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Effects of silo types on nutritive value and acceptability of cassava peel-wheat offal silage by West African dwarf goats

Ajayi, M. O. and Onifade, M. A.
Animal Production and Management Unit
Department of Animal Science, University of Ibadan, Nigeria.
Corresponding author: moajayi5@gmail.com

Abstract

There is low awareness on the local containers for preparing silage, which could be used in the traditional livestock keeping in order to mitigating the forage scarcity often occasioned by prolonged dry season. Against this background, the quality of silage and acceptability by WAD goats of ensiled cassava peel-wheat offal prepared from pit, bucket and polythene were investigated. Twenty-five percent of wheat offal and seventy-five percent of cassava peels were ensiled in three different ensiling materials: pit, plastic bucket and polythene bags. The treatments were replicated four times in a completely randomized design and ensiling lasted for 21 days. The temperature, pH, colour, smell and texture were assessed. Dry Matter-DM, Crude Protein-CP, Acid Detergent Fibre-ADF, Neutral Detergent Fibre-NDF and Acid Detergent Lignin-ADL were determined. Microbial profile: Total Bacteria Count-TBC, mouldiness and fungi in the silage were determined. Concentration of Total Volatile Fatty Acids (TVFA), lactic acid, acetic acid, butyric acid and propionic acid were assessed. Six WAD goats were used to determine the coefficient of preference (CoP) using cafeteria feeding technique. The results revealed that silage temperature from the plastic bucket (31.08˚C) and polythene bag (31.42˚C) were significantly (P<0.05) higher than that from the pit (29.23˚C). Values obtained for pH in different containers were similar. Dark brown silage, fruity odour and firm texture were observed for all the treatments. Crude protein content was significantly (P<0.05) higher for silages in the plastic bucket (8.96%) and polythene bag (8.43%) than that in the pit. Higher significant difference was also observed in the DM of silages prepared in pit (36.37%) than that in polythene bag and plastic bucket. The NDF, ADF and ADL contents were similar for all silages. There were not significant (P>0.005) differences in microbial profile of the silages. The TVFA, lactic acid, acetic acid, butyric acid, and propionic acid of the silages were similar. However, higher significant (P<0.05) difference was observed for TBC (0.89x 10^8 cfu/g) of silage made from pit compared with 0.84 x 10^8 cfu/g from plastic bucket and 0.82x 10^8 cfu/g from polythene bag. The CoP values was greater than unity for all treatments. It was concluded that silage produced in the pit silo had better nutritive value than that in the plastic bucket and polythene bag, however, all the silages were accepted by WAD goats, pit, plastic bucket and polythene bag can be used by smallholder livestock farmers as alternative to conventional silo.

Keywords: Polythene bag silo, bucket silo, pit silo, microbial profile, fermentation characteristics

Effets des types de silos sur la valeur nutritive et l'acceptabilité de l'ensilage d'abats de manioc et de blé par les chèvres naines d'Afrique de l'Ouest

Résumé

Il y a une faible connaissance des conteneurs locaux pour la préparation de l'ensilage, qui pourraient être utilisés dans l'élevage traditionnel afin d'atténuer la pénurie de fourrage souvent occasionnée par une saison sèche prolongée. Dans ce contexte, la qualité de l'ensilage et l'acceptabilité par les chèvres NAO d'abats ensilés de manioc et de blé préparés

à partir de fosse, de seau et de polyéthylène ont été étudiées.
Vingt-cinq pour cent des abats de blé et soixante-quinze pour cent des pelures de manioc ont été ensilés dans trois matériaux d'ensilage différents : noyau, seau en plastique et sacs en polyéthylène. Les traitements ont été répétés quatre fois dans une conception complètement randomisée et l'ensilage a duré 21 jours. La température, le pH, la couleur, l'odeur et la texture ont été évalués. La matière sèche-MS, la protéine brute-PB, la fibre de détergent acide-FDA, la fibre de détergent neutre-FDN et la lignine de détergent acide-LDA ont été déterminées. Profil microbien : Le nombre total de bactéries (NTB), la moisissure et les champignons dans l'ensilage ont été déterminés. La concentration des acides gras volatils totaux (AGVT), de l'acide lactique, de l'acide acétique, de l'acide butyrique et de l'acide propionique a été évaluée. Six chèvres NAO ont été utilisées pour déterminer le coefficient de préférence (CdP) en utilisant la technique d'alimentation de la cafétéria. Les résultats ont révélé que la température de l'ensilage du seau en plastique (31,08 ˚C) et du sac en polyéthylène (31,42 ˚C) était significativement (P<0,05) supérieure à celle de la fosse (29,23 ˚C). Les valeurs obtenues pour le pH dans différents récipients étaient similaires. Un ensilage brun foncé, une odeur fruitée et une texture ferme ont été observés pour tous les traitements. La teneur en protéines brutes était significativement (P<0,05) plus élevée pour les ensilages dans le seau en plastique (8,96 %) et le sac en polyéthylène (8,43 %) que dans la fosse. Une différence significative plus élevée a également été observée dans la MS des ensilages préparés en fosse (36,37%) que celle en sac en polyéthylène et seau en plastique. Les teneurs en FDN, FDA et LDA étaient similaires pour tous les ensilages. Il n'y avait pas de différences significatives (P>0,005) dans le profil microbien des ensilages. L'AGVT, l'acide lactique, l'acide acétique, l'acide butyrique et l'acide propionique des ensilages étaient similaires. Cependant, une différence significative plus élevée (P<0,05) a été observée pour le NTB (0,89 x 10^8 UFC/g) d'ensilage fabriqué à partir de fosse par rapport à 0,84 x 108 UFC/g pour un seau en plastique et 0,82 x 108 UFC/g pour un sac en polyéthylène. Les valeurs de CdP étaient supérieures à l'unité pour tous les traitements. Il a été conclu que l'ensilage produit dans le silo à fosse avait une meilleure valeur nutritive que celui dans le seau en plastique et le sac en polyéthylène, cependant, tous les ensilages étaient acceptés par les chèvres NAO, la fosse, le seau en plastique et le sac en polyéthylène peuvent être utilisés par les petits éleveurs comme alternative au silo classique.

Mots-clés : silo à sacs en polyéthylène, silo à seaux, silo à fosse, profil microbien, caractéristiques de fermentation

Introduction

Silage, one of the major forms of feed preservation through fermentation has been effective in developed countries to preserve feed materials during the period of surplus against the off season. This method of feed preservation is gaining more attention in Nigeria, especially among ruminant farmers in South-western Nigeria and can serve as a solution to the problem of non-availability of feed for ruminants for both small holder and large scale farmers. The availability of conserved feed for ruminants can abate the teething conflict of crop farm invasion by grazing ruminants, a problem that has caused some crop farmers to abandon their farms due to reduction in farm produce(Ajayi *et al.,* 2019), if carefully executed and implemented. The principles of making silage is the same in-respective of the location but variation exist in the type of silo used. The variation in silo types may be due to the herd composition, farm size, capital base, knowledge and information base and also materials available in the area. According to Johnson

and Harrison (2001), pile, bunker, bags or upright silos have been used for feed preservation in developed countries. In Nigeria, the use of plastic drums is widely adopted for producing silage (Olorunnisomo and Adewumi, 2015). To enhance ruminant production among poor-resourced smallholder farmers, there is need for sustainable silo types for silage production and the following factors should be considered; availability, affordability and recyclability of the materials used as silos. Interestingly, enhancing production among this set of ruminant producers is imperative, the smallholder farmers constitute about 80% of Nigeria farmers who are major contributors to the Nation's Gross Domestic Product (GDP) (Mgbenka and Mbah, 2016).Moreover, many of the ruminant farmers practiced mixed farming, production of crops and rearing of animals (Ajayi*et al.,* 2019; Ajayi and Odu, 2020). The residues generated from the crop farm can be preserved as feed for animals all year round, and this will in-turn increase profitability, enhance better livelihood for the farmers and as well provide sufficient food for the populace. Thus, achievingthe second goal of end to hunger, food security, improved nutrition and sustainable Agriculture of Sustainable Development Goals (SDG) adopted by all United Nation Members States in 2015. Therefore, as silage production is getting more popular in Nigeria, there is limited information on the effect on silo types on silage quality, this study aimed at evaluating the quality of silage and its acceptability by WAD goats using different types of silos to ensile cassava peel and wheat offal.

Materials and methods

Experimental site

This study was carried out at the Small Ruminant Unit of the Teaching and Research Farm, University of Ibadan, Oyo State, Nigeria.

Experimental procedures

Plastic bucket of 20litres capacity and recycled granulated sugar polythene bags were obtained from sugar retailers, pit silo of 17 inches depth, 20 inches length and 15 inches breadth was dug and all replicated four times. The composition of silage in the three silo types were 25% wheat offal + 75% cassava peels. Cassava peel was wilted for 12 hours by spreading on polythene sheet with occasional turning to improve the dry matter under favourable weather condition (Rafiuddin *et al*., 2017). The wheat offal and cassava peels were thoroughly mixed, compressed and packed into different silo types. Plastic bucket and pit silos were lined and covered with polythene bags to avoid contamination with sand. Sandbags were placed on each of the silos to prevent oxygen inflow and were kept in cool, dry and rat proof environment. Ensiling lasted for 21 days, physical characteristics were carried out as reported by Ajayi and Joseph (2019). Dry matter and crude protein of the silage was done according to AOAC (1990) and fibre fraction (NDF, ADF and ADL) according to Van Soest *et al. (*1991). Microbial profile was examined according to Powell and Archer (1989) while the fermentation characteristics were assessed as described by Kayol and Borilek (1995). Six WAD goats weighing 16 Kg ±2.5 were used for the acceptability study using cafeteria method as described by Karbo *et al. (*1993) for five days.

$$\text{CoP} = \frac{\text{Intake of individual silage offered}}{\text{Mean intake of the silage types}}$$

If the CoP is < 1, the material is poorly accepted and when > 1, the material is well accepted (Karbo *et al*., 1993).

Statistical analysis

All data obtained were subjected to analysis of variance (ANOVA) while means were separated using Duncan's Multiple Range Test SAS (1999) package.

Results and discussion

Physical characteristics of ensiled cassava peels and wheat offal in different silos is presented in Table 1. Silage temperature is a key indicator of its stability, in this study, temperature increased significantly in both polythene bag and bucket silos with values of 31.42°C and 31.08°C, respectively compared to pit silo with 29.23°C.The temperature values obtained were within the values of 28℃ to 35℃ reported by t'Mannetje (1999) for good quality silage. The difference in the values of temperature recorded could be due to the variations in the ambient temperature due to the positioning of the silos. The pH of an ensiled sample is a measure of its acidity, it is influenced by the buffering capacity, the dry matter of the ensiled material and most especially the lactic acid concentration during fermentation. The pH values varied from 4.00 in bucket silo to 4.13 in pit silo, significant difference was not observed in the different silos. However, the values obtained from the three silos were within the recommended values reported by Kung *et al*. (2018), for good quality silage showing that the silages were well preserved. A dark-brown colour was observed across the silo types, the observed colour corroborates the report of Oduguwa *et al. (*2007) that a well preserved silage should have a little or non-significant difference from the colour of the original material ensiled. The dry and firm texture observed in the different silos is in accordance with the report of SaunandHeinrichs (2008) that good quality silage should be dry and firm due to the production of lacticacid and acetic acid. The fruity odour cut across all the silo types, corroborating the report of Lyimo *et al*. (2016) that well fermented silage should exhibit a pleasant, vinegar, alcoholic or fruity smell.

Table 1: Physical characteristics of ensiled cassava peel and wheat offal in different silo type

	Ensiling containers			
Parameters	Plastic Bucket	Pit	Polythene Bag	SEM
Temperature(℃)	31.08[a]	29.23[b]	31.42[a]	0.15
pH	4.13	4.00	4.10	0.03
Colour	Dark-Brown	Dark-Brown	Dark-Brown	-
Texture	Dry and Firm	Dry and Firm	Dry and Firm	-
Odour	Fruity	Fruity	Fruity	-

[ab] means in the same row with different superscript are significantly (P<0.05) different

Chemical composition of ensiled cassava peel and wheat offal in different silos is presented in Table 2. The dry matter content of 36.37% observed in pit silo was significantly higher than 33.28% in bucket and 33.92% in polythene silos. The low dry matter contents recorded in bucket and polythene silos could be due to the high temperature recorded in this study for silages in both silos. This result corroborates the findings of Kung *et al*. (2018), that increase in silage temperature reduces its dry matter. The CP in polythene bag silo (8.43%) and Bucket (8.69%) were significantly ($p<0.05$) higher than the value obtained in pit silo (7.67%). The high CP in polythene bag and bucket silos could be due to rapid degradation of micro-organisms during fermentation caused by changes in the ambient temperature (**Rafiuddin *et al*., 2017**). The values obtained for NDF varied from 46.29% in pit to 47.37% in bucket and no significance was recorded across the treatments. Similar trend of non-significance was observed in ADF and ADL, the ADF values varied from 25.83% in bucket to 24.59% in pit silo.

Microbial profile of ensiled cassava peels

and wheat offal in different silo types is shown in Table 3. Total bacteria count of silage in pit ($0.89x10^8$cfu/g) was significantly different from bucket and polythene with the values of $0.84x10^8$cfu/g. and $0.82x10^3$cfu/g, respectively. The pH of polythene and bucket silos improve the TBC, which is important in reducing the growth of undesirable microorganisms and loss of nutrients (Liu *et al.,* 2016).Likewise values for Mold counts were $0.20x10^2$cfu/g, $0.15x10^2$cfu/g and $0.13x10^2$cfu/g for pit, bucket and polythene respectively. Yeast Counts recorded was $0.23x10^2$cfu/g for pit, $0.21x10^2$cfu/g for bucket and $0.19x10^2$cfu/g for polythene silo. Yeast count recorded in this study was below the threshold of 10^5 colonies reported by Tabacco *et al.* (2009) which means it prevents aerobic deterioration across the silo types likewise improved its stability.

The concentrations of common fermentation end products of ensiled cassava peel and wheat offal in different silo types is illustrated in Table 4. There was no significant ($p>0.05$) difference in all the fermentation parameters. Total volatile fatty acid values recorded in bucket was 7.93g/kg^{-1}DM, 7.74g/kg^{-1}DM was obtained in pit and polythene had 7.23g/kg^{-1}DM. However, the values obtained in bucket (0.56g/kg^{-1}DM) and polythene (0.56g/kg^{-1}DM) silos were the same compared to pit (0.39g/kg^{-1}DM) and no significant difference was observed. Silage pH is one of the main determinants that influence the extent of fermentation and quality of ensiled crops, and well-preserved silage usually have a low pH but high lactic acid concentration (Xue *et al.,* 2020). The lactic acid value of 4.70g/kg^{-1}DM was obtained in polythene silo, compared to 4.62g/kg^{-1}DM of bucket and 4.37g/kg^{-1}DM in pit silo. Yuan *et al*. (2015) corroborated this report that the lactic acid bacteria also increase nutritive quantities and maintain silage quality by stopping of mischievous epiphytic microbial masses. The acetic acid value in polythene was 2.22g/kg^{-1}DM, bucket had 2.16g/kg^{-1}DM and pit was 1.98g/kg^{-1}DM. The same trend was recorded in butyric acid as values obtained in polythene (0.70g/kg^{-1}DM) silo is higher than values obtained in bucket (0.66g/kg^{-1}DM) and pit (0.59g/kg^{-1}DM) silos.

Table: 2 Chemical composition of ensiled cassava peel and wheat offal in different silo types

	Ensiling containers			
Parameters (%)	Bucket	Pit	Polythene Bag	SEM
CP	8.96[a]	7.67[b]	8.43[a]	0.17
DM	33.28[b]	36.37[a]	33.92[b]	0.56
NDF	47.37	46.29	46.73	0.05
ADF	25.83	24.59	25.14	0.27
ADL	7.34	6.72	6.59	0.31

[ab] means in the same row with different superscript are significantly ($P<0.05$) different
CP (Crude Protein), DM (Dry Matter), NDF (Neutral Detergent Fibre), ADF (Acid Detergent Fibre), ADL (Acid Detergent Lignin), SEM (Standard Error Mean).

Table 3: Microbial profile of ensiled cassava peel and wheat offal in different silo types

Parameter	Ensiling containers			SEM
	Bucket	Pit	Polythene bag	
Total Bacteria (10^8cfu/g)	0.84[b]	0.89[a]	0.82[b]	0.02
Mold counts (10^2cfu/g)	0.15	0.20	0.13	0.03
Yeast (10^2cfu/g)	0.21	0.23	0.19	0.03

[ab] means in the same row with different superscript are significantly (P<0.0 5) different
SEM- Standard Error Mean

Table 4: Concentrations of common fermentation end products of ensiled cassava peel and wheat offal in different silo types

Parameter	Ensiling containers			SEM
	Bucket	Pit	Polythene bag	
Total VFA (g/kg $^{-1}$DM)	7.93	7.23	7.74	0.38
Propionic Acid (g/kg^{-1}DM)	0.56	0.59	0.53	0.06
Lactic Acid (g/kg^{-1}DM)	4.62	4.57	4.70	0.14
Acetic acid (g/kg^{-1}DM)	2.16	2.08	2.22	0.11
Butyric acid (g/kg^{-1}DM)	0.66	0.49	0.70	0.01

[ab] means in the same row with different superscript are significantly (P<0.05) different
SEM- Standard Error Mean

Figure 1 shows the coefficient of preference of ensiled cassava peel and wheat offal in different silo types. The daily mean consumption varied from 4.44kg to 4.60kg with no significant difference observed, the coefficient of preference was 1.65, 1.60 and 1.72 for pit, polythene and bucket silos, respectively. The CoP of the silage were greater than 1 which showed that all the silage in each of the silo types were preferred by the animals.

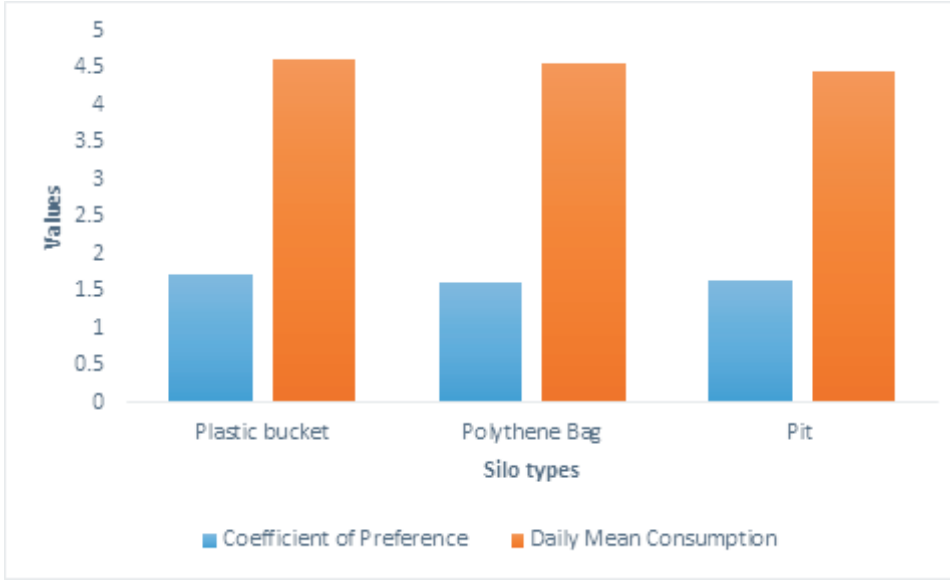

Figure 1: Coefficient of Preference and Daily mean consumption of Ensiled Cassava Peel and Wheat Offal in Different Silo Types

Conclusion

The study showed that polythene bags, pit silo and plastic buckets can be affordably used as fermentation storage containers in the production of nutritive and acceptable silages for WAD goats by smallholder's farmers.

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