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in

López-Francos A. (ed.), Jouven M. (ed.), Porqueddu C. (ed.), Ben Salem H. (ed.), Keli A. (ed.), Araba A. (ed.), Chentouf M. (ed.).
Efficiency and resilience of forage resources and small ruminant production to cope with global challenges in Mediterranean areas

Zaragoza : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 125

2021
pages 503-506

Article available on line / Article disponible en ligne à l'adresse :

http://om.ciheam.org/article.php?IDPDF=00008053

To cite this article / Pour citer cet article

Sibaoueih M., Hamidallah N., Chriyaa A. **Biomass, chemical composition and digestibility of some vegetable and legume residues for ruminants in the Chaouia area.** In : López-Francos A. (ed.), Jouven M. (ed.), Porqueddu C. (ed.), Ben Salem H. (ed.), Keli A. (ed.), Araba A. (ed.), Chentouf M. (ed.). *Efficiency and resilience of forage resources and small ruminant production to cope with global challenges in Mediterranean areas.* Zaragoza : CIHEAM, 2021. p. 503-506 (Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 125)

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Biomass, chemical composition and digestibility of some vegetable and legume residues for ruminants in the Chaouia area

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Abstract. This study was carried out to evaluate the biomass, chemical composition and in vitro dry matter digestibility (IVDMD) of some crop by-products. Two categories were evaluated. First group included vegetable residues such as cauliflower (CR), sweet potato (SPR), fennel (FR), vegetable beet (VBR), artichoke (AR), turnip (TR), carrot (CAR) and the second group included legume residues such as bean (BR), lentil (LR) and pea (PR). The total dry biomass was evaluated by the quadrat method at harvesting. It was approximately 100,000 tons of which 76% are legume residues. The dry matter (DM) varied between 13.5 % in VBR to 19.7 % in SPR while the average was about 95.1% for legume residues. The lowest crude protein (CP) content was recorded in PR showing 57.8 g / kg DM while the highest was from the VBR with 181 g / kg DM. The legume residues (BR, LR and PR) recorded higher neutral detergent fiber (NDF) values of 487, 472.8 and 500 g / kg DM, respectively. The average acid detergent fiber (ADF) content of vegetable and legume residues was 227 and 394 g / kg DM, respectively. Acid detergent lignine (ADL) ranged from 16.6 in CR to 108 g / kg DM in LR. Ash content of vegetable residues ranged from 118 in SPR to 279 g / kg DM in VBR and was on average 114 g / kg DM in legume residues. The TR recorded the highest IVDMD being 66 % followed by VBR 61.6 % with the lowest value obtained for SPR being 32.7 %. The biomass of different crops by-products is not negligible and could be used as part of the diet of ruminants according to their nutritive value

Keywords. By-products – Biomass – Nutritive value – Animal feed – Low rainfall area.

Rendement, composition chimique et digestibilité des résidus de quelques cultures maraichères et de légumineuses alimentaires pour ruminant dans la région Chaouia

***Résumé**. L'objectif de ce travail est d'évaluer le rendement, la composition chimique et la digestibilité in vitro de la matière sèche (DIVMS) de deux catégories de résidus de cultures. Les résidus de cultures maraichères à savoir le chou-fleur (CF), la patate douce (PD), le fenouil (FN), la betterave potagère (BR), l'artichaut (AR), le navet (NV), la carotte (CAR) et les résidus de légumineuses alimentaires tels que la fêve (FV), la lentille (LT) et le petit pois (PP). Le rendement sec a été évalué par la méthode des quadrats au moment de la récolte. Il est estimé à 100 000 tonnes, dont 76 % sont les résidus de légumineuses. La matière sèche (MS) variait entre 13,5 % pour BR et 19,7 % pour PD et était en moyenne de 95,1 % pour les résidus de légumineuses. La faible teneur en protéines brutes (PB) a été enregistrée dans les PP, avec 57,8 g / kg de MS tandis que les BR ont la teneur la plus élevée 181 g / kg MS. Les résidus de légumineuses (FV, LT et PP) ont enregistré les valeurs les plus élevées de fibres au détergent neutre (NDF) de 487, 472,8 et 500 g / kg MS, respectivement. La teneur moyenne en fibres au détergent acide (ADF) des résidus de maraichage et de légumineuses était respectivement de 227 et 394 g / kg de MS. La lignine variait de 16.6 pour CF à 108 g / kg MS pour LT. La teneur en cendres des résidus de maraichage variait de 118 pour PD à 279 g / kg MS pour BR et était en moyenne de 114 g / kg MS pour les résidus de légumineuses. Les NV ont enregistré la DIVMS la plus élevée (66 %), suivi des BR (61,6 %), alors que les PD sont les moins digestibles (32,7 %). La biomasse de différents sous-produits de culture est non négligeable et pourrait être valorisée dans l'alimentation des ruminants en fonction de la variabilité de leurs valeurs nutritive.*

***Mots clés.** Résidus de culture – Biomasse – Valeur nutritive – Alimentation animale – Zone à faible pluviométrie.*

I – Introduction

Feeding ruminant is a challenge for the development of animal production in low rainfall areas. In these areas, forage is limited and poorly diversified, rangelands are deteriorated quantitatively and qualitatively and animal feeds are expensive. The search for alternative feed resources is a solution to reduce the cost of production without affecting productivity. These alternatives include crop residues, agro-industry by products or any resource that may be used in animal feeding. Proper use of these resources in animal feeding requires knowledge of their chemical composition and nutritive value. The objective of this work was to evaluate the availability of some vegetable and legume residues in the Chaouia region and to provide information concerning their nutritive value.

II – Materials and methods

After harvesting, the remaining parts of seven vegetables and three legumes were studied. The former included cauliflower (*Brassica oleracea* var *botrytis*), sweet potato (*Ipomoea batatas*), fennel (*Foeniculum vulgare*), vegetable beet (*Beta vulgaris* subsp. *Vulgaris*), artichoke (*Cynara scolymus*), turnip (*Brassica rapa* subsp. *Rapa*), carrot (*Daucus carota* subsp. *Sativus*). The later were bean (*Vicia faba*), lens (*Lens culinaris*) and pea (*Pisum sativum*). Vegetable residues samples were collected at the North of Chaouia while the legume residues were collected from the center of the same area.

Residues from each crop were collected from 4 plots. On each plot (0.5 ha), nine squares of $1m^2$ were distributed uniformly during the harvesting period. Collected residues from each square were weighed in the field and were placed in a bag. After drying at 50°C untill constant weight, three composite samples per plot were prepared.

Ash was determined by calcining the sample in the oven at 550 °C for 6-7 hours. Crude protein (CP) and crude fiber (CF) were determined respectively by Kjeldahl method (AOAC, 1990) and Weende method (AOAC, 1990). Neutral and acid detergent fibres and acid detergent lignin (NDF, ADF, ADL) were determined according to Van Soest *et al*. (1967) and in vitro dry matter digestibility (IVDMD) was obtained by Tilly and Terry method (1967). Data of chemical composition and IVDMD were subjected to analysis of variance while the least significant differences test was used to compare the samples means. Differences were accepted when $P < 0.05$)

III – Results and discussion

1. Yield

Total dry biomass collected was estimated at 100,000 tonnes of which 76% was legume food residues (Table 1). The highest yield was recorded in fennel and vegetable beet residues showing 40.83 q / ha and 39.58 q / ha, respectively. While the yield of legume food residues at harvest were 12.69; 12.8 and 15.19 q / ha respectively for bean, lens and pea.

2. Chemical composition

Vegetable residues at harvest were rich in water. Their dry matter content varied between 19.7% in sweet potato residue to 13.5% in vegetable beet residue while food legume residues were almost dry at harvesting and their humidity was around 5 % (Table 2).

Table 1. Biomass of differents vegetable and legume residues

	Yield at harvest (q/ha)	Dry biomass (t)
Vegetable residues		
Cauliflower residue	32.7	4,604
Sweet potato residue	29.2	4,542
Fennel residue	40.8	4,750
Vegetable beet residue	39.6	4,092
Artichocke residue	34.2	4,820
Turnip residue	23.3	4,036
Carrot residue	30	8,760
Food legume residues		
Bean residue	12.7	20,560
Lens residue	12.8	22,600
Pea residue	15.2	21,360
Total		100,127

Table 2. Chemical composition and *in vitro* dry matter digestibility (IVDMD) of vegetable and food legume straws

	DM (%)	Ash (%DM)	CP (%DM)	CF (%DM)	NDF (%DM)	ADF (%DM)	ADL (%DM)	IVDMD (%)
Vegetable residues								
Cauliflower residue	14.4^{f}	17.6^{c}	11.4^{b}	20.7^{b}	28.3^{a}	19.1^{a}	1.7^{a}	53.9^{c}
Sweet potato residue	19.7^{b}	11.8^{a}	14.7^{c}	27.4^{c}	39.8^{d}	27.8^{c}	6.7^{c}	32.7^{a}
Fennel residue	15.5^{d}	21.1^{d}	13.7^{c}	21.1^{b}	26.5^{ab}	23.8^{b}	6^{bc}	54.6^{c}
Vegetable beet residue	13.5^{e}	27.9^{e}	18.1^{e}	18.8^{a}	32.4^{c}	18.2^{a}	6.9^{c}	61.6^{e}
Artichocke residue	13.5^{e}	18.8^{c}	13.1^{c}	21.1^{b}	39.9^{d}	25.4^{f}	5.6^{bc}	48.5^{b}
Turnip residue	15.1^{d}	17.2^{c}	10.5^{b}	24.2^{c}	29.5^{b}	20^{a}	5.6^{bc}	66^{f}
Carrot residue	17.3^{c}	14.7^{b}	16.8^{d}	20.8^{b}	26.3^{a}	19.5^{a}	5^{b}	57^{d}
Average	15.6	18.4	14.1	21.6	31.8	22	5.4	53.5
Legume residues								
Bean residue	95.0^{a}	11.1^{a}	6.4^{a}	35.1^{e}	48.7^{e}	41.3^{e}	9.3^{d}	50.3^{b}
Lens residue	95.5^{a}	11.3^{a}	6.8^{a}	32.3^{d}	47.3^{e}	38.6^{d}	10.8^{e}	50.6^{b}
Pea residue	94.9^{a}	11.7^{a}	5.8^{a}	33.2^{d}	49.9^{f}	38.2^{d}	8.2^{d}	58.8^{d}
Average	95.1	11.4	6.4	33.5	48.6	39.4	9.4	53.2

Values in the same columns followed by different letters are significantly different ($P < 0.05$).

The crude protein content of vegetable residues ranged from 10.5 to 18.1 % DM. The highest value ($P < 0.05$) was recorded in vegetable beet residue while the lowest ($P < 0.05$) was recorded in turnip residue. Gasa *et al*. (1989) obtained 14.3 % DM for cauliflower residue while Bakshi *et al*. (2016) and Mahgoub *et al.* (2018) reported a higher nitrogen content for cauliflower leaves 17% DM and 23 % DM respectively. The average protein content of food legume residues was 6.35 % DM, which is almost twofold of cereal straw (Muñoz, 1991). Haddad and Husein (2001) found higher protein content (8.2 % DM) for lens residue.

The average CF content was 21.6 and 33.5 % DM, respectively, in vegetable and food legume residues. The lowest value ($P < 0.05$) was noted in vegetable beet.

Food legume residues recorded the highest value of neutral detergent fiber (48.6 % DM). ADF and ADL values were 22 % DM and 39.4 % DM and 5.4 % DM and 9.4 % DM, respectively in vegetable and legume residues.

Turnip residue had the highest IVDMD (66%) while sweet potato residue was the least digestible (32.7%). Pea residue recorded the highest IVDMD among food legume residues of which remains high compared with IVDMD cereal straw (Muñoz, 1991).

IV – Conclusions

Vegetable and food legume residues studied in this work generate a significant biomass that can be valorized in animal feeding in low rainfall area where forage resources are limited. The chemical composition and digestibility are better than those of cereal straw commonly used as fodder. Further studies still needed to elucidate the incorporating rates in ruminant diets and adequate conservating methods.

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