard procedures of AOAC (2000)

Physico-chemical parameters

Physico-chemical parameters were determined using the methods described by Kilic (1986). Colour was assessed using a colour chart. Odour and texture were adjudged by six (6) individuals. A pH meter installed with a thermometer was used to determine the silage pH and temperature.

Acceptability trials

A cafeteria experiment was conducted to evaluate the acceptability of ensiled mixtures of cabbage leaves and pineapple peels using Ten (10) WAD goats lasting seven days after The initial seven days adaptation period. About 1.5kg of each diet was offered for a duration of six (6) hours per day in eight (8) different concrete feeding troughs. Feed preference was determined from the coefficient of preference (CoP) value (Falola *et al.*, 2013). A relatively preferred diet was confirmed when CoP value is greater than 1(Unity) (Karbo *et al*., 1993).

$$\text{CoP} = \frac{\text{Intake of individual feed offered}}{\text{Mean intake of all the feed offered}}$$

Statistical analysis

All data collected were subjected to analysis of variance (ANOVA) using the procedure of SAS (1999). Significant treatment mean values were compared using the Duncan Multiple Range Test of the same package. The mean obtained for Dry matter intake was ranked using SPSS 2.0.

RESULTS AND DISCUSSIOS

Table 1 shows the chemical composition of ensiled cabbage leaves with pineapple peels. Results showed that dry matter (%) of silage diets ranged between 37.30 (T4) and 45.00 (T1). Crude protein (CP) content of diets differed significantly ($P<0.05$) with values increasing as PP increased in diets. Crude protein (CP) values (%) ranged from between 16.48 (T1) and 20.13 (T4). The CP values observed in this work were higher than those (10.63-12.54%) reported elsewhere (Abegunde *et al*., 2021) for guinea grass ensiled with or without additive. They were also higher than CP values reported for ensiled and unensiled 4, 6 and 8 weeks re-growth of vetiver grass (Falola *et al*., 2013) andCP values of 23.63 and 31.46 g/kg for elephant grass ensiled with 10% wheat bran and 20% wheat bran, respectively as reported by Silva *et al.* (2014). The improved CP values observed in diets of CL and PP in this work might be due to the nutritive qualities of the components of the silage in terms of the CP component. Furthermore, the crude protein values observed in all diets were above the minimum required value of 8.0 % to ensure efficient functioning of the rumen micro flora (Van Soest, *et al*., 1991). Ether extract values ranged between 6.66 – 9.42%. These values were higher than those (3.32 - 3.45%) reported by Abegunde

et al.(2021) for five-weeks re-growth guinea grass ensiled with or without additive and 3.07-3.70% reported for silages from four different maize hybrids (Kamalak *et al*., 2003).

Table 1: Chemical composition (%) of ensiled Cabbage leaves and Pineapple peels.

Parameters (%)	PP	CL	T1	T2	T3	T4	SEM	PROB
Dry matter	16.47	12.60	45.00^{a}	44.67^{b}	40.93^{c}	37.30^{d}	3.11	<0.0001
Crude Protein	7.29	23.98	16.48^{d}	17.93^{c}	18.23^{b}	20.13^{a}	1.19	<0.0001
Crude Fibre	11.18	14.07	10.43	10.54	10.32	10.28	0.33	<0.0001
Ether Extract	1.84	4.73	4.58^{a}	3.45^{b}	2.90^{c}	2.58^{c}	0.26	<0.0001
Ash	5.61	12.76	10.87^{b}	10.89^{b}	11.17^{a}	10.48^{b}	0.54	<0.0001
NFE	71.84	38.97	45.60^{a}	43.07^{b}	43.30^{b}	41.23^{c}	2.71	<0.0001

Table 2: Physico-chemical parameters of ensiled Cabbage leaves and Pineapple peels

	T1	T2	T3	T4
Colour	Pale green with brown patches	Olive green with white patches	Olive green	Olive green
Odour	Slightly pleasant with choking smell	Pleasant slightly fruity smell	Pleasant fruity smell	Pleasant fruity smell
pH	6.01	6.08	5.88	5.88
Temperature	27.4	27.6	27.5	27.6
Texture	Firm	Firm and dry	Firm and dry	Firm and dry

T1= 100% cabbage peels with no pineapple peels; T2= 90% cabbage peels with 10% pineapple peels; T3= 80% cabbage peels with 20% pineapple peels; T4= 70% cabbage peels with 30% pineapple peels.

Table 3: Acceptability of ensiled Cabbage leaves and Pineapple peels by WAD goats

Diets	MDMI (KgDM)	Coefficient of preference	Preference Ranking
T1	0.037	0.84	4
T2	0.047	1.09	2
T3	0.049	1.11	1
T4	0.041	0.96	3

MDMI= Mean Dry Matter Intake; T1= 100% cabbage peels without pineapple peels; T2= 90% cabbage peels with 10% pineapple peels; T3= 80% cabbage peels with 20% pineapple peels; T4= 70% cabbage peels with 30% pineapple peels.

Table 2 shows the physicochemical parameters of ensiled cabbage leaves with different inclusion levels of pineapple peels. The colour, odour and texture of silages in T2 - T4 had acceptable physical attributes while pH values ranged from 5.88 (T3 and T4) – 6.01 (T1). Good silage usually preserves the original colour of any forage and has a pleasant and fruity smell indicative of a good and well preserved (Oduguwa *et al.,* 2007). According

to Zhou *et al*, (2018), measuring the pH and quantifying the production of organic acids and alcohols are the main basis of evaluating silage fermentations. The observed pH values were higher than the recommended values of 4.3-4.7 for well-preserved silages (Kung *et al*., 2001). This could be as a result of incomplete fermentation, processing methods or the type of pineapple peels used. The texture obtained in T1 was firm and slightly different from what was obtained in other silage diets (firm and dry). This may be as a result of the absence of pineapple peels in Treatment 1.

Table 3 shows the acceptability of ensiled Cabbage leaves and Pineapple peels by WAD goats. The order of preference for diets by WAD goats was T3 >T2 > T4 > T1. The Coefficient of preference (CoP) values obtained for T2 and T3 were above Unity (1) hence conferring acceptable status on them. Diets T1 and T4 were rejected since the CoP values were below one. Preference of silage diets T2 and T3 may have been as a result of the level of pineapple peels added to the treatments as an additive, which improved the fermentation and conferred a pleasant aroma on the silage diets. This corroborates the results of Falola *et al*. (2013), who reported an increase in the intake and preference of diets of vetiver grass ensiled with cassava peels by WAD goats. The rejection of silage diet T4 is confounding indicating that animals will tend to reject diets with higher fibre levels when they have diets of lower fibre levels to choose from. The coarseness of the silage diet 4 is as a result of higher level of PP. This corroborates the findings of Falola *et al*. (2013) who observed that goats accepted silage diets with less crude fibre and less coarse texture while rejecting others.

Conclusion

Results showed that silages made from CL and PP have potential as feed for ruminants with acceptable physical attributes particularly when PP is included at 10-20%. Higher levels of inclusion of PP in silages will bring about a rejection of diets by WAD goats.

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