Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria (INIA)
Available online at www.inia.es/sjar

Spanish Journal of Agricultural Research 2007 5(4), 517-521
ISSN: 1695-971-X

Short communication. Forage and nutritive value of the pruning residues (leaves plus summer lateral shoots) of four grapevine (*Vitis vinifera* L.) cultivars at grape harvest and two post-harvest dates

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Abstract

The annual pruning of vineyards produces shoot and leaf residues that have traditionally been fed to sheep and goats. The aim of this work was to determine the forage and nutritive values of grapevine (*Vitis vinifera* L.) leaves plus summer lateral shoots at grape harvest and two post-harvest dates. The study cultivars were Cabernet Sauvignon, Merlot, Sauvignon Blanc and Sémillon, all grafted onto 5BB rootstocks. The leaves and summer lateral shoots were removed at the same time from each cultivar at three dates: grape harvest, 15 days post-harvest, and 30 days post-harvest. No significant differences were seen between the cultivars in terms of their mean crude protein (CP) (45.44-46.33 g kg^{-1}), crude fibre (CF) (37.12-37.50%), neutral detergent fibre (NDF) (324.63-324.87 g kg^{-1}), acid detergent fibre (ADF) (247.44-249.44 g kg^{-1}), potassium (2.11-2.14 g kg^{-1}), calcium (3.85-3.95 g kg^{-1}) or iron (0.037-0.038 g kg^{-1}) contents at any of the three sampling dates. The highest fresh matter (1,765.33 kg ha^{-1}) and dry matter (DM) yields (610.67 kg ha^{-1}) were obtained from Sauvignon Blanc. The fresh matter yield, DM yield, CP, CF, NDF and ADF contents on the different sampling dates all differed significantly. The maximum fresh matter yield (1,925.33 kg ha^{-1}), DM yield (634.67 kg ha^{-1}) and CP content (61.67 g kg^{-1}) were recorded at grape harvest. The potassium, calcium and iron contents ranged from 2.11-2.15, 3.86-3.92 and 0.036-0.038 g kg^{-1} respectively at all stages. The leaves plus summer lateral shoots of Cabernet Sauvignon, Merlot, Sauvignon Blanc and Sémillon grapevine cultivars can be beneficially fed to sheep, goats and cattle in some viticultural regions of Turkey and other parts of the world.

Additional key words: acid detergent fibre, mineral content, neutral detergent fibre, yield.

Resumen

Comunicación corta. Valores forrajeros y nutritivos de residuos de poda (hojas y brotes laterales de verano) de cuatro cultivares de vid (*Vitis vinifera* L.) en el momento de la cosecha y en dos fechas de postcosecha

Tradicionalmente, la poda anual de las vides (*Vitis vinifera* L.) produce residuos de brotes y hojas que sirven de alimento para las ovejas y cabras. El objetivo de este trabajo fue determinar los valores forrajeros y nutritivos de hojas de vides y brotes laterales de verano en el momento de la cosecha y después de la cosecha. Los cultivares estudiados fueron Cabernet Sauvignon, Merlot, Sauvignon Blanc y Sémillon, todos injertados en portainjertos 5BB. Se arrancaron simultánemente hojas y brotes laterales de todos los cultivares en tres fechas: recolección de uva, y 15 y 30 días tras la cosecha. No se observaron diferencias significativas entre cultivares, en ninguna de las tres fechas de muestreo, en las medias de los contenidos en proteína cruda (CP) (45,44-46,33 g kg^{-1}), fibra cruda (CF) (37,12-37,50%), fibra detergente neutra (FDN) (324,63-324,87 g kg^{-1}), fibra detergente ácida (FDA) (247,44-249,44 g kg^{-1}), potasio (2,11-2,14 g kg^{-1}), calcio (3,85-3,95 g kg^{-1}) o hierro (0,037-0,038 g kg^{-1}). Los mayores rendimientos de materia fresca (1.765,33 kg ha^{-1}) y materia seca (DM) (610,67 kg ha^{-1}) se obtuvieron con Sauvignon Blanc. Los rendimientos en materia fresca, DM, CP, CF, FDN y FDA difirieron significativamente en todas las fechas de muestreo. Los contenidos máximos de materia fresca (1.925,33 kg ha^{-1}), DM (634,67 kg ha^{-1}) y CP (61,67 g kg^{-1}) se registraron en el momento de la recolección de la uva. Los contenidos en potasio, calcio y hierro variaron entre 2,11-2,15, 3,86-3,92 y 0,036-0,038 g kg^{-1} respectivamente en todos los muestreos. Las hojas y brotes laterales de verano de Cabernet Sauvignon, Merlot, Sauvignon Blanc y Sémillon pueden ser beneficiosas en la alimentación del ganado en algunas regiones vitícolas de Turquía y otras partes del mundo.

Palabras clave adicionales: contenido mineral, fibra detergente ácida, fibra detergente neutra, producción.

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Received: 09-02-070; Accepted: 17-09-07.

Proteins are vital for proper nourishment. The 70-80 g of protein required daily to maintain good human health should be in the form of both plant (45%) and animal (55%) proteins (Ates and Tekeli, 2001). However, in less-developed and developing countries, the demand for animal protein is often lower than that for plant protein, perhaps because of preference, but partly because people with modest incomes cannot afford to buy animal products. Certainly in Turkey the production of animal products is insufficient, which increases their cost: the country's animal population therefore needs to be increased. The forage used to feed animals in Turkey and other less-developed countries is provided by grazing land, forage crops, and the supernumerary materials of other cultivated plants (Tekeli and Ates, 2006a).

Grapevines (*Vitis vinifera* L.) are grown all over the world's moderate climate belts (isotherms around 10-20°C), i.e., between 30° and 50° North (including the Mediterranean basin) and South (Celik *et al*., 1998). Apart from grapes, these plants produce considerable quantities of by-products. For example, the annual pruning of vineyards produces grapevine shoot and leaf residues that have traditionally been fed to sheep and goats after the grape harvest (Romero *et al*., 2000). These residues are thought to be a source of protein and mineral ions. Mineral elements make up approximately 1.5-5% of animal bodies (Tekeli *et al*., 2003), and their different functions (Ensminger *et al*., 1990) require that adequate concentrations of all the necessary types be maintained if health is to be preserved. A lack of one element cannot be balanced by the surfeit of another (Ates and Tekeli, 2005).

The aim of this work was to determine the forage and nutritive values of grapevine leaves plus summer lateral shoots at grape harvest and at two post-harvest dates for four important cultivars grown in Turkey.

All work was conducted in the vineyards of the village of Yagzir, near Tekirdag in western Turkey, over the seasons of 2004 and 2005. These vineyards lie at 40°59'N, 27°33'E at an altitude of 100 m; the mean total precipitation they receive is 482 mm, and the annual mean temperature 10.5°C. The soil of these vineyards is a Xerept, low in organic matter (0.78%), moderate in its P (60.11 kg ha^{-1}) and K (210.12 kg ha^{-1}) contents, and with a pH of 6.8. The Tekirdag area is home to important viticultural (6,000-7,000 ha, 75,000-80,000 Mg yr^{-1}) and stock-raising (210,000-220,000 sheep and goats, 125,000-135,000 cattle) activity. In this region, pruning residues may be fed to animals at different stages after the grape harvest.

The experimental plants, all nine years old and grafted onto 5BB rootstocks, represented four wine grape cultivars: Cabernet Sauvignon, Merlot, Sauvignon Blanc and Sémillon. Spacing in the vineyards was 2.5 × 1.5 m; all plants were Guyot-trained. Downy mildew —*Plasmopara viticola* (B. et C.) Berlese et de Toni — and powdery mildew —*Uncinula necator* (Schw.) Burr.— were the most common diseases observed affecting these plants. To control downy mildew, Mancozeb (72%) (200 g per 100 L of water) was applied at the pre-bloom stage when the shoots reached 20-25 cm height, followed by a second spraying after the heavy rain of May and June in both years. Further sprayings were performed according to climatic conditions (rainfall and temperature), disease load and intensity. To control powdery mildew, cyproconazole + sulphur (mixture 0.8% + 80%; 100 g per 100 L of water) was initially applied at the pre-bloom stage when the shoots were 20-25 cm in height. Later, as the disease spread, spraying was performed at two week intervals from berry set to *véraison*.

Fertilizers, including N, P and K were applied to the vineyard soils: N, as $(NH_4)_2SO_4$ (containing 21% N; total 400 kg ha^{-1}), was applied during shoot growth (200 kg ha^{-1}) and bloom (200 kg ha^{-1}) in both study years; total P, as triple superphosphate (42%) (360 kg ha^{-1}), was applied in the autumn of the first year; K, as K_2SO_4 (50%; 300 kg ha^{-1}) was applied in the autumn of both study years. None of the vineyards was irrigated.

The study plots were 7.5 × 7.5 m in size and arranged in a randomised block design with three replicates (Turan, 1995). Three grapevine plants were selected for examination in each. The leaves plus summer lateral shoots (which made up 30% of all shoots on both grapevine arms) were removed by hand from plants of each cultivar on three sampling dates: at grape harvest (1st year, October 2; 2nd year, October 5), at 15 day post-harvest (1st year, October 17; 2nd year, October 20), and at 30 days post-harvest (1st year, November 1; 2nd year, November 4).

The fresh matter yield (kg ha^{-1}) for each cultivar and time was determined and recorded. The dry matter

[1] Abbreviations used: ADF (acid detergent fibre), CF (crude fibre), CP (crude protein), DM (dry matter), LSD (least significant difference), NDF (neutral detergent fibre).

(DM) yield (kg ha^{-1}) was calculated by drying approximately 500 g samples at 55°C for 24 h followed by storage for a further day at room temperature (Tekeli and Ates, 2006b). The crude protein (CP) and crude fibre (CF) contents were determined by the micro-Kjeldahl and Weende methods respectively. The mineral contents were analysed after dry-ashing at 550°C in a muffle furnace and dissolving in deionised water to standard volumes. The K ratio was determined by flame photometry (AOAC, 1999). The Ca and Fe ratios were determined by atomic absorption spectrophotometry. The neutral detergent fibre (NDF) and acid detergent fibre (ADF) contents were determined following Romero *et al.* (2000).

The results were analysed using the least significant difference (LSD) test ($P = 0.01$); calculations were made using TARIST statistical software (Acikgoz *et al.*, 1994).

No significant differences were observed between years for any component in any cultivar at any sampling date. Therefore, means for the results of the two years were used in comparisons. Table 1 shows the results for the different variables measured. No significant differences were seen between the cultivars in terms of the mean (i.e., taking into account all sampling times) CP (45.44-46.33 g kg^{-1}), CF (37.12-37.50%), NDF (324.63-324.87 g kg^{-1}), ADF (247.44-249.44 g kg^{-1}), K (2.11-2.14 g kg^{-1}), Ca (3.85-3.95 g kg^{-1}) or Fe (0.037-0.038 g kg^{-1}) content of grapevine leaves plus summer lateral shoots ($P > 0.01$). The highest fresh matter (1,765.33 kg ha^{-1}) and DM yields (610.67 kg ha^{-1}) were obtained from the Sauvignon Blanc cultivar ($P < 0.01$).

The sampling stage significantly affected the fresh matter yield, DM yield, CP, CF, NDF and ADF contents of all cultivars ($P < 0.01$). The maximum fresh matter yield (1,925.33 kg ha^{-1}), DM yield (634.67 kg ha^{-1}) and CP content (61.67 g kg^{-1}) were found at grape harvest stage in all cultivars. The CF (33.67%), NDF (320.70 g kg^{-1}) and ADF (246.17 g kg^{-1}) contents were lower at grape harvest than at any other date ($P < 0.01$) in all cultivars. The CP contents recorded agreed with those reported by Rebolé *et al*. (1988) and Rebolé (1994) for grapevine branches and leaves. Romero *et al*. (2000), who investigated the digestibility and voluntary intake of vine leaves by sheep, found a higher CP content for the leaves (68 g kg^{-1}), while the leaf NDF and ADF contents were 319 g kg^{-1} and 254 g kg^{-1} respectively. Madibela *et al*. (2000) reported a CP content of 135 g kg^{-1} and an ADF content of 214 g kg^{-1} for the leaves of *Tapinanthus lugardii* (N.E.Br.) Danser. The present CP contents were lower than those of the parasitic plants *T. lugardii*, *Erianthenum ngamicum*, *Viscum rotundifolium* and *V. verrucosum* reported by Modibela *et al*. (2000). Ates and Tekeli (2005) reported the CP and CF ratios to range from 16.30 to 22.57% and 19.60-24.23% respectively in orchardgrass (*Dactylis glomerata* L.) and white clover (*Trifolium repens* L.). The present values were lower than those reported by Ates and Tekeli (2005). Tekeli and Ates (2006a,b) reported 16.16-21.20% CF in Persian clover (*Trifolium resupinatum* L.) – higher than in the present findings. After plant

Table 1. Forage (fresh matter yield, dry matter yield, crude protein, crude fibre, neutral detergent fibre, acid detergent fibre), and nutritive value (K, Ca and Fe contents) of the leaves plus summer lateral shoots of four grape cultivars at different sampling dates. TARIST software was used for the LSD comparison of the means of the two experimental years.

	Stages				Cultivars				
	Harvest	15 days after harvest	30 days after harvest	LSD	Sauvignon Blanc	Merlot	Cabernet Sauvignon	Sémillon	LSD
Fresh matter yield, kg ha^{-1}	1,925.33a	1,685.33b	885.33c	90.06**	1,765.33a	1,557.33b	1,421.33c	1,250.67d	100.38**
Dry matter yield, kg ha^{-1}	634.67a	520.00b	306.67c	50.06**	610.67a	506.67b	448.00c	381.33d	50.83**
Crude protein content, g kg^{-1}	61.75a	46.00b	29.67c	10.77**	45.89	46.33	45.44	45.56	NS
Crude fibre content, %	33.67c	36.61b	41.68a	1.13**	37.50	37.23	37.42	37.12	NS
NDF, g kg^{-1}	320.70c	324.06b	329.35a	1.91**	324.63	324.68	324.63	324.87	NS
ADF, g kg^{-1}	246.17b	249.08a	249.67a	2.23**	249.44	247.89	248.44	247.44	NS
K, g kg^{-1}	2.11	2.13	2.15	NS	2.14	2.11	2.13	2.14	NS
Ca, g kg^{-1}	3.86	3.92	3.91	NS	3.95	3.92	3.87	3.85	NS
Fe, g kg^{-1}	0.038	0.038	0.036	NS	0.037	0.038	0.037	0.038	NS

** $P < 0.01$. NS: $P > 0.01$.

cell growth ceases the cell walls thicken and the secondary wall is formed. Unlike the primary walls, the secondary walls do not contain protein and may vary significantly among cell types in terms of their composition and structure. However, secondary walls are generally composed of a network of cellulose fibrils embedded in an amorphous matrix of hemicelluloses, pectin and lignin. Generally, young plant cell walls are richer in pectin and lower in fibre than older plant cell walls (Ates and Tekeli, 2005; Tanner and Morrison, 1983).

Table 1 shows the effect of sampling date on the mineral content to be non-significant ($P > 0.01$). The content of K, Ca and Fe in the leaves plus summer lateral shoots ranged from 2.11 to 2.15 g kg^{-1}, 3.86 to 3.92 g kg^{-1} and 0.036 to 0.038 g kg^{-1} respectively in all the cultivars examined and at all stages. The NRC (2001) reports the major mineral nutrient requirements of gestating or lactating beef cows to be 0.6-0.8% (w/w) for K and 0.18-0.44% for Ca. Baysal *et al*. (1991) reported the Ca, K and Fe contents in vine leaves were 3.92 g kg^{-1}, 2.13 g kg^{-1} and 0.39 g kg^{-1} respectively. The present mineral element contents were similar to those reported by Baysal *et al*. (1991). Khanal and Subba (2001) determined contents of 2.2-57.2 g kg^{-1} for Ca, 9.0-28.9 g kg^{-1} for K, and 0.095-0.66 g kg^{-1} for Fe in the leaves of a number of major fodder trees. Gizachew and Smit (2005), who investigated the CP and mineral composition of major crop residues and supplemental feeds, reported contents of 16.0 g kg^{-1} for Ca, 19.9 g kg^{-1} for K and 0.15 g kg^{-1} for Fe in grass pea (*Lathyrus sativus* L.) haulms (figures higher than those recorded in the present work).

The high CF content of the grapevine leaves plus summer lateral shoots reported here might be due to the high NDF levels and low protein contents recorded. The highest fresh matter and DM yields were obtained from Sauvignon Blanc cultivar at the grape harvest stage. The leaves plus summer lateral shoots of Cabernet Sauvignon, Merlot, Sauvignon Blanc and Sémillon grapevine cultivars can be beneficially fed to sheep, goats and cattle in some viticultural regions of Turkey and other parts of the world.

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