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Chemical composition and *in vitro* dry matter digestibility of dual-purpose sweet potato vine cultivars as alternative forage in ruminant diets

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Abstract
This study set out to assess the dual-purpose sweet potato vine cultivars' chemical composition and *in vitro* dry matter digestibility, as potential substitute fodder in ruminant diets. Six sweet potato cultivars were established in three replicates as part of the randomized full block design experiment. There were six cultivars used. At 120 days, the vines were harvested. The dry matter range was between 13.73% and 12.92%. The crude protein was between 16.84% and 23.70%. Kenspot 1 had the greatest energy, whereas Kenspot 2 had the lowest. Whereas NDF and ADF were lowest in Kenspot 4 and highest in Kenspot 2, respectively. The organic matter digestibility was between 80% and 84%. Kenspot 1 had the highest percentage (84.21%), while Kenspot 3 had the lowest (80.70%). The results of this study revealed that the five dual-purpose cultivars have excellent potential for use as fodder.

Keywords: Digestible energy, fermentation, gas, kinetics, protein

1. Introduction
The area of land that can be utilized to cultivate pastures and forages has reduced significantly as a result of the growing population and shrinking land sizes, as the little available land is now being used to grow food crops [4]. This has made it necessary to find crops with multiple uses that can be utilized for cattle feed and human food. Sweet potato vines *(Ipomoea batatas)* has attracted a lot of interest from many scientists in recent years. This is due to its adaptation to dryer environments and their potential for use as human and livestock food. However, there is no data on herbage yields and its effects on livestock output in sub-Saharan Africa, therefore its promise as a feed for livestock hasn't been fully realized [26].

According to research done at the International Potato Centre (CIP) in 2008, farmers favor the dual-purpose cultivars since they produce high yields of tubers for human food and livestock feed due to the fact that harvesting can occur at any time during the growing season. A total of 12.8 t/ha of sweet potato tubers are produced in Kenya each year on roughly 59.2 thousand ha of land [4]. However, the quantity of vines grown adjacently has not been recorded. In East Africa, sweet potato vines (SPVs) can provide considerable supplement to other forages and pastures for dairy cows, goats, and pigs [26]. In a study done in Uganda, milk consumption per calf was lowered by 120 liters during a 70-day period in a trial carried out in Uganda to assess the feasibility of sweet potato vine-based diets as partial milk substitutes (PMS) for dairy calves [30]. At Kenya Agricultural and Livestock Research Organization (KALRO), Foods Crop Research Institute in Njoro, a number of sweet potato cultivars have been released recently for different agro-ecological zones. Among them were the cultivars Kenspot 1, 2, 3, 4, 5, and 6, among others. This work is a step in the direction of bridging the information gap on biomass and nutritional value for animals, which is currently unmet.

2. Materials and Methods
This study was conducted in KALRO-Lanet, which is located in Nakuru a County in Kenya. The centre is located 1920 meters above sea level, between longitude 36° 09' E and latitude00° 18' S.

2.1 Growing Forage Sweet Potatoes
A good seed bed was established on the prepared land. A pathway of one-meter-wide connected each of the eighteen 2.5 × 2.5-meter plots. The experiment was set up using a randomized complete block design (RCBD). Six cultivars of SPV, including Wagabolige, Kenspot 1, 2, 3, 4, and 5, were planted in three duplicates at random. The control was a sweet potato cultivar called Wagabolige, which is an enhanced forage type [24].

2.2 Chemical analysis
Feed samples were evaluated using the methodology described by [32]. The methods from [2] were used to complete the proximate analysis.

2.3 *In vitro* gas production
Using rumen fluid in calibrated glass syringes, samples weighing about 200 mg were cultured *in vitro* in triplicate according to the protocol of [19]. Prior to filling each syringe with 30 mL of rumen liquor-buffer mixture (ratio: 2:1) and incubating them in a water bath kept at 39°C, the syringes were pre-warmed to 39 °C. Additionally, blanks containing solely buffered rumen fluid were used. Following 3, 6, 12, 24, 48, 72, and 96 hours of incubation, the gas production measurements were taken. In order to ascertain the feed's degradability, the estimated values of gas production were put into the model created by [25]. The formula used to determine the *in vitro* organic matter digestibility was OMD (%) = 18.53 + 0. 9239 (gas production at 48 hours) + 0.0540 CP [19]. The Australian Agricultural Council's (AAC, 1990) [1] formula was used to estimate the metabolizable energy (ME) of tropical forages, as follows: MY DM/MJ = DOM gKg-1 DM × 18.5 × 0.81. Where DM is dry matter, DOM is digestible organic matter (gKg-1 DM), MJ is mega joules, and ME is the metabolizable energy (MJ/Kg DM).

2.4 Statistical analysis
The general linear model of ANOVA [28] software (version 9.0) was used to analyse the data. LSD was used to differentiate means at ($p<0.05$).

3. Results
Table 1 displays the cultivars' composition and yield. The control cultivar, Wagabolige, produced the maximum biomass quantity ($p<0.05$), which was followed by Kenspot 3 and Kenspot 4. The energy levels of the various cultivars varied significantly, with Kenspot 1 having the greatest value and Kenspot 2 having the lowest. NDF and ADF fiber content was highest ($p<0.05$) in Kenspot 2 and lowest ($p<0.05$) in Kenspot 1. In Kenspot 1, crude protein (CP) was highest ($p<0.05$), while in Kenspot 3, it was lowest. The energy levels of Kenspot 1 and Kenspot 4 were highest ($p<0.05$), whereas the lowest energy levels were found in Kenspot 2 and Kenspot 5. Kenspot 2, Kenspot 5, and Kenspot 1, in that order. Of the cultivars tested, Kenspot 4 had the highest dry matter (DM), albeit not significantly ($p<0.05$).

Table 1: Yield and chemical composition of six cultivars of sweet potato vines on fresh basis

Cultivar	DM%	Yield t/ha	Energy (MJ)	Crude Protein (%)	NDF %	ADF %
Kenspot 1	13.02^{d}	29.4^{cb}	8.72^{a}	23.70^{a}	40.15^{c}	21.50^{e}
Kenspot 2	12.93^{e}	16.4^{d}	7.50^{ed}	19.23^{c}	42.28^{b}	24.96^{cb}
Kenspot 3	12.92^{e}	31.7^{b}	7.35^{f}	16.84^{d}	46.11^{a}	28.78^{a}
Kenspot 4	13.73^{a}	29.2^{cb}	8.00^{b}	21.82^{b}	42.85^{b}	23.29^{d}
Kenspot 5	13.50^{b}	19.5^{cd}	7.47^{d}	19.78^{c}	43.02^{b}	25.46^{b}
Wagabolige	13.12^{c}	64.5^{a}	7.72^{c}	19.60^{c}	42.94^{b}	24.40^{c}

^{abcd} at 5% ($p<0.05$), means in a column with distinct subscripts differ considerably.
DM: Dry Matter; NDF: Neutral Detergent Fibre; ADF: Acid Detergent Fibre;

3.1 *In vitro* gas production
Table 2 summarizes the varying degrees of gas output. Within 24 and 48 hours, Kenspot 1 produced the most gas (42.1 ml/200 g DM and 69.9 ml/200 g DM, respectively), while Kenspot 3 produced the least (38.4 ml/200 g and 66.5 ml/200 g, respectively). Within the range of 68.2 to 78.2 ml and 0.21 to 0.52/hr, respectively, were the potential (a + b) and rate (c). Feed transit through the rumen is mostly explained by the gas production rate (c), while feed degradability is linked to the potential gas production (a + b) [15]. This suggests that a richer nutritional profile for rumen microbes may be the cause of the higher values found for the potential methane production in the Kenspot 1. Organic matter digestibility (OMD) values varied from 80 to over 84%. Kenspot 1 had the highest percentage (84.21%), while Kenspot 3 had the lowest (80.70%).

Table 2: *In vitro* gas production (ml/200 g DM) of six cultivars of sweet potato vines

Cultivar	24	48	a + b	c(%h)	OMD 48(%)
Kenspot 1	42.1^{a}	69.9^{a}	78.2^{a}	0.33^{b}	84.21^{a}
Kenspot 2	39.2^{b}	68.3^{c}	68.4^{e}	0.52^{a}	82.49^{c}
Kenspot 3	38.4^{b}	66.5^{d}	68.2^{e}	0.28^{c}	80.70^{f}
Kenspot 4	34.0^{c}	68.5^{b}	75.3^{c}	0.25^{d}	82.82^{b}
Kenspot 5	33.2^{d}	68.2^{c}	72.5^{b}	0.23^{e}	82.43^{d}
Wagabolige	33.1^{d}	68.1^{c}	72.0^{d}	0.21^{f}	82.33^{e}

^{abcd} at 5% ($p<0.05$), means in a column with distinct subscripts differ considerably 48 OMD: Organic matter digestibility *in vitro* determined using the following formula: Menke and Steingass (1988) defined OMD (%) as 18.53 + 0.9239 Gas output + 0.0540 Crude protein. The constants a, b, and c are defined by [25].

4. Discussion
All six varieties of sweet potatoes vines were quite nutritious. They all possessed a substantially greater CP above 80 g CP/kg DM threshold that defines low quality forages [18]. As a result, this has a positive effect on rumen microbial activity [31]. Additionally, the fibre was lower than 600 g/kg DM level that is typically considered as the upper limit for good quality forage for ruminants [20]. The low NDF was in line with the widespread finding that NDF is generally lower in non-grass forages than in grass [21]. The six cultivars had enough fibre,

measured as NDF and defined as total cell wall content, for ruminating, salivary circulation, rumen buffering, and the well-being of the rumen wall [5] Additionally, the high energy as a result of a high OM digestibility allows ruminant animals to get enough metabolizable energy needed in protein synthesis [27, 22]. However, Kenspot 3 had the least values for crude protein and the highest fibre leading to low dry matter intake and decreased nutrients digestion. The quality of the six vine forages varieties matched that of forage sweet potato described in the literatures by [29, 33, 17, 23]. The DM matched the values published by [3, 23]. The organic matter values were similar with to those reported for forage sweet potato by [6, 9, 3]. As reported by [7, 16, 33] the CP values were also within these ranges. levels of Fibre (NDF, ADF, and ADL) were within the range as described by [23, 13]. All six sweet potato cultivars showed excellent nourishment for the sheep, as evidenced by the great nutritional digestibility observed. For instance, OM digestibility was higher than the typical range of 500–600 g/kg DM for tropical grasses [21, 12, 22]. The organic matter digestibility contrasted favourably with the 678-831 g/kg DM for forage sweet potato reported by [29]. The highest OM digestibility was found in Kenspot 1, which also had the highest Energy, CP, and lowest NDF. This is consistent with findings by [21] which demonstrated high metabolizable energy improved digestibility while high fibre decreased digestibility. Furthermore, [21] revealed a positive correlation between nutritional digestibility and OM digestibility, which was linked to the energy in the feed. The amount of NDF affected how digestible the OM was. The rate of NDF digestion is influenced by lignification, rumen bacterial activity, and the amount of time feed is retained in the rumen [21]. The OM digestibility of the six cultivars was comparable, and they had nearly the same structure of cells and intrinsic traits for NDF and CP. The findings of [11, 8] were consistent with this outcome

5. Conclusion

Compared to typical tropical grasses, the six cultivars had lower fibre content and greater levels of OM and CP, making them acceptable for feeding sheep. They met the requirements for high quality feed by having high ME and high OM, CP, and NDF digestibility. The six cultivars might be able to provide sheep with the necessary nutrients, but their low dry matter content might make them unsuitable for usage as the exclusive source of nutrition. For this reason, feeding it as a supplement to forage is advised.

6. Recommendations

This study therefore, recommends utilizing sweet potato vines as an appropriate fodder supplement. The performance of sheep and dairy goats fed these sweet potato cultivars and their impact on animal products like milk require more investigation.

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8. References

1. AAC. Feeding standards for Australian livestock. Australian Agricultural Council. Ruminant sub-committee, CSIRO, Australia; c1990.
2. AOAC. Official methods of analysis. Association of Official Analytical Chemists, Gaithersburg, MD, USA. 18th Ed; c2005.
3. Chhay T, Borin K, Phiny C. A note on the effect of fresh mulberry leaves, fresh sweet potato vines or mixture of both foliages on intake, digestibility and N retention of growing pigs given a basal diet of broken rice. Livestock Research for Rural Development; c2007. p. 19. article #136. http://www.lrrd.org/lrrd19/9/chha19136.htm (last accessed 10 February 2016).
4. FAO. Livestock in food security. Food and Agriculture Organization Statistical database for agriculture. Crops and products domain; c2012. http://faostat.fao.org/ (Accessed 19, August 2013).
5. Fox DG, Sniffen CJ, O'Connor JD, Rusell JB, Van Soest PJ. A net carbohydrate and protein system for evaluating cattle diets. III. Cattle requirements and diet adequacy. J Anim. Sci. 1992;70:3578-3596.
6. Farrell DJ, Jibril H, Perez-Maldonado RA, Mannion PF. A note on a comparison of the feeding value of sweet potato vines and lucerne meal for broiler chickens. Anim. Feed Sci. Techn. 2000;85:145-150.
7. Giang HH, Ly LV, Ogle B. Evaluation of ensiling methods to preserve Sweet potato roots and vines as pig feed. Livestock Research for Rural Development. 2004;1:45.
8. Hagerman AE, Robbins CT, Weerasuriya Y, Wilson TC, McArthur C. Tannin chemistry in relation to digestion. J. Range Man. 1992;45:57-62.
9. Iyeghe-Erakpotobor GT, Aliyu R, Uguru J. Evaluation of concentrate, grass and legume combination on performance and nutrient digestibility of grower rabbits under tropical conditions. AJB. 2006;4:2004-2008.
10. Jaetzold R, Schmidt H, Hornetz B, Shisanya C. The Farm Management Handbook of Kenya. Central Kenya. Volume II, 2nd edition. Ministry of Agriculture, Kenya; c2006.
11. Kaitho RJ. Nutritive value of browse as protein supplements to poor quality roughages. PhD thesis. Wageningen University, Netherlands; c1997.
12. Kariuki JN. The potential of improving napier grass under smallholder dairy farmer`s conditions in Kenya. PhD thesis. Wageningen University, Netherlands; c1998.
13. Kebede T, Lemma T, Tadesse E, Guru M. Effect of level of substitution of sweet potato vines for concentrate on body weight gain and carcass characteristic of browsing Arsi Bale goats. JCAB. 2008;2:36-42.
14. Muddebihal S, Chandrashekar GS, Ramegowda GK, Patil SV, Amarananjundeswara H, Krishna HC, *et al*. Studies on impact of storage materials and methods on potato tuber moth, *Phthorimaea operculella* Zeller (Lepidoptera: Gelechiidae) on potato. Int. J. Biol. Sci. 2021;3(2):53-56. DOI: 10.33545/26649926.2021.v3.i2a.135
15. Khazaal KA, Dentino MT, Ribeiro JM, Ørskov ER. Prediction of apparent digestibility and voluntary intake of hays fed to sheep: comparison between using fibre components, *in vitro* digestibility or characteristics of gas production or nylon bag degradation. Animal Science. 1995;61:527-538.
16. Lam V, Ledin I. Effect of feeding different proportions of sweet potato vines (*Ipomoea batatas*) and Sesbania gradiflorain the diet on feed intake and growth of goats. Livestock Research for Rural Development. 2004;16:77.
17. Larbi A, Etela I, Nwokocha HN, Oji UI, Anyanwu NJ,

Gbaraneh LD, *et al*. Fodder and tuber yields and fodder quality of sweet potato cultivars at different maturity stages in West African humid forest and Savanna zones. Anim. Feed Sci. and Techn. 2007;135:126-138.
18. Leng RA. Factors affecting the utilization of poor-quality forages by ruminants particularly under tropical conditions. Nutr. Res. Reviews. 1990;3:277-303.
19. Menke KH, Steingass H. Estimation of the Energetic Feed Value obtained from chemical analysis and *in vitro* gas production using rumen fluid. Animal Resource Development1998;28:7-55.
20. Meissner HH, Koster HH, Nieuwuodt SH, Coertze RJ. Effect of energy supplementation on intake and digestion of early and mid-season rye grass and panicum/smuts finger hay. S. Afr. J Anim. Sci. 1991;21:33-42.
21. Minson DJ. Forage in Ruminant Nutrition. Academic Press, London; c1990.
22. Muia JMK. Use of Napier grass to improve smallholder milk production in Kenya. PhD thesis, Wageningen University, Netherlands; c2000.
23. Olorunnisomo OA. Yield and quality of sweet potato forage pruned at different intervals for West African dwarf sheep. Livestock Research for Rural Development. 2007;19:36.
24. Ondabu N, Irungu KRG, Tarus S, Ontiti S. Sweet Potato Vine selection programme at Lanet. Proceedings of the 9th Triennial Symposium of the International Society for Tropical Root Crops Africa Branch, Mombasa, Kenya, 1–5 November; c2007. p. 490-494.
25. Ørskov ER, McDonald I. The estimation of protein degradation in the rumen from incubation measurements weighted according to the rate of passage. Journal Agricultural Science. 1979;92:499-503.
26. Peters D. Assessment of the potential of sweet potato as livestock feed in East Africa: Rwanda, Uganda, and Kenya. Report presented to the International Potato Center (CIP); c2008.
27. Preston TR, Leng R. Matching Ruminant Production Systems with available resources in the Tropics and sub tropics. CTA publication, Armidale, Australia; c1987. p. 245.
28. SAS, Statistical Analysis System Institute. SAS User’s Guide. Statistics, Software Version 9.00, SAS Institute, Cary, North Carolina, USA; c2002.
29. Snijders PJM, Muia J, Kariuki JN. Yield and quality of sweet potato vines harvested at different stages, Research Report, Naivasha, Kenya; c1992.
30. Taabu HL, Ndyomugyenyi EK, Mutetikka D, Ebong C. Effect of feeding sweet potato vine-based diets as partial milk substitutes for dairy calves in Uganda. Livestock Research for Rural Development. 2016;28:18.
31. Van Soest PJ. Nutritional Ecology of the Ruminant, 2nd edn. Cornell University Press, Ithaca, NY; c1994.
32. Van Soest PJ, Robertson JB, Lewis BA. Methods for dietary fibre, neutral detergent fibre, and no starch polysaccharides in relation to animal nutrition. J Dairy Sci. 1991;74:3583-3597.
33. Kiragu JW, Mitaru BN, Irungu KRG. Supplementing Napier grass with different proportions of sweet potato vines on growth and rumen development. Paper presented at Joint Tanzania Society of Animal Production and Veterinary Association of Tanzania, 29 November–1 December 2007, Arusha, Tanzania; c2007.