



Agroindustrial Science

Website: <http://revistas.unitru.edu.pe/index.php/agroindscience>Escuela de Ingeniería
AgroindustrialUniversidad Nacional de
Trujillo

Nutritional and energy value of *Vicia sativa* pods

Valor nutricional y valor energético de vainas de *Vicia sativa*Flor-Anita Corredor ^{1,*} , Jorge F. Passuni ¹ ; E. Ciria Noli ¹ ;
Rosario M. Bernaola-Paucar ¹ 

¹ Estación Experimental Agraria Santa Ana, Dirección de Desarrollo Tecnológico Agrario, Instituto Nacional de Innovación Agraria, Huancayo, Junín 12007, Perú.

ABSTRACT

Vicia sativa is one of the most important crops for livestock feed. Pods from *Vicia sativa* seed production are usually discarded. The objective of this study was to report the nutritional value of *Vicia sativa* pods. Report of the bromatological analysis was 17.58% for crude protein, 44.96% for neutral detergent fiber, and 55.81% for in vitro dry matter digestibility. Estimates of the energy value on dry matter basis (Mcal kg⁻¹) were made for digestible and metabolizable energy, with values of 2.46 and 2.01, respectively. *Vicia sativa* pods promise enormous potential as a protein supplement on livestock diets when other sources are not available.

Keywords: harvest residues; pods; chemical composition.

RESUMEN

Vicia sativa es uno de los cultivos más importantes para la alimentación del ganado. Las vainas de la producción de semillas de *Vicia sativa* generalmente se descartan. El objetivo de este estudio fue informar el valor nutricional de las vainas de *Vicia sativa*. El reporte del análisis bromatológico fue de 17,58% para proteína cruda, 44,96% para fibra detergente neutra y 55,81% para digestibilidad in vitro de materia seca. Se realizaron estimaciones del valor energético sobre la base de materia seca (Mcal kg⁻¹) para la energía digestible y metabolizable, con valores de 2,46 y 2,01, respectivamente. Las vainas de *Vicia sativa* prometen un enorme potencial como suplemento proteico en la dieta del ganado cuando no se dispone de otras fuentes.

Palabras clave: residuos de cosecha; vainas; composición química.

1. Introduction

Vicia sativa is an important legume cultivated worldwide as forage (Huang *et al.*, 2017). The genus is originated from the arid regions of the Middle East, though, it is extensively spread in America continent through the temperate zones (Francis *et al.*, 2000). Its cultivation is more cost-effective as it does not require the application of intensive nitrogen fertilizers to the fields (Bevz and Toshkina, 2020). In the Peruvian highlands, the availability of forage for livestock decreased during the dry (lack of rain) season. Extensive animal production under the traditional grazing system suffer nutritional deficiencies, for instance, decreased in milk production and weight loss.

Multiple studies had evaluated the use of *Vicia sativa* as a hay or mixed with other forage in cattle, sheep, and goats (Weber *et al.*, 1997; Berhane and Eik, 2006; Lanyasunya *et al.*, 2007). For instance, in cattle, Weber *et al.* (1997) showed greater in vitro digestibility and live weight gain in diets that included *Vicia sativa*. In sheep, Lanyasunya *et al.* (2007) concluded that *Vicia sativa* hay used as a protein supplement in *Sorghum alnum* control diets improved daily weight gain and dry matter (DM) consumption. In goats, Berhane and Eik (2006) reported greater live weight gains in dams and offspring, when including *Vicia sativa* hay supplementation on diets, also, a higher number of dams were able to sustain pregnancy during the dry season. In

Recibido 3 noviembre 2020
Aceptado 15 diciembre 2020

*Autor correspondiente: corredor@alumni.iastate.edu (F-A. Corredor)
DOI: <http://dx.doi.org/10.17268/agroind.sci.2020.03.13>

general, these previous studies showed that *Vicia sativa* is an important food source for livestock. Currently there are very few studies that characterize the nutritional value of *Vicia sativa* in the central highlands of Peru (Bartl et al., 2009; Montoya, 2017) and to the best of our knowledge, chemical composition of *Vicia sativa* pods (VSP) have not been previously reported. Therefore, the objective of this study was to characterize the nutritional value of VSP.

2. Material and methods

Location and sampling

The work was conducted at the National Institute of Agrarian Innovation (INIA, for its acronym in Spanish) at Santa Ana Experimental Station, located in Huancayo, Junin, Peru (longitude 11° 55' 00" S, latitude and 76° 10' 00" W, altitude 3,260 m.a.s.l). Annual rainfall averages of 818.40 mm with temperature range between 4.09 and 20.24 °C (SENAMHI -Perú, 2019). Two hectares of *Vicia sativa* were cultivated and fertilized at a rate of 0 N, 10 P, and 60 K (kg ha⁻¹). After being dried out in the field, VSP were separated from the plants and samples were randomly collected.

Chemical analysis and estimation of energy values

For chemical analysis, VSP were oven dried at 60 °C and milled through a 1.0 mm screen. Crude protein (CP) was determined according to AOAC (1990). *In vitro* dry matter digestibility (IVD) and neutral detergent fiber (NDF) were analyzed by the methods of Goering and Van Soest (1970). Digestible energy (DE; 4.4xIVD 100⁻¹) and metabolizable energy (ME; 3.6xIVD 100⁻¹) were estimated following the description of Lafore et al. (1999).

3. Results and discussion

The chemical composition of VSP is given on dry matter basis in Table 1. For CP, Badrzadeh et al. (2008), Calsamiglia et al. (2016), and Jabessa et al. (2020), reported values in a range from 9.9% to

18%, which are similar to our results. While Huang et al. (2017) and Bartl et al. (2009), reported values higher than 20.6%. Values reported by Bartl et al. (2009) and Huang et al. (2017) were higher than the CP reported by us of 17.58%, which could be due to sample content (stem and leaves) which increases the protein content of their sample. Forage protein content should be adequate to feed ruminants, while minimizing nitrogen excretion, and therefore pollution (Wilkens et al., 2020).

For NDF, Huang et al. (2017) reported an average value of 24.2% with a range between 14.4% to 42.3%. Badrzadeh et al. (2008), Bartl et al. (2009), and Calsamiglia et al. (2016) reported values in a range from 34.8 to 57.7. However, Jabessa et al. (2020) reported a higher NDF content, with an average value of 73.4 for NDF. The NDF level found in the present study corresponded with the average reported in the literature. The NDF is inversely related to the level of food consumption therefore, when a feed diet is formulate, the NDF might be a good indicator of consumption (Meyer, 2010). To the best of our knowledge, there are no previous reports of IVD values in *Vicia sativa*.

Estimated energy values for digestible energy (DE) and metabolizable energy (ME) are given on dry matter basis in Table 1. Energy values are commonly estimated from TND, and IVD (Eastridge, 2002; Weiss and Tebbe, 2019). In this study, we estimated the energy for VSP values based on the chemical values of IVD, CP, and NDF, according to previous studies findings performed with forages in Peru (Lafore et al., 1999; Montoya, 2017). Estimated energy values findings for VSP were similar to the ones reported for the *Vicia sativa* from Huang et al. (2017) and Calsamiglia et al. (2016). According to Huang et al. (2017) the DE and ME content of *Vicia sativa* varies from 3.25 to 3.90 and from 2.07 to 2.99 Mcal kg⁻¹, respectively. According to FEDNA, the ME content varies from 2.13 to 2.40 from lower to higher qualities of the forages (Calsamiglia et al., 2016).

Table 1

Chemical composition and energy values based on dry matter in *Vicia sativa* pods

Composition ¹	Value	Badrzadeh et al. (2008)	Huang et al. (2017)	Bartl et al. (2009)	Calsamiglia et al. (2016)	Jabessa et al. (2020)
CP ²	17.58±0.19	18	20.6 to 39.3	28.4 to 27.1	9.9 to 16.6	16.5
NDF ²	44.96±0.13	35.2	14.4 to 42.3	34.8 to 37.7	36.4 to 57.7	73.4
IVD ²	55.81±0.29	-	-	-	-	-
DE ³	2.46	-	3.25 to 3.90	-	-	-
ME ³	2.01	-	2.07 to 2.99	-	2.13 to 2.40	-

¹ CP: Crude protein, NDF: Neutral detergent fiber, IVD: *in vitro* dry matter digestibility, DE: digestible energy, ME: metabolizable energy

² Values expressed in percentage

³ Values expressed in Mcal kg⁻¹

In general, previous studies of *Vicia sativa* nutrient content are similar to those presented in our study, suggesting the potential of VSP as a source of important nutrients for incorporation into animal diets. Taken together these results, VSP nutritive content are similar to the *Vicia sativa* stem and leaves.

4. Conclusions

Overall, chemical composition of VSP showed a moderate energy content and a high CP content. These results demonstrated that the use of VSP as a protein supplement is a feasible option. Additionally, VSP could be an option to increase livestock output during the season of scarce of rain (dry season). Further analysis of inclusion levels in the use of animal diets should be determined. Using VSP as a protein supplement in animal diets, with adequate processing techniques, could improve animal performance.

Acknowledgements

The authors would like to thank to the Estación Experimental Agraria Santa Ana members who participated in this study. We appreciate the support of the Inter-American Institute for Cooperation on Agriculture-IICA, the Peruvian National Agricultural Innovation Program-PNIA, and the Peruvian National Institute of Agrarian Innovation-INIA. We would like to thank to Ph.D. Carlos Arbizu and members of the Jóvenes Investigadores project for useful comments.

ORCID

F-A. Corredor  <https://orcid.org/0000-0002-4192-4600>

J. Passuni  <https://orcid.org/0000-0002-9253-1356>

C. Noli  <https://orcid.org/0000-0002-8037-738X>

R. Bernaola-Paucar  <https://orcid.org/0000-0003-0397-3898>

References

AOAC. 1990. Official Methods of Analysis: 15th Edition. Washington, DC, USA.

Badrzadeh, M.; Zarazg Zahed, F.; Esmailpour, B. 2008. Chemical composition of some forage *Vicia* spp. in Iran. *Journal of Food, Agriculture and Environment* 6(2): 178-180.

Bartl, K.; Gamarra, J.; Gómez, C.A.; Wettstein, H.R.; Kreuzer, M.; Hess, H.D. 2009. Agronomic performance and nutritive value of common and alternative grass and legume species in the Peruvian highlands. *Grass and Forage Science* 64(2): 109-121.

Berhane, G.; Eik, L.O. 2006. Effect of vetch (*Vicia sativa*) hay supplementation on performance of Begait and Abergelle goats in northern Ethiopia. I. Milk yield and composition. *Small Ruminant Research* 64(3): 225-232.

Bezv, S.; Toshkina, E. 2020. Cultivation of legume-grain agroecosystems for the purpose of resource saving in forage production. In *IOP Conference Series: Earth and Environmental Science* 422: 012034.

Calsamiglia, S.; Ferret, A.; Bach, A. 2016. Tablas FEDNA de valor nutritivo de forrajes y subproductos húmedos 2a edición (FEDNA tables of the nutritional value of fodder and by-products 2nd edition). Fundación Española para el Desarrollo de la Nutrición Animal, Madrid.

Eastridge, M.L. 2002. Energy in the New Dairy NRC. The Ohio State University.

Francis, C.M.; Enneking, D.; Abd El Moneim, A.M. 2000. When and where will vetches have an impact as grain legumes?, 34: 375-384.

Goering, H.K.; Van Soest, P.J. 1970. Forage fibre analyses, Agricultural Handbook No. 379. Washington, DC, USA: USDA.

Huang, Y.F.; Gao, X.L.; Nan, Z.B.; Zhang, Z.X. 2017. Potential value of the common vetch (*Vicia sativa* L.) as an animal feedstuff: a review. *Journal of Animal Physiology and Animal Nutrition*, 101(5): 807-823.

Jabessa, T.; Amare, Z.; Dejene, G. 2020. Performance Evaluation of Vetch Varieties/Genotypes for Their Agronomic Performance and Nutritive Value in Selected Midland of East Guji Zone, Adola, Southern Oromia and Ethiopia. *Asian Journal of Advanced Research and Reports* 2: 54-59.

Lafore, M.; San Martín, F.; Bojórquez, C.; Arbaiza, T.; Carcelén, F. 1999. Diagnóstico alimenticio y composición químico nutricional de los principales insumos de uso pecuario del valle del mantaro. *Revista de Investigaciones Veterinarias Del Peru* 10(2): 74-78.

Lanyasunya, T.P.; Mukisira, E.A.; Kariuki, S.T.; Ilatsia, E.D. 2007. Effects of *Commelina benghalensis*, *Vicia sativa* and *Medicago sativa* used as protein supplements on performance of Dorper sheep fed *Sorghum almum*. *Tropical and Subtropical Agroecosystems* 7(3): 211-216.

Meyer, K. 2010. The relationship between forage cell wall content and voluntary food intake in mammalian herbivores. Dissertation University of Zurich, Vetsuisse Faculty. 29 pp.

Montoya, K. 2017. Características agronómicas y valor nutricional de 7 cultivos forrajeros bajo secano en la sierra central (Agronomic characteristics and nutritional value of 7 forage crops under rainfed agriculture in the central highlands). Thesis Universidad Nacional Agraria La Molina, Perú.

SENAMHI -Perú. 2019. Reporte diario de los datos meteorológicos de la estación Experimental Agraria Santa Ana (Santa Ana Agricultural Research Station daily report of meteorological data).

Weber, M.; Restle, J.; Ferreira, F.; Lupatini, G.; Gomes, A. 1997. Produção animal em pastagens de aveia (*Avena strigosa* Schreb) adubada com nitrogênio ou em mistura com ervilhaca (*Vicia sativa* L.). *Revista Brasileira de Zootecnia* 26(2): 396-402.

Weiss, W.P.; Tebbe, A.W. 2019. Estimating digestible energy values of feeds and diets and integrating those values into net energy systems. *Translational Animal Science* 3(3): 953-961.

Wilkens, M.R.; Schnepel, N.; Muscher-Banse, A.S. 2020. Dietary protein and calcium modulate parathyroid vitamin D receptor expression in young ruminants. *Journal of Steroid Biochemistry and Molecular Biology* 196: 105503.