Variation in concentration of condensed tannin in sainfoin (*Onobrychis viciifolia*) accessions from a Swiss collection

B.N. Azuhnwi[1,2], B. Boller[3], M. Martens[4], F. Dohme[2], S. Ampuero[2], M. Kreuzer[1] and H.D. Hess[2]

[1] ETH Zurich, Institute of Animal Science, Switzerland
[2] Agroscope Liebefeld-Posieux Research Station ALP, Posieux, Switzerland
[3] Agroscope Rekenholz-Tänikon Research Station ART, Reckenholz-Zurich, Switzerland
[4] Eric Schweizer Ltd, Switzerland

Contact: B.N. Azuhnwi, *nche.azuhnwi@alp.admin.ch*

Condensed tannins (CT) are a highly diverse group of plant secondary metabolites with promising nutritional, animal health and environmental effects (Mueller-Harvey, 2006). The diversity that CT exhibit can lead to inter- as well as intraspecific differences (Stewart et al., 2000). Giner-Chavez et al. (1997) found between 4- and 6-fold variations in CT content within the same forage specie. *Onobrychis viciifolia* (sainfoin) is a perennial temperate legume with moderate CT concentration, attracting renewed interest in forage and nutritional research because it was shown to reduce gastrointestinal nematode load (Hekendorn et al. 2006) and ruminal ammonia load (Scharenberg et al., 2007). We hypothesise here that different accessions of sainfoin differ in type and concentration of CT and also that environmental factors such as soil, climate and management influence this variation.

Methods

Fifteen different sainfoin accessions were established in spring 2007 at three different sites in Switzerland: Thun (altitude 559 m); Ellighausen (altitude 520 m) and Reckenholz (440 m), on plots of 1.5 m × 6.0 m as a randomized complete block design with 3 replications each. Standard protocols were used to determine agronomic and morphological characteristics of plots in the field. The plant material was harvested at about 5 cm from ground level in late May and early July 2008, as first and second cut, respectively, and frozen. Samples were lypholised and ground to pass a 1 mm screen. The butanol/HCl method (Terrill et al., 1992) was used to determine the concentration of CT in extractable, protein-bound and fibre-bound forms. An internal standard for this determination was prepared by the purification of the Visnovsky accession through a column of Sephadex. The data was subjected to the Mixed procedure of SAS, with site as random effect, and accession and cut as fixed effects followed by least significant difference (LSD) test for multiple comparison among means.

Results and Discussion

CT concentrations clearly varied ($P < 0.001$) among accessions and across sites and cuts. Interaction ($P < 0.001$) were found between accessions, sites and cuts as well. The Visnovsky accession had the lowest CT concentration across all sites and cuts. First cut CT concentrations were lower ($P < 0.001$) than second cut CT concentrations for most of the 15 accessions across all three sites. Differences in CT concentration between the first and second cut were more marked for the single flowering accessions compared to the multiple flowering accessions for all 3 sites. This reflects the higher concentration of CT of leaves compared to stems (Häring et al. 2007). The highest CT concentrations were found in the leafy regrowth of the Wiedlisbach accession.

Table 1 Variation of total condensed tannin concentration (g/kg DM) of 15 sainfoin accessions (n=6)

Site	Thun		Ellighausen		Reckenholz		Flowering
Cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	type†
Accession							
Echandens	41.6	52.1	46.3	53.9	51.1	56.2	M
Cuarens	40.0	67.9	49.0	71.4	51.5	67.1	Si
La Rippe	39.1	52.1	45.0	58.9	57.2	57.2	M
Middes	45.4	58.3	48.9	55.1	58.2	52.2	M
Pompaples	42.7	82.3	46.7	80.2	56.6	76.1	Si
Moiry	41.4	69.5	50.3	74.8	54.3	69.3	Si
Sarzens	42.6	66.8	53.2	75.6	50.3	81.7	Si
Premier	50.2	68.2	47.1	70.0	58.2	70.2	Si
Vinzel	53.6	74.8	53.0	75.8	45.3	76.8	Si
Perly 66	57.8	58.0	53.1	72.1	54.1	58.1	M
Thun Allemend	54.2	74.3	55.7	71.4	60.4	81.5	Si
Wiedlisbach	49.5	84.9	52.9	84.3	57.2	82.8	Si
OVO505	57.3	53.7	54.0	62.3	60.1	65.6	M
Visnovsky	41.6	42.9	47.0	48.6	42.4	49.6	M
Perly	50.9	62.4	59.5	58.0	62.7	59.9	M
P values							
Accession		<0.001					
Site		<0.001					
Cut		<0.001					
Accession × cut		<0.001					
Accession × site		<0.001					
Cut × site		<0.001					
Accession × cut × site		<0.001					
$LSD_{Accession \times cut \times site}$		5.3					

† M- multiple flowering; Si- single flowering

Conclusion

The results of this study show that the CT concentration in sainfoin accessions from the Swiss collection vary significantly among accessions, sites and cuts. This indicates that major differences in nutritional value and animal-health related properties may be expected as well.

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Vergleich von Energieumsatz, körperlicher Aktivität und Fressverhalten in weidenden Kühen und in mit Gras gefütterten Kühen im Laufstall

L.D. Kaufmann[1], A. Münger[1], M. Rérat[1], P. Junghans[2], S. Görs[2], C.C. Metges[2] und F. Dohme[1]

[1]Forschungsanstalt Agroscope Liebefeld-Posieux ALP, CH-1725 Posieux
[2]Forschungsinstitut für die Biologie der Nutztiere FBN, D-18196 Dummerstorf

Kontakt: L.D. Kaufmann, *luzia.kaufmann@alp.admin.ch*

Die Leistung von mit Gras gefütterten Kühen ist oft tiefer als erwartet. Eine Überschätzung des Energiegehaltes des Grases oder aber ein Mangel an glycogenen und aminogenen Nährstoffen, bedingt durch eine unausgewogene Ration, werden ebenso als Gründe genannt, wie der Einfluss der Ration auf die endokrine Kontrolle, welche die Verteilung der Nährstoffe beeinflusst (Bruinenberg et al., 2002). Bei faserreicherem Futter nehmen Kühe grössere Futtermengen auf, wodurch die Verdauungsorgane stärker durchblutet werden und vermehrt Wärme produziert wird (Reynolds et al., 1991a). Ferner kann eine grasbetonte Fütterung mit erhöhtem Fasergehalt zu einem Mangel an fermentierbarer organischer Substanz führen, was eine schlechtere Verwertung des Rohproteins (RP) und somit eine höhere Ausscheidung von Stickstoff zur Folge haben kann (Reynolds et al., 1991b). Für Kühe auf der Weide kommt noch der zusätzliche Energiebedarf für körperliche Aktivität hinzu (Agnew und Yan, 2000). Graf et al. (2005) zeigten zum Beispiel, dass Kühe mit Vollweide im Vergleich zu Kühen, die Teilweide und zusätzlich Heu oder Maissilage im Stall erhielten, mehr Zeit mit Fressen verbringen mussten, um die gleiche Menge an Trockensubstanz (TS) aufzunehmen. In der Literatur liegen die Schätzungen für den zusätzlichen Bedarf an Energie für Erhaltung bei Weidehaltung zwischen +10% (Bruinenberg et al., 2002) und +50% (National Research Council, 2001) Die meisten Messungen des Energieumsatzes von Kühen basieren auf Daten aus der indirekten Kalorimetrie in Respirationskammern. Genaue Informationen über den Energieumsatz von weidenden Kühen sind bisher kaum verfügbar. Mit der ^{13}C-Bikarbonat Verdünnungstechnik (Junghans et al., 2007) ist es möglich, den Energieumsatz von grasenden Wiederkäuern genauer zu bestimmen. Ziel der vorliegenden Studie war es daher, den Energieumsatz von Kühen auf der Weide mit dem Energieumsatz von mit Gras gefütterten Kühen im Laufstall zu vergleichen. Des Weiteren wurde der Zusammenhang zwischen Energieumsatz und körperlicher Aktivität untersucht.