Tropical and Subtropical Agroecosystems, 17 (2014): 547 - 555

CHEMICAL COMPOSITION AND *IN VITRO* DRY MATTER DIGESTIBILITY OF VINES AND ROOTS OF FOUR SWEET POTATO (*Ipomoea batatas*) VARIETIES GROWN IN SOUTHERN ETHIOPIA

[COMPOSICIÓN QUÍMICA Y DIGESTIBILIDAD IN VITRO DE LA MATERIA SECA DE FOLLAJE Y RAÍCES DE CUATRO VARIEDADES DE PATATA DULCE (*Ipomoea batatas*) CULTIVADAS EN EL SUR DE ETIOPÍA]

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SUMMARY

Chemical composition and *in vitro* true dry matter digestibility (IVTDMD) of vine and its fractions (leaf, petiole and stem) and roots of two early maturing (Belela and Temesgen) and two medium maturing varieties (Beletech and Tulla) were investigated. Vine and root samples from each variety were harvested from triplicate plots (5.1m x 4.8m). Vine samples were partitioned in two equal parts: one part analyzed as whole vine and the second part was fractionated into leaf, petiole and stem. Differences in chemical composition and IVTDMD between vine and its fractions (leaf, petiole and stem) were significant (p<0.05). Leaf had crude protein (CP) content of 26.1, 22.3, 20.5 and 28.4%DM; Neutral detergent fiber (NDF) 25.4, 25.3, 30.7 and 30.2%DM and IVTDMD 90.7, 90.6, 87.5 and 90.1%; petiole had CP of 7.9, 12.1, 7.7and 10.0%DM; NDF 27.8, 29.4, 28.5 and 27.9%DM and IVTDMD 93.4, 93.4, 91.4 and 91.5% and stem had CP of 8.2, 10.9, 8.3 and 10.3%DM; NDF 38.5, 37.5, 40.4%DM and 40.2 and IVTDMD 78.2, 77.8, 74.4 and 76.3%, respectively, for Belela, Temesgen, Beletech and Tulla. In vine CP of 18.7, 18.1, 15.5 and 17.3%DM; NDF 32.7, 31.4, 38.3%DM and 36.9 and IVTDMD 86.2, 86.3, 83.1 and 83.5%, respectively, for Belela, Temesgen, Beletech and Tulla were found. There was also significant (p<0.05) variations in CP and NDF but not (p<0.05) in IVTDMD of roots between varieties. Root CP of 6.9, 7.7, 6.8 and 6.3 % DM; NDF 7.2, 6.0, 6.5 and 6.3 %DM and IVTDMD 94.3, 94.5, 94.9 and 94.6%, respectively, for Belela, Temesgen, Beletech and Tulla were found. In conclusion, Belela and Temesgen had better quality than Beletech and Tulla in most measured parameters.

Key words: Chemical composition; i*n vitro* true dry matter digestibility; varieties.

RESUMEN

Se evaluó la composición química y la digestibilidad verdadera *in vitro* (IVTDMD) del follaje y sus fracciones (hoja, pecíolo y tallo) y las raíces de dos variedades de maduración temprana (Belela y Temesgen) y dos variedades de maduración media (Beletech y Tulla) de batata dulce. Las muestras de follaje y raíz de cada variedad fueron cosechadas de parcelas triplicadas (5.1m x 5.8m). Las muestras de follaje fueron divididas en dos porciones iguales: una porción fue analizadas como un todo y la segunda porción se fraccionó en hoja, pecíolo y tallo. Se encontró diferencias significativas (P<0.05) en composición química e IVTDMD entre el follaje y sus fracciones. La hoja tuvo un contenido de PC de 26.1, 22.3, 20.5 y 28.4% MS, FDN de 25.4, 25.3, 30.7 y 30.2% MS e IVTDMD de 90.7, 90.6, 87.5 y 90.1%; el pecíolo tuvo PC de 7.9, 12.1, 7.7 y 10.0% MS; FDN de 27.8, 29.4, 28.5 y 27.9% MS e IVTDMD de 93.4, 93.4, 91.4 y 91.5% el tallo tuvo PC de 8.2, 10.9, 8.3 y 10.3%MS; FDN de 38.5, 37.5, 40.4% MS y 40.2 e IVTDMD de 78.2, 77.8, 74.4 y 76.3%, respectivamente para las variedades Belela, Temesgen, Beletech y Tulla. En el follaje la PC fue de 18.7, 18.1, 15.5 y 17.3%MS; FDN 32.7, 31.4, 38.3%MS y 36.9 e IVTDMD de 86.2, 86.3, 83.1 y 83.5%, respectivamente para Belela, Temesgen, Beletech y Tulla. Se encontró variación significativa

($p<0.05$) en la PC y FDN, pero no ($p<0.05$) en IVTDMD entre las raíces de las variedades. La PC de la raíz fue de 6.9, 7.7, 6.8 y 6.3 % MS; FDN de 7.2, 6.0, 6.5 y 6.3 %MS e IVTDMD 94.3, 94.5, 94.9 y 94.6%, respectivamente, para Belela, Temesgen, Beletech y Tulla. En conclusión, Belela y Temesgen tuvieron mayor calidad que Beletech y Tulla en la mayoría de los parámetros medidos.

Palabras clave: composición química; digestibilidad verdadera *in vitro*; variedades de batata.

INTRODUCTION

In Ethiopia, sweet potato (*Ipomoea batatas*) is cultivated in most highland areas and at times its cultivation is being expanded towards the lowlands of the country (Kebede *et al*., 2008). It is widely cultivated root crop in drought prone parts including eastern, southern and southwestern Ethiopia (Terefe, 2003). The leading sweet potato producing area in Ethiopia is the Southern Nations, Nationalities and Peoples Regional State (CACC, 2002).

Sweet potato varieties differ in their potential as animals feeds (An, 2004; Ondabu *et al*., 2005). Variations in chemical composition between sweet potato cultivars and plant parts of a given variety have been reported (Orodho *et al*., 1993; Woolfe, 1992; An, 2004; Ondabu, 2005; Tesfaye and Chali, 2008; Naskar and Nedunchezhiyan, 2009).

In many parts of Ethiopia, sweet potato is primarily cultivated for its root production while its by-products are commonly fed to ruminants or left on the field during defoliation and root harvesting time (Tsega and Tamir, 2009). Sweet potato vines and damaged roots, unfit for human consumption, can serve as valuable livestock feeds (Adugna, 2008). In Ethiopia, there are a number of sweet potato varieties cultivated on both research stations and farmer's field (EARO, 2009). However, information regarding the potential of these varieties as animal feeds is scanty.

The first step in determination of a nutritive value of a feed is chemical analysis (Woolfe, 1992) which can be used to evaluate its potential as animal feed (An, 2004), although the actual value can be arrived by determining the digestibility of its nutrients (Woolfe, 1992). The objective of this study, therefore was to evaluate nutrient composition and *in vitro* dry matter digestibility of vine (and its fractions; leaf, petiole and stem) and roots of four sweet potato varieties (Belela, Beletech, Temesgen and Tulla).

MATERIALS AND METHODS

Research site

The study was carried out in Southern Ethiopia in Hawassa at Hawassa University farm and research center. The site is located 71 5′ N latitude and 381 29′ E longitude and at an elevation of 1700 m above sea level. Rainfall is bi-modal and in the average annual ranges from 700 and 1200 mm. The mean minimum and maximum temperatures in the study site are 13.5^{0}C and 27.6^{0}C, respectively (NMA, 2012).

Sample preparations

Vine cuttings, with 30 cm length and having a minimum of four nodes, of two early maturing (Belela and Temesgen) and two medium maturing (Beletech and Tulla) sweet potato varieties were obtained from Southern Agricultural Research Center, Ethiopia and cultivated on triplicate plots of 5.1m x 4.8m in Hawassa University farm and research center at the end of June, 2011. A spacing of 60 cm between rows and 30 cm between plants and planting density of 55,555 plants ha^{-1}were used. Earthing and hand weeding was carried 30 and 60 days after planting. Belela, Temesgen and Beletech were selected because they are the most promising cultivars and widely cultivated by farmers. Tula was selected because it is a newly introduced and being widely distributed to farmers, in various parts of Ethiopia including Hawassa, as a candidate to alleviate vitamin-A deficiency in mans' nutrition.

Samples of both sweet potato vines and roots were harvested at 120 days (for the early maturing varieties) and 150 days (for the medium maturing varieties) after planting from the corresponding plots. Then each vine sample from individual plots was divided into two equal parts; one half was analyzed as whole vine and the remaining half was fractionated into leaf, petiole and stem and analyzed. Samples of vine (and its fractions) and roots were dried in air-forced oven at 60^{0}C for 48 hrs and their partial dry matter content was calculated. The partially dried samples were ground using Thomas Willy mill (model 4) to pass through 1mm sieve size and used for chemical analysis and *in vitro* DM digestibility determination.

Chemical analysis

Chemical analyses were performed on partially dried and 1 mm sieve ground sweet potato vine and its botanical fractions (leaf, petiole and stem) and sweet potato roots. DM content of all samples was determined by drying in air-forced oven at 105^0C for 12 hrs (AOAC, 1990). The total Nitrogen (N) content of all samples was determined by the Kjeldahl method (AOAC, 1990) and then crude protein (CP) content was calculated as N x 6.25. The ash content of the samples was determined by complete burning in a muffle furnace at 600^0C for 3 hours (AOAC, 1990). The neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined according to procedures of Van Soest *et al*. (1991) by using filter-bag (Ankom® Technology, # F57) technique of ANKOM technology (ANKOM A200, ANKOM Technology, Macedon, New York 14502, USA).

***In Vitro* true dry matter digestibility**

In-vitro true dry matter digestibility (IVTDMD) of all samples was determined by ANKOM Technology-DAISYII Incubator. 0.25 g dried samples ground to pass via 1 mm sieve size were weighed in to ANKOM Filter bag (Ankom® Technology, # F57) and then incubated in the ANKOM jars containing rumen fluid and medium mixture (solution A and B) for 48 hours. The rumen fluid was collected from two fistulated sheep fed twice a day with a diet of grass hay and concentrate and necessary minerals based on their daily requirements. Water was provided ad-libitum. After incubating for 48 hrs, the filter bags were washed with tap water until it was clear, soaked with acetone and then further extracted with neutral detergent solution in the ANKOM200 fiber analyzer.

Statistical analysis

Data on chemical composition and in vitro true DM digestibility were analyzed for ANOVA using the General Linear Model (GLM) procedure of SPSS version 20. Duncan's new multiple range test was used to determine the differences (statistical significance) between treatment means at 5% level of significance. The following statistical models were used to analyze the data.

For chemical composition and IVTDMD of sweet potato vine and root

$$Y_{ij} = \mu + A_i + +e_{ij}$$

Where;

Y_{ij} = response variable
μ = overall mean
A_i = effect of variety
e_{ij} = random error

For chemical composition and IVTDMD of sweet potato vine botanical fractions

$$Y_{ijk} = \mu + A_i + B_j + AB_{ij} + e_{ijk}$$

Where;

Y_{ijk} = response variable
μ = overall mean
A_i = variety
B_j = vine botanical fraction (leaf, petiole and stem)
AB_{ij} =interaction effect
e_{ijk}= random error

RESULTS

Chemical composition and *In Vitro* true dry matter digestibility of vine and its botanical fractions

The chemical composition and IVTDMD of sweet potato vines of the four varieties is shown in Table 1. Belela and Temesgen were similar (p>0.05) in DM, ash and IVTDMD. Beletech and Tulla were similar (p>0.05) in DM, ADF and IVTDMD. The DM and NDF contents of Beletech and Tulla were higher (p<0.05) than Belela and Temesgen, while the ash content and IVTDMD was higher in the later varieties. The ADF content of Belela was higher than Temesgen but lower than Beletech and Tulla (p<0.05). Beletech had higher (p<0.05) vine ADL content than the other varieties. The differences in CP content of the four varieties were significant (p<0.05) in the order of: Belela > Temesgen > Tulla > Beletech.

Table 2 shows the chemical composition and in IVTDMD of vine botanical fractions (leaf, petiole and stem) of the four sweet potato varieties. Temesgen had the highest leaf DM (p<0.05), but there was no difference (p>0.05) among other varieties. Belela and Temesgen had lower petiole DM than both Beletech and Tulla (p<0.05). Belela and Temesgen had lower stem DM, while Beletech had the highest (p<0.05) DM content.

Table 1: Chemical composition and *in vitro* true dry matter digestibility vines of four sweet potato varieties

Parameter	Variety				S.E.	P
	Belela	Temesgen	Beletech	Tulla		
Dry matter (%)	13.9^{b}	13.2^{b}	16.3^{a}	15.9^{a}	0.21	< 0.001
Ash (% DM)	14.8^{a}	15.0^{a}	13.7^{b}	11.6^{c}	0.23	< 0.001
Crude protein(% DM)	18.7^{a}	18.1^{b}	15.5^{d}	17.3^{c}	0.20	< 0.001
Neutral detergent fiber (%DM)	32.7^{c}	31.4^{d}	38.3^{a}	36.9^{b}	0.31	< 0.001
Acid detergent fiber (% DM)	24.6^{b}	23.2^{c}	27.7^{a}	27.2^{a}	0.32	< 0.001
Acid detergent lignin (% DM)	6.8^{bc}	6.3^{c}	9.0^{a}	7.1^{b}	0.17	< 0.001
IVTDMD (%)	86.2^{a}	86.3^{a}	83.1^{b}	83.5^{b}	0.33	< 0.001

Means in a row with different superscript letters (a-d) differ significantly ($p < 0.05$); S.E.: Standard error; IVTDMD: *in vitro* true DM digestibility

The highest and lowest ($p<0.05$) leaf ash contents were found in Belela and Tulla, respectively. Leaf ash content of Temesgen and Beletech was similar ($p>0.05$). Petiole and stem ash contents were higher in Temesgen and lowest in Tulla ($p<0.05$). Leaf CP content was higher in Tulla and lowest in Beletech ($p<0.05$). Petiole and stem CP contents were higher in Temesgen and lowest in both Belela and Beletech ($p<0.05$).

Beletech had the highest and Belela and Temesgen ($p<0.05$) the lowest leaf NDF contents. Petiole NDF content was similar ($p>0.05$) in all varieties, except Temesgen which had highest ($p<0.05$) NDF content. Belela and Temesgen had similar, but lower than Beletech and Tulla ($p<0.05$) stem NDF content.

Leaf ADF content was highest in Beletech and lowest in Temesgen ($p<0.05$). The highest petiole ADF content was found in Temesgen and Tulla and the lowest in Belela ($p<0.05$). Belela and Temesgen had similar ($p>0.05$) and lower ($p<0.05$) ADF than Beletech and Tulla which had similar ($p>0.05$) stem ADF content.

The ADL content of leaf was similar ($p>0.05$) in all varieties, except Temesgen which had lowest ($p<0.05$) ADL content. Beletech and Tulla had similar ($p>0.05$) and higher ($p<0.05$) petiole ADL content than the other varieties. The highest stem ADL content was found in Beletech and the lowest in both Belela and Tulla ($p<0.05$).

IVTDMD of the leaf was similar ($p>0.05$) in all varieties except, Beletech which had lower IVTDMD ($p<0.05$). Belela and Temesgen had similar ($p>0.05$) petiole and stem IVTDMD. Beletech and Tulla had similar ($p>0.05$) petiole IVTDMD. However, Belela and Temesgen had higher ($p<0.05$) petiole and stem IVTDMD than Beletech and Tulla.

Chemical composition and *in vitro* true dry matter digestibility of sweet potato roots

The chemical composition and IVTDMD of sweet potato roots is shown in Table 3. Roots differ ($p<0.05$) only in DM, CP, NDF and ADL. Temesgen and Beletech had higher ($p<0.05$) DM contents than Belela and Tulla. The lowest ($p<0.05$) DM content was found in Tulla.

The CP content was highest in Temesgen and lowest in Tulla ($p<0.05$) while Belela and Beletech had similar ($p>0.05$) and intermediate CP contents. The highest NDF content was found in roots of Belela and Beletech and the lowest in Temesgen and Tulla ($p<0.05$). Root ADL content of all varieties was similar ($p>0.05$), except Belela which had the highest ADL content ($p<0.05$). Root IVTDMD was similar ($p>0.05$) in all varieties.

DISCUSSION

Chemical composition and *in vitro* true dry matter digestibility of vine and its botanical fractions

The results of the current study (Tables 1 and 2) showed variations in chemical composition among sweet potato varieties in vine and vine fractions which is also agrees with earlier reports (Tesfaye and Chali, 2008; Lebot, 2009). Vine DM content in the present study (Table 1) is in agreement with the DM ranges (9.7-18.2% and 13.9-19.2%) reported by Ondabu *et al*. (2005) and Naskar and Nedunchezhiyan (2009), respectively. It was also comparable with DM content (17.3%) by Weldegeriel (2007), but, lower than the value (21.1%) reported by Netsanet (2006).

Table 2: Chemical composition (% DM) and *in vitro* true dry matter digestibility (%) of leaf, petiole and stem of four sweet potato varieties

		Parameter						
		DM	Ash	CP	NDF	ADF	ADL	IVTDMD
Vine part	Variety	%	--------------------------%DM--------------					%
Leaf								
	Belela	20.1^{b}	14.4^{a}	26.1^{b}	25.4^{c}	15.9^{c}	6.0^{a}	90.7^{a}
	Temesgen	22.7^{a}	12.0^{b}	22.3^{c}	25.3^{c}	15.3^{d}	5.1^{b}	90.6^{a}
	Beletech	19.7^{b}	11.7^{b}	20.5^{d}	31.7^{a}	19.3^{a}	6.5^{a}	87.5^{b}
	Tulla	19.6^{b}	11.1^{c}	28.4^{a}	30.2^{b}	17.1^{b}	6.3^{a}	90.1^{a}
Petiole								
	Belela	7.9^{b}	23.8^{b}	7.9^{c}	27.8^{b}	20.3^{c}	3.1^{b}	93.4^{a}
	Temesgen	7.7^{b}	24.6^{a}	12.1^{a}	29.4^{a}	23.2^{a}	2.6^{c}	93.4^{a}
	Beletech	9.7^{a}	20.2^{c}	7.7^{c}	28.5^{b}	22.2^{b}	3.8^{a}	91.4^{b}
	Tulla	10.0^{a}	19.3^{d}	10.0^{b}	27.9^{b}	22.9^{a}	3.6^{a}	91.5^{b}
Stem								
	Belela	13.9^{c}	11.7^{b}	8.2^{c}	38.5^{b}	28.1^{b}	7.3^{c}	78.2^{a}
	Temesgen	13.4^{c}	12.7^{a}	10.9^{a}	37.5^{b}	28.5^{b}	8.9^{b}	77.8^{a}
	Beletech	19.0^{a}	11.6^{b}	8.3^{c}	40.4^{a}	29.8^{a}	10.9^{a}	74.5^{c}
	Tulla	18.1^{b}	10.5^{c}	10.3^{b}	40.2^{a}	29.5^{a}	7.7^{c}	76.3^{b}
	S.E.	0.19	0.2	0.2	0.32	0.23	0.17	0.27
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001

Means with different superscript letters (a-d) within a column for a give vine part differed significantly (p<0.05); S.E.: standard mean DM: Dry matter; CP: Crude protein; NDF: Neutral detergent fiber; ADF: Acid detergent fiber; ADL: Acid detergent lignin; IVTDMD: *In-vitro* true DM digestibility

Table 3: Chemical composition and *in vitro* true DM digestibility of roots of four sweet potato varieties

	Variety					
Parameters	Belela	Temesgen	Beletech	Tulla	S.E.	P
Dry matter (%)	24.0^{b}	26.8^{a}	26.1^{a}	19.7^{c}	0.31	< 0.001
Ash (% DM)	4.7	4.5	4.7	4.8	0.15	0.542
Crude protein(% DM)	6.9^{b}	7.7^{a}	6.8^{b}	6.3^{c}	0.17	< 0.001
Neutral detergent fiber (%DM)	7.2^{a}	6.0^{b}	6.5^{ab}	6.3^{b}	0.28	0.047
Acid detergent fiber (% DM)	5.3	4.6	4.8	4.9	0.26	0.322
Acid detergent lignin (% DM)	0.56^{a}	0.47^{b}	0.46^{b}	0.48^{b}	0.02	0.009
IVTDMD (%)	94.3	94.5	94.9	94.6	0.19	0.211

Means in the same row with different superscript letters (a-c) differ significantly (p<0.05); S.E.: standard error; IVTDMD: *in vitro* true DM digestibility

Leaf DM content in all varieties in the present study (Table 2) was slightly higher than the values (18.2 and 18.9%) reported for two sweet potato cultivars by Oradho *et al.* (1996) and (18.6%) reported by Aregheore (2004) whereas, the petiole and stem DM contents were comparable with the ranges (7.0-11%) and (14.6-17.9%), respectively, reported by the same authors.

If DM content of forages is below 20%, as in the case of young grazed grass, intake can be depressed due to increased volume of water in the rumen (Pasha *et al.*, 1994). Low DM content of sweet potato vine could limit its consumption due to high intake of water and may need wilting or demanded additives during ensiling (Ruize *et al.*, 1980). The DM content of vines of all varieties and petiole and stem fractions except leaf in the current study was below the minimum DM level of 20% that could affect intake in ruminants (Pasha *et al.*, 1994). However, very high moisture content (83-88%) could avoid additional free water requirement by goats fed sweet potato vines (Adugna, 2008) and this could be a merit in areas prone to water shortage.

Sweet potato vine is a good source of protein (An, 2004). Vine CP contents of the present study were comparable with the reports of Oradho *et al*. (1996), Wolfe (1992) and Aregheore (2004) except variety Beletech which had lower CP content. The CP contents of Belela and Temesgen were comparable with the reports of Tesfaye and Chali (2008) for the same varieties, but higher than the repot of Nestanet (2006) for variety Belela.

CP contents (% DM) of leaf, petiole and stem fractions of sweet potato vines (22.4-32.42%, 7.8-13.25% and 8.2-14.06%) were reported by Oradho *et al*. (1996), Wolfe (1992) and Aregheore (2004), respectively, which are comparable with the results of the current study. The leaf and stem CP contents of the current study were also comparable with the range of 25.5 to 29.8% and 11.5 to 13.7% of DM for leaf and stem, respectively, reported by An (2004).

According to Norton (1994), feeds having less than 8% CP are unable to provide the minimum ammonia level (70 mg N/liter) required by rumen microbes for optimum activity (digestion). Food CP content of less than 8-10% DM may result in lower intake in mature sheep and cattle (Forbes, 2007). A minimum CP requirement (11.3%DM) for growth by ruminants (ARC, 1984) and (12%DM) by lactating cows (Forbes, 2007) have been proposed.

The CP requirement of cows at early lactation, mid-lactation, late lactation and dry periods, respectively, is in the range of 16-18%, 14-16%, 12-14% and 10-12% (Target10, 2002). The CP content of vine (Table 1) and leaf (Table 2) of all varieties in the present study was higher than the minimum requirements of rumen microbes, the levels that may not affect intake in sheep and cattle, the minimum level required by growing ruminant and the requirements of cows at different stage of lactation, suggesting that they could be fed solely and/or used as a supplement for feeds low in CP contents like crop residues.

The CP content petiole and stem botanical fractions of the current studied varieties, with the exception of Belela and Beletech petioles; were above the minimum required level for rumen microbial activity. In general, the high CP content of the leaf of sweet potato varieties, as observed in the current experiment, makes it a good protein supplement.

The range of NDF and ADF contents of sweet potato vines in the present study (Table 1) were within the range (24.90-44.88%DM) and (20.23-29.74%DM) reported by Tesfaye and Chali (2008), respectively. However, the NDF and ADF contents of both Belela and Temesgen were lower than their values reported by Tesfaye and Chali (2008) and by Netsanet (2006) for variety Belela.

The NDF, ADF and ADL of the leaf, petiole and stem in the current study (Table 2) were within the ranges reported by Oradho *et al*. (1996) and Aregheore (2004). The NDF (23.2-29.8%DM) and ADF (13.6-19.9%DM) contents of leaf reported by An (2004) were also comparable to the results of the present study (Table 2). For dairy cows a minimum of 30% NDF and 19% ADF are required for healthy rumen (Target 10, 2002). Based on this information, sweet potato vine and its botanical fractions of the present study could be good source of fiber for dairy cows.

According to Kamalak *et al.* (2004), IVTDMD is negatively related to NDF, ADF and ADL but positively related to CP content in trees and shrub leaves. The variation in IVTDMD of sweet potato vine and its botanical fraction in the current study could therefore be attributed to variations in their cell wall and CP concentrations.

The IVTDMD of vine (Table 1) and its botanical fractions (Table 2) of the present study were higher than the values (72.3 and 77.2%) DM digestibility of vines of two sweet potato cultivars reported by Ruize *et al*. (1980). Adugna (2008) also reported that sweet potato has 71.1% IVTDMD, which is lower than the results of the current study. These variations could be due to differences in variety, environmental factors (soil fertility, rainfall, temperature etc.) and stage of maturity (Papachristou and Papanastasis, 1994).

Apparent DM digestibility of 90.3% in rabbit feeding on sweet potato leaf was reported by Abonyi et al. (2012) and this could indicate high digestibility of sweet potato leaf. A study on 48 hrs DM degradability in N'dama steers indicated that 77-83% and 55-78% rumen DM degradability for leaf and stem of three sweet potato varieties, respectively (Etela and Kalio, 2011). These results may support the higher and lower IVTDMD of leaf and stem of the current study, respectively.

Chemical composition and *in vitro* true dry matter digestibility of sweet potato roots

The DM content of sweet potato roots in the present study (Table 3) was lower than the range (29.20-30.80%) reported by Olorunnisomo *et al*. (2006) but falls within the range (15.0-42.0%) reported by Tsou *et al*. (1989). Variety, climate, location, day length, cultivation practices and harvesting time can all influence DM content of sweet potato roots (An, 2004; Lebot, 2009).

The ash content of the roots of all varieties in the present study were comparable with the 5.3%DM reported by Dominguez (1990) and the range (3.0-4.0%DM) reported by Olorunnisomo *et al*. (2006).

The CP contents of sweet potato roots in the current study were comparable with the values reported by Dominguez (1990), Wolfe (1992) and Olorunnisomo *et al*. (2006), but they were below the minimum requirements of rumen microbes (Norton, 1994). Similarly, Otieno *et al*. (2008) had reported sweet potato root as being low in CP and despite of its high carbohydrate content, it could not be able to fulfill the CP requirement of livestock unless supplemented with additional protein sources. The low CP content of sweet potato roots together with low starch digestibility and presence of trypsin inhibitor are considered as the major constraints of livestock feedings based on sweet potato roots diets (Peters, 2010).

The cell wall contents of sweet potato root are generally low compared to its vine (Giang *et al*., 2004). The NDF contents of sweet potato roots in the present study were comparable with the value (6.9%DM) reported by Dominguez (1990) but lower than the value (13.9%DM) reported by Giang *et al*. (2004) and the range (8.0-9.5%DM) submitted by Olorunnisomo *et al*. (2006). The ADF contents were comparable with 5.5%DM reported by Dominguez (1990), but slightly higher than the range (3.0-4.0%) obtained by Olorunnisomo *et al*. (2006). The ADL contents in all varieties of the present study were slightly lower than the value (0.7%DM) reported by Dominguez (1990).

IVTDMD of sweet potato roots of the four varieties were similar ($p>0.05$) and seem to be high which can possibly explained in terms of their low cell wall contents. Backer *et al*. (1980) showed that DM in vitro digestibility of sweet potato roots can be as high as 92% and hence roots can be classified as feeds of high energy value. Chanjula *et al*. (2003) found potential rumen DM degradability of 97.6, 97.5 and 97.2% for three sweet potato cultivars and these results could support the higher IVTDMD of the current sweet potato roots. However, feeding of sweet potato roots alone to ruminants could reduce performance and affect health of animals; loss of weight and occurrence of scour with four weeks of feeding in sheep fed 100% Sweet potato roots were reported by Olorunnisoma (2007).

CONCLUSION

The differences in chemical composition and IVTDMD of vine and its botanical fractions (leaf, petiole and stem) between the studied varieties indicate that selection for higher nutritive merit could be important when incorporating of sweet potato vine in ruminant feeding. The CP content and IVTDMD and lower cell wall contents (NDF, ADF and ADL) observed in Belela and Temesgen, could make them prime to select than Beletech and Tulla. However, Compared with literatures, chemical composition and IVTDMD of the four sweet potato varieties revealed that they could be used as a potential feed, especially as protein supplement to low quality feed.

Acknowledgments

All the financial supports of this research were funded by International Potato Center (CIP)-USAID and we are grateful for the support. The authors sincerely acknowledge the Southern Agricultural Research (Ethiopian) for providing sweet potato varieties. We thank the School of Animal and Range Sciences of Hawassa University, College of Agriculture for giving us all the laboratory facilities and moral supports to accomplish our research. The authors also highly acknowledge the technical supports provided by Mr. Taddesse Bokere during laboratory analysis of the feed samples.

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Submitted July 19, 2014 – Accepted December 05, 2014