# CONVERTING FEED WASTE TO WEALTH: MAKING AND FEEDING OF CABBAGE WASTE SILAGE

**Tolulope O. Ososanya[1], Chika Ozumba[2], Edoh Ofugocho[1], Abdullahi Akande[3], Temitope O. Bankole[1], Ngozi F. Anurudu[1], Olufemi Alaba[1], Bukola R. Fagbenro[1] and Babatunde Ogunwumiju[1]**

1. Department of Animal Science, University of Ibadan, Ibadan, Nigeria

*Email*: tososanya85@gmail.com

2. 1B Arthur Street, Sittingbourne, ME12 1BA, United Kingdom

3. Lousia Ryland House, 44 Newhall Street, Birmingham, West Midlands, B3 3PL, United Kingdom

# INTRODUCTION

- Cabbage trimming in Nigerian markets generates high-moisture waste with high disposal costs
- High moisture content limits cabbage waste (CW) handling, transport and storage
- Conventional feed ingredients (e.g., soybean meal, groundnut cake) are expensive and often inaccessible
- Dry-season forages are low in crude protein and high in fibre (Bamikole and Babayemi, 2004)
- Cabbage waste is digestible and rich in crude protein, potentially a good feed for ruminants
- Ruminants tolerate up to 50% dietary inclusion of CW due to superior fibre digestion (Nkosi et al., 2009)

- Ensiling CW with absorbents (wheat offal, cassava peels, brewers' dry grain) improves storability and nutrient balance

- Cabbage waste is a promising, under-utilised agro-waste (Wadhwa et al., 2006)

- Despite CW's nutritional value, its high moisture makes it impractical for direct use

- Its perishability limits application in smallholder systems without preservation

- There's a need to reconcile CW's potential with practical feeding and storage challenges

- This study evaluated the physico-chemical properties, growth performance, rumen microbial assay, and carcass characteristics of Yankasa rams fed diets containing varying proportions of ensiled CW

# MATERIALS AND METHODS

**Experimental Design**

- Completely Randomised Design

**Experimental Layout/Silage Formulations**

- **Five treatments (T1–T5)** were formulated as follows:
  - **T1:** 0% CW + 60% WO + 20% BDG + 20% CP
  - **T2:** 10% CW + 50% WO + 20% BDG + 20% CP
  - **T3:** 20% CW + 40% WO + 20% BDG + 20% CP
  - **T4:** 30% CW + 30% WO + 20% BDG + 20% CP
  - **T5:** 40% CW + 20% WO + 20% BDG + 20% CP

# PARAMETERS MEASURED

❖ **Silage Quality Assessment (after 21 days)**

- **Physico-chemical characteristics**

- Colour, Odour, Texture, pH (AOAC, 2005), Temperature ($^{O}C$)

- **Chemical composition**

- Dry matter (%), Crude protein (CP, %), Crude fibre (CF, %), Ether extract (EE, %), Nitrogen free extract (NFE, %), Ash (%) (AOAC, 2005)
- Neutral detergent fibre (NDF, %), Acid detergent fibre (ADF, %), Acid detergent lignin (ADL, %) (Van Soest et al., 1994)

❖ **Acceptability Test**

- Coefficient of Preference (Bamikole et al., 2004)
- Percentage Preference, Preference Ranking (Olorunnisomo and Fayomi 2012)

❖ **Feeding Trial (109 days)**

- **Animals:** 6 rams/treatment (n = 30), Average weight 16.1 ± 1.3 kg
- **Indices measured:**
  - Dry Matter Intake (DMI, g/day)
  - Body Weight Change (BWC, kg)
  - Feed Conversion Ratio (FCR)

❖ **Rumen Microbial Assay (Day 109)**

- Samples from 2 animals per treatment
- Analysed for:
  - Total Bacteria Count (TBC - $10^4$ CFU/mL), Total Fungi Count (TFC - $10^4$ CFU/mL) (Harrigan and McCance, 1976)
  - Total Protozoa Count (TPC - $10^3/cm^3$) (Frumholtz *et al*. 1989)

❖ **Carcass Evaluation**

- 3 rams per treatment were sacrificed
- Indices measured:
  - Dressing Percentage (DP) (Aduku and Olukosi , 2000)
  - Rib Eye Area (REA, $cm^3$) (Osorio and Osorio, 2003)

❖ **Data Analysis**

- Descriptive statistics and ANOVA
- Significance level: $\alpha = 0.05$

# RESULTS

**Table 1: Physico-chemical characteristics of cabbage waste ensiled with wheat offal**

| Parameters | S1 | S2 | S3 | S4 | S5 | SEM |
|---|---|---|---|---|---|---|
| Colour | LB | LBG | DBG | DBG | DBG | |
| Odour | Slightly fruity | Fruity | Fruity | Fruity | Fruity | |
| Texture | Slightly firm | Firm | Firm | Firm | Firm | |
| pH | $4.90^{a}$ | $4.60^{b}$ | $3.99^{c}$ | $3.83^{d}$ | $3.70^{e}$ | 0.01 |
| Temperature ($^{O}C$) | $28.91^{a}$ | $28.71^{b}$ | $28.63^{c}$ | $28.56^{d}$ | $28.40^{e}$ | 0.01 |

$^{a,b,c,d,e}$ means on the same row with different superscripts are significantly different ($P<0.05$) at 5% probability level using Duncan's Multiple Range Test. Standard error of mean (SEM) light brown (LB) , light brownish green (LBG), dark brownish green (DBG), wheat offal (WO), cabbage waste (CW) , brewers dry grain (BDG) , dried cassava peel (DCP)

S1: 60% WO+0%CW+20%BDG+20%DCP
S2: 50%WO+10%CW+20%BDG+20%DCP
S3: 40%WO+20%CW+20%BDG+20%DCP
S4: 30%WO+30%CW+20%BDG +20%DCP
S5: 20%WO+40%CW+20%BDG+20%DCP

**Table 2: Chemical Compositions of Cabbage Waste Ensiled with Wheat Offal**

| Parameters | S1 | S2 | S3 | S4 | S5 | SEM |
|---|---|---|---|---|---|---|
| MC (%) | 58.60$^{d}$ | 61.50$^{c}$ | 63.50$^{bc}$ | 64.40$^{b}$ | 72.00$^{a}$ | 0.09 |
| DM (%) | 41.40$^{a}$ | 38.50$^{b}$ | 36.50$^{bc}$ | 35.60$^{c}$ | 28.00$^{d}$ | 0.06 |
| CP (%) | 9.89$^{b}$ | 10.47$^{b}$ | 13.28$^{a}$ | 14.83$^{a}$ | 12.50$^{a}$ | 0.74 |
| CF (%) | 14.38$^{a}$ | 18.90$^{ab}$ | 12.85$^{bc}$ | 12.22$^{c}$ | 12.49$^{bc}$ | 0.28 |
| EE (%) | 2.76$^{ab}$ | 2.43$^{b}$ | 2.90$^{a}$ | 3.13$^{a}$ | 2.87$^{a}$ | 0.75 |
| NFE (%) | 58.05$^{a}$ | 58.63$^{a}$ | 50.60$^{b}$ | 49.88$^{b}$ | 54.96$^{ab}$ | 0.78 |
| Ash (%) | 13.94$^{b}$ | 13.32$^{b}$ | 20.42$^{a}$ | 18.86$^{a}$ | 14.87$^{a}$ | 0.85 |
| NDF (%) | 44.55$^{d}$ | 47.10$^{c}$ | 50.67$^{a}$ | 49.80$^{b}$ | 50.73$^{ab}$ | 0.63 |
| ADF (%) | 28.40 | 29.90 | 29.52 | 28.84 | 30.63 | 0.37 |
| ADL (%) | 12.90$^{e}$ | 14.10$^{d}$ | 14.90$^{c}$ | 16.05$^{b}$ | 16.83$^{a}$ | 0.00 |

$^{a,b,c,d,e}$ means on the same row with different superscripts are significantly different ($P<0.05$) at 5% probability level using Duncan's Multiple Range Test. Standard error of mean (SEM) light brown (LB) , light brownish green (LBG), dark brownish green (DBG), wheat offal (WO), cabbage waste (CW) , brewers dry grain (BDG) , dried cassava peel (DCP)

S1: 60% WO+0%CW+20%BDG+20%DCP
S2: 50%WO+10%CW+20%BDG+20%DCP
S3: 40%WO+20%CW+20%BDG+20%DCP
S4: 30%WO+30%CW+20%BDG +20%DCP
S5: 20%WO+40%CW+20%BDG+20%DCP

**Table 3: Acceptability of cabbage Waste Ensiled with Wheat Offal by Yankasa Rams**

| Parameters | S1 | S2 | S3 | S4 | S5 | SEM |
|---|---|---|---|---|---|---|
| AVFI (kg) | 1.74 | 1.78 | 1.80 | 1.82 | 1.80 | 0.02 |
| CoP | $1.02^{ab}$ | $1.01^{ab}$ | $1.06^{a}$ | $1.01^{ab}$ | $1.09^{a}$ | 0.03 |
| Percentage Preference | $18.75^{b}$ | $20.00^{ab}$ | $21.05^{ab}$ | $21.15^{ab}$ | $21.53^{a}$ | 0.37 |
| Preference Ranking | $5^{th}$ | $4^{th}$ | $3^{rd}$ | $2^{nd}$ | $1^{st}$ | |

$^{a,b,c,d,e}$ means on the same row with different superscripts are significantly different ($P<0.05$) at 5% probability level using Duncan's Multiple Range Test. Standard error of mean (SEM), coefficient of preference (CoP), average feed intake (AVFI), wheat offal (WO), cabbage waste (CW) , brewers dry grain (BDG) , dried cassava peel (DCP)

S1: 60% WO+0%CW+20%BDG+20%DCP
S2: 50%WO+10%CW+20%BDG+20%DCP
S3: 40%WO+20%CW+20%BDG+20%DCP
S4: 30%WO+30%CW+20%BDG +20%DCP
S5: 20%WO+40%CW+20%BDG+20%DCP

**Table 4: Feed Intake and Performance of Yankasa Rams Fed Cabbage Waste Based Diets**

| Parameters | S1 | S2 | S3 | S4 | S5 | SEM |
|---|---|---|---|---|---|---|
| Initial Weight (kg) | 16.39 | 16.40 | 16.45 | 16.45 | 16.50 | 0.96 |
| Final Weight (kg) | 24.00 | 27.50 | 28.00 | 31.00 | 29.25 | 1.43 |
| Body Weight Gain (kg) | 7.88$^{b}$ | 10.88$^{ab}$ | 12.00$^{ab}$ | 15.00$^{a}$ | 12.75$^{a}$ | 0.79 |
| Daily Weight Gain (g) | 80.36$^{b}$ | 110.97$^{ab}$ | 122.45$^{ab}$ | 153.06$^{a}$ | 130.10$^{a}$ | 8.02 |
| DMI (g/d) | 915.15 | 924.81 | 1100.03 | 1112.61 | 951.86 | 12.36 |
| FCR | 12.24$^{a}$ | 9.17$^{ab}$ | 8.90$^{ab}$ | 7.10$^{b}$ | 7.23$^{b}$ | 0.68 |

$^{a,b,c,d,e}$ means on the same row with different superscripts are significantly different ($P<0.05$) at 5% probability level using Duncan's Multiple Range Test. Standard error of mean (SEM), feed conversion ratio (FCR) , dry matter intake (g/day) (DMI) , wheat offal (WO), cabbage waste (CW) , brewers dry grain (BDG) , dried cassava peel (DCP)

S1: 60% WO+0%CW+20%BDG+20%DCP

S2: 50%WO+10%CW+20%BDG+20%DCP

S3: 40%WO+20%CW+20%BDG+20%DCP

S4: 30%WO+30%CW+20%BDG +20%DCP

S5: 20%WO+40%CW+20%BDG+20%DCP

**Table 5: Microbial Population of Yankasa Rams Fed Cabbage Waste Based Diets**

| Parameters | S1 | S2 | S3 | S4 | S5 | SEM |
|---|---|---|---|---|---|---|
| Bacteria ($10^4$ cfu/mL) | 4.66 | 4.85 | 4.72 | 5.16 | 5.28 | 0.10 |
| Fungi ($10^4$ cfu/mL) | 1.00 | 1.16 | 1.26 | 1.30 | 1.40 | 1.07 |
| Protozoa ($10^3$ /$cm^3$) | $0.95^c$ | $1.05^b$ | $1.05^b$ | $1.14^b$ | $1.35^a$ | 0.18 |

$^{a,b,c,d,e}$ means on the same row with different superscripts are significantly different ($P<0.05$) at 5% probability level using Duncan's Multiple Range Test. Standard error of mean (SEM), wheat offal (WO), cabbage waste (CW), brewers dry grain (BDG), dried cassava peel (DCP)

S1: 60% WO+0%CW+20%BDG+20%DCP
S2: 50%WO+10%CW+20%BDG+20%DCP
S3: 40%WO+20%CW+20%BDG+20%DCP
S4: 30%WO+30%CW+20%BDG +20%DCP
S5: 20%WO+40%CW+20%BDG+20%DCP

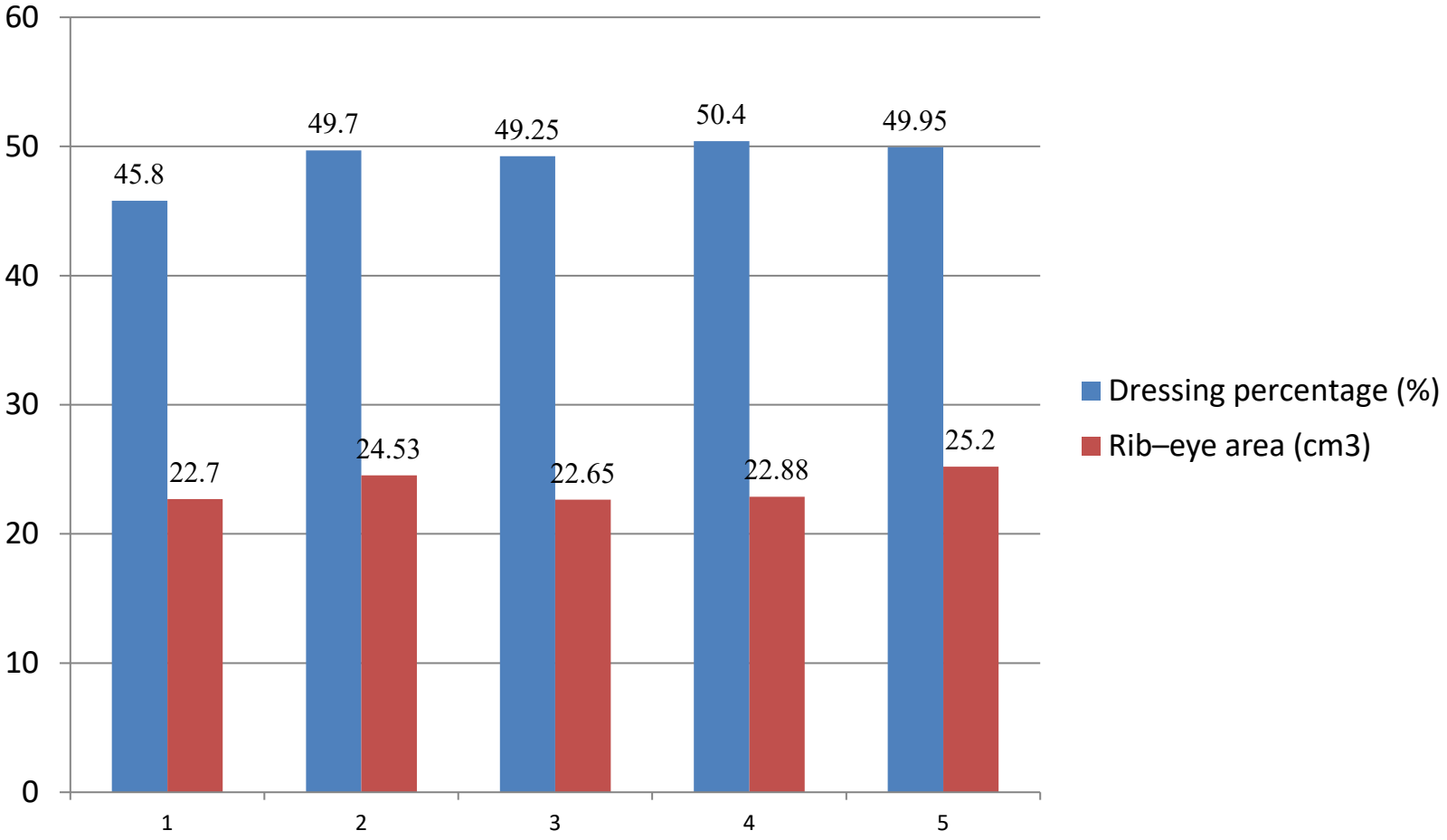


**Figure 1: Dressing Percentage and Rib-eye Area of Yankasa rams fed cabbage waste based diets**

# CONCLUSION

Combination of cabbage waste and absorbents at 30% improved its utilisation as ruminant feed, enhanced weight gain by 90.3% and reduced feed conversion ratio of rams

# References


- Aduku, A. O. and Olukosi, J. O. (2000). Animal products processing and handling in the tropics. Living books series publication, Abuja, Nigeria. Pp 24 – 32.
- AOAC, (2005).The Official Methods of Analysis. 18th ed. (edited by W. Horwitz). Gaithersberg, USA: Association of Official Analytical Chemists, 18th Edition ,Washinton D.C.
- Bamikole, M. A. and Babayemi, O.J. 2004. Feeding goat with Guinea grass-verano stylo, nitrogen fertilized grass and energy concentrate. *Archievos de Zootenica* 53: 13 - 23.
- Bamikole, M. A., Ikhatua, U. J., Arigbede, O. M., Babayemi, O. J. and Etela, I. 2004. An evaluation of the acceptability of some nutritive and antinutritive compounds and the dry matter degradation profile of five species of fiscus. *Tropical Animal Health Production* 36: 157 - 167.
- Frumholtz P.P., Newbold C. J and Wallace R J., 1989. Influence of Aspergillus oryzae fermentation fermentation of a basal ration in the rumen simulation technique (Rusitec). *Journal of Agricultural Science* 113: 169 –172.
- Harrigan, W. F., and McCance M. E., 1976. Laboratory methods in food and dairy microbiology, Academic Press, London Pp 66 - 81.

- Nkosi, B. D., Meeske, R., Palic, D., Langa, T., Leeuw, K. J. and Groenewald, I. B. 2009. Effects of ensiling whole crop maize with bacterial inoculants on the fermentation, aerobic stability, and growth performance of lambs. *Animal Feed Science Technology* 154: 193 – 203
- Olorunnisomo, O. A. and Fayomi, O. H. 2012. Quality and preference of Zebu heifers for legume or elephant grass-silages with cassava peel. Livestock Research for Rural Development Volume 24 Article #168. http://www.lrrd.org/lrrd24/9/olor24168.htm
- Osório, J. D. S. (2003). *Produção de carne ovina: técnicas de avaliação" in vivo" e na carcaça*. Universidade Federal de Pelotas.
- Wadhwa, M., Kaushal, S. and Bakshi, M. P. S. 2006. Nutritive evaluation of vegetable wastes as complete feed for goat bucks. *Small Ruminant Research* 64: 279 - 284.
- Van Soest, P. J. 1994. Nutritional Ecology of Ruminats. 2nd Edition. Cornell Universiity Press, USA. Pp 476.


OBRIGADO
gracias
どうも
ARIGATO
hvala
DANKU
takk
MERSI
merci
obrigado
danke schön
köszi
PALDIES
ありがとう
TEŞEKKÜR EDERIM
謝謝
THANK YOU
muchas gracias
grazas
GRAZZI
OBRIGADO
благодаря
OBRIGADO
どうも
ARIGATO
THANKS
OBRIGADO
qujanTAK
muchas gracias
MOLTE GRAZIE
TAK
vielen dank
PALDIES
OBRIGADO
danke
DANKU
mesi
감사합니다
köszi
благодаря
grazie
DZIKI
TACK
Gràcies
MULTUMESC
TEŞEKKÜR EDERIM
muchas gracias
obrigado
спасибо
多謝
NA GODE