



The effect of using different levels of tannic acid on performance and nutrient digestibility on milk consuming Semintal calves

Arash Yadollahi¹, Javad Kolaji², Mehran Aboozari³, Reza Alipoor Filabadi⁴, Morteza Karami*⁵

Artigo

Abstract: The purpose of the current study was to determine the effect of different levels of tannic acid on performance and nutrient digestibility on Semintal calves in Shahrekord farm, Iran. A total of 40 ten day old Semintal calves were randomly assigned to the 4 experimental treatments with 10 calves each. The calves were feed by basal diet as control, 2.5, 5 and 10 gram per liter of tannic acid of their milk consumption respectively. The result showed that dietary inclusion different levels of tannic acid improved feed intake, body weight gain and feed conversion ratio in treated calves. As result revealed DM.OM, CP, NFC, ADF and ADF digestibility improved in treated calves compared to the control. The result of fecal consistency score showed that Inclusion of tannic acid resulted in improved fecal consistency at 0-50 days ($P \leq 0.05$). In conclusion using different levels of tannic acid could be useful and had good effects on performance and nutrient digestibility on Holstein dairy calves.

Key words: Digestibility, Semintal calves, Fecal consistency, Performance, Tannic acid.

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Corresponding authors Email: E-mail: yas.rahimiyan.yr@gmail.com

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1- Agricultural Engineering Organization, IAO. Shahrekord, Iran.

2- Department of Veterinary Laboratory Sciences, Tabriz University, Tabriz Iran

3- Department of Animal Sciences, Faculty of Agriculture, Shahrekord branch, Islamic Azad University, Shahrekord, Iran.

4- Department of Animal Sciences, Faculty of Agriculture, Abhar Branch, Islamic Azad University, Abhar, Iran.

5-Department of Animal Sciences, Agriculture and Natural resources Research and Education Center, Shahrekord, AREEO, Iran.

Introduction

Tannins are a class of astringent, polyphenolic biomolecules that bind to and precipitate proteins and various other organic compounds including amino acids and alkaloids (Swain, 1965 and Lavin, et al., 2010). Tannic acid is found in the nutgalls formed by insects on twigs of certain oak trees *Quercus infectoria* and other *Quercus* species (DESRUES et al., 2016). It is a precipitative stabilizer extracted from gall nuts. With the chemical formula $C_{76}H_{52}O_{46}$ it has a structure similar to that of other polyphenols. Tannins represent one of the most abundant polyphenolic compounds in plants.

Tannins exist as a multitude of chemically unique entities in nature. The most commonly occurring tannins are typically divided into two major classes based on chemical structure: hydrolysable (HT) or condensed tannins (CT). Hydrolysable tannins are esters of gallic or ellagic acid linked to a polyol core, typically glucose. Condensed tannins or proanthocyanidins consist of flavan-3-ol subunits linked together to form oligomers and polymers (SPENCER et al., 1988 and MURDIATI et al., 1992).

The adult ruminants can tolerate levels of

hydrolysable tannins in their feed without any detectable loss in performance characteristics, whether measured as growth or milk production (Frutos et al., 2004; Liu, 2003). Tannins can be used as chemical feed additive to reduce degradation of protein in the rumen. The tannin-protein complexes are less soluble and less accessible to proteolytic enzymes at the ruminal pH, thereby slowing the rate of ruminal degradation (BRODERIC, 1974 and PLUMLEE et al., 1998, NETO et al., 2014). Dumanovski and Sotosek, 1998 and Rai and Shukla (1979) showed that there was no significant increase in milk production in lactating cows fed on (11% tannic acid) in concentrate mixture compared to control diet.

Additionally Bhatt et al. (2005) mentioned that there was significant improvement in body weight gain, calculated energy output as well as milk protein content in animals fed with 7.5% tamarind seed husk in the diet. Nakamura et al., 2003 showed that the tannic acid is degraded in the gut by bacteria or enzymes and its degradation products are absorbed. Data from (Haslam, 1996; Mangan, 1988) study showed that the moderate tannin level may provide protection against microbial degradation of dietary proteins in the rumen,

increase efficiency of rumen microbial protein synthesis and protect ruminants from bloat

On the other hand, high levels of tannins produce adverse effects decreased nutrient utilization and animal productivity, and death (BUTTER et al., 1999). The objective of this study was to evaluate the effect of using tannic acid on performance and nutrient digestibility and fecal consistency on Holstein dairy calves.

Material and methods

Diets and animal management

The current study was performed at the Shahrekord dairy farm in Farsan county Iran. A total of 40 milk consuming Semintal calves (32 ± 5 kg) at the first age of birth were used in this study. The calves were randomly attributed to individual cube cages into the experimental dietary treatments as a completely random design. Calves were fed by colostrums within first 4 days of birth. After that they fed milk until 60 days (4 liter per day until 25 days and 6 liter per day until 60 days in both of the morning and afternoon). Dietary treatments consisted of basal diets (control), basal diet supplemented with 2.5, 5 and 10 milligram per liter of their milk consumption of tannic acid during a 60 day experimental period.

The diets were formulated to meet all the nutritional requirements for calves based on National Research Council (NRC, 2001).

Also the rations and water were offered for *ad libitum* intake during the experiment. The calves weighed on 6, 21, 36 and 60 days of experimental period. Additionally, they were separately weighed every week on a sensitive digital scale (50 g). Feed intake (FI) also was measured daily and fresh food was given each calf in every day. Feed conversion ratio (FCR) were measured by average daily gain and feed intake difference in each group.

Samples were collected in air tight plastic containers and refrigerated until determination of fecal dry matter content. Samples of concentrates, hay and feces were oven dried at 60°C to determine dry matter (DM), ash, crude protein, digestible protein, crude fat, neutral detergent fiber (NDF), and starch as described by (Jansen et al., 2000) using acid insoluble ash as internal marker. Fecal consistency of calves was monitored using the procedure as below by the method of HEINRICHS et al. (2003).

Scoring was as follows: for scour scoring, 1 = normal, 2 = soft to loose, 3 = loose to watery, 4 = watery, mucous, slightly bloody, 5 = watery, mucous. All

data were subjected the mixed procedure of SAS software based on completely random design.

The treatments were separated by Duncan's tests at ($P \leq 0.05$) statistical level.

Result and Discussion

The feed intake, body weight gain, body weight and feed conversion ratio by

using different levels of tannic acid compared to the control were not changed. Feed intake and body weight gain were increased throughout of 2.5 (ml.L) and 5 (ml.L) tannic acid usage. Data also showed that feed conversion ratio induced when Semintal calves fed by tannic acid in their diets.

Table 2- The effect of using different levels of tannic acid on performance in dairy calve

Variable	Tannic acid supplementation				SEM
	0	2.5 (ml.L)	5 (ml.L)	10 (ml.L)	
Feed intake (g.d)	37.68	38.43	39.27	37.20	0.075
Body weight gain (g.d)	21.02	22.98	23.83	24.09	1.16
Feed conversion ratio	1.79	1.65	1.65	1.54	0.075

*Means within a row with no common letter are significantly different ($P < 0.05$).

Lee et al., (2010) demonstrated that linear increase in feed to gain ratio and a linear decrease of daily body weight gain with increasing levels of tannic acid in pigs. Stukelj et al. (2010) noted that the test diets also included organic acids and that the tannic acid diet gave numerically lower values than the basal diet. They suggested that younger animals might be more sensitive to the presence of tannic acid. Erlich (1999) found that higher tannin content of sorghum had a positive effect on feed intake during finishing phase of

fattening pig. Blakeslee and Wilson, (1989) showed that feed intake and egg production were significantly reduced in birds given the highest doses of tannic acid.

Waghorn et al., (1994) showed that tannins also lower rumen turnover rate as well as digestibility of nutrients which has greater impact on reducing feed intake than decrease palatability. Because tannins are capable of binding with dietary proteins, rendering them less degradable within the rumen (Min et al. 2003) and the growth performance responses to supplemental

tannins have been generally attributed to enhancements in intestinal metabolizable protein supply (BEN-SALEM et al. 1999).

Data from Table 3 showed that nutrient digestibility of EE were increased by tannic acid treatment. There weren't significant differences for OM, CP, NFC, ADF and NDF between treatments compared to the control. Data showed that using of using different levels of tannic acid changed nutrient digestibility in treated Holstein calves. Palmer and Jones (2001) found increased in vitro dry matter and

nitrogen digestibility by addition of tannins. They showed that tannins protein complexes also bind with NDF, ADF and ADL thereby increase their amount in feces than intake levels thereby showed a negative digestibility. Kumar and Singh, (1984) showed that tannins could reduce digestibility of the nutrients in the diets.

They also mentioned that tannins mainly exert this effect on proteins, but they also affect other feed components to different degrees.

Table 3- The effect of using different levels of whey powder on nutrient digestibility

Variable	Tannic acid supplementation				SEM
	0	2.5 (ml.L)	5 (ml.L)	10 (ml.L)	
Ethyl extract (EE)	75.71	76.54	73.65	69.10	3.15
Organic matter(OM)	66.22	68.56	70.42	73.12	1.62
Crude Protein(CP)	66.85	66.35	69.50	62.72	2.17
Non Fiber Carbohydrate (NFC)	70.81	74.33	73.25	72.74	0.69
Acid Detergent Fiber(ADF)	47.69	50.10	55.16	52.61	2.56
Neutral Detergent Fiber(NDF)	51.83	52.16	57.79	53.18	1.39

*Means within a row with no common letter are significantly different (P<0.05).

Fecal consistency score significantly decreased by using tannic acid ($P \leq 0.05$). Adamczyk et al, 2012 showed that the ingestion of tannic acid caused constipation and can be used to treat diarrhea Table 4. There is plenty of evidence to support the anti diarrheal effect of medicinal plants found to be rich in tannins (MORINAGA et al., 2005). Palombo, 2006 showed that feeding some

polyphenes could affect nutrient digestibility and fecal consistency in calves. Field, 2003 mentioned that the polyphenols and polyphenol derived compounds or alkaloids may act on the biochemical mediators that activate vasodilatation and production of exudates in the intercellular compartments of the intestines (OLIVEIRA et al., 2010, AL-MAMARY, et al.,2001).

Table 4- The effect of using different levels of tannic acid on fecal consistency score

Variable	Tannic acid supplementation				SEM
	0	2.5 (ml.L)	5 (ml.L)	10 (ml.L)	
0-50 days	1.47 ^{a*}	1.36 ^{ab}	1.41 ^{ab}	1.19 ^b	0.135

*Means within a row with no common letter are significantly different ($P < 0.05$)

Conclusion

We may conclude that using of different levels of tannic acid at with 2.5, 5 and 10 milligram could have effects on performance and increased nutrient digestibility and also improved fecal consistency in Semintal milk consuming calve.

References

ADAMCZYK, B.; SALMINEN, J.P.; SMOLANDER, A. AND KITUNEN, V. 2012. Precipitation of proteins by tannins: effects of concentration, protein/tannin ratio and pH. *International Journal of Food Science and Technology* 47:875-878. <https://doi.org/10.1111/j.1365-2621.2011.02911.x>

AL-MAMARY, M.; MOLHAM, A.H.; ABDULWALI, A.A. AND AL-OBEIDI, A. 2001. In vivo effects of dietary sorghum tannins on rabbit digestive enzymes and

mineral absorption. *Nutrition Research* 21:1393-1401.

BEN SALEM, H.; NEFZAOU, A., BEN SALEM, L.; TISSERAND, J.L., 1999. Different means of administering polyethylene glycol to sheep: effect on the nutritive value of *Acacia cyanophylla* Lindl. Foliage. *Anim Sci* 68,809-818.

BHATTA, R., VAITHIYANATHAN, S., SINGH, N.P.; SHINDE, A.K. AND VERMA, D.L. 2005. Effect of Feeding Tree Leaves as Supplements on Nutrient Digestion and Rumen Fermentation Pattern in Sheep Grazing Semi-Arid Range of India-I. *Small. Rumin. Res.*, 60: 273-280. <https://doi.org/10.1016/j.smallrumres.2005.01.009>

BUTTER, N.L.; DAWSON, J.M. AND BUTTERY, P.J. 1999. Effects of dietary tannins on ruminants. In: Caygill J.C., Mueller-Harvey I. (eds.) *Secondary plant products*. Nottingham, Nottingham University Press,51-70.

- BRODERICK, G.A. 1974. In-vitro procedures for estimating rate of ruminal protein degradation and proportions of protein escaping the rumen undegraded. *Journal Nutrition* 108:181–190. <https://doi.org/10.1093/jn/108.2.181>
- CONSTABLE, P.D. 2004. Antimicrobial use in the treatment of calf diarrhea. *Journal Vet. Int. Med.* 18: 8–17. [https://doi.org/10.1892/0891-6640\(2004\)18](https://doi.org/10.1892/0891-6640(2004)18).
- DESRUES, O.; FRYGANAS, C.; ROPIAK, H.M.; MUELLER-HARVEY, I.; ENEMARK, H.L. AND THAMSBORG, S. M. 2016. Impact of chemical structure of flavanol monomers and condensed tannins on in vitro anthelmintic activity against bovine nematodes. *Parasitology* 143:444-454.
- DIAZ, M.C.M.E. VAN AMBURGH, J.M. SMITH, J.M. KELSEY, AND E.L. HUTTEN. 2001. Composition of growth of Holstein calves fed milk replacer from birth to 105-kilogram body weight. *J. Dairy Sci.* 84:830–842. [https://doi.org/10.3168/jds.S0022-0302\(01\)74541-9](https://doi.org/10.3168/jds.S0022-0302(01)74541-9)
- DUMANOVSKI, F.; SOTOSEK, F.; 1998. Current understanding of the use of Farnatan in animal feeding. *Krmiva* 40(5): 263-273.
- DUNCAN, D.B. 1955. Multiple range and Multiple Ftest. *Biometrics*, 11:1.
- EHRlich, C., 1999. The Ethnobotany of *Cordyline fruticosa* (L.) A. Chev.: The “Hawaiian Ti Plant”. Unpublished Ph.D dissertation, University of Buffalo, New York.
- FIELD, M. 2003. Intestinal ion transport and the pathophysiology of diarrhea. *Journal Clin Invest* 111: 931-943.
- FRUTOS P.; RASO, M.; HERVAS, G., MANTECON, A.R.; PEREZ, V., GIRALDEZ, F.J. 2004. Is there any detrimental effect when a chestnut hydrolyzable tannins extractis included in the diet of finishing lambs? *Anim Res* 56, 127-136. INRA, EDP Sciences, 2004. <https://doi.org/10.1051/animres:2004001>
- HASLAM E. 1996. Natural polyphenols (vegetable tannins) as drugs: possible modes of action. *Journal Nat Prod* 59: 205-215.
- HEINRICHS, A.J.C.M.; JONES, L.R. VANROEKEL, AND M.A. FOWLER. 2003. Calf Track: A system of dairy calf workforce management, training, and evaluation and health evaluation. *Journal Dairy Science* 86(Suppl. 1):115. (Abstr.)
- JAMROZ D, WILICZKIEWICZ A, SKORUPINSKA, J, ORDA J, KURYSZKO J AND TSCHIRCH, H, 2009. Effect of sweet chestnut tannin (SCT) on the performance, microbial status of intestine and histological characteristics of intestinal wall in chickens. *British Poultry Science*, 50, 687–699.
- JOHNSON, P.L., L.A. DREVJANY, O.B. ALLEN, AND L.M. REASBECK. 1988. Supplementation of skim milk fed to veal calves: Carcass characteristics, chemical, instrumental, and sensory parameters. *Can Journal Animal Science* 68:1069-1077.
- KUMAR R., SINGH M. 1984. Tannins: their adverse role in ruminant nutrition. *Journal Agricola Food Chemistry* 32, 447-453. <https://doi.org/10.1021/jf00123a006>
- LAVIN, S. R.; CHEN, Z. AND ABRAMS, S. A. 2010. Effect of tannic acid on iron absorption in straw-colored fruit bats (*Eidolon helvum*). *Zoo Biology* 29:335-343. <https://doi.org/10.1002/zoo.20258>

- LEE SH, SHINDA PL, CHOI JY, KWONA IK, LEE JK, PAK SI, CHO WT AND CHAE BJ, 2010. Effects of tannic acid supplementation on growth performance, blood hematology, iron status and faecal microflora in weanling pigs. *Livestock Science*, 131, 281–286.
- LIU, R.H. 2013. Health benefits of fruit and vegetables are from additive and synergistic combinations of phytochemicals. *The American Journal of Clinical Nutrition*.78 (3):517 S –520. <http://dx.doi.org/10.1093/ajcn/78.3.517S>
- MANGAN J.L. 1988 Nutritional effects of tannins in animal feeds. *Nutrition Research Reviews*, 1, 209-231.
- MURDIATI, T.B.C.S. McSweeney, and J. B. Lowry. 1992. Metabolism in sheep of gallic acid, tannic acid and hydrolysable tannin from *Terminalia oblongata*. *Australian Journal of Agricultural Research* 43:1307.–1319. [CSIRO Document Delivery](http://www.csiro.au/DocumentDelivery).
- MORINAGA, N.; IWAMARU, Y.; YAHIRO, K.; TAGASHIRA, M.; MOSS, J. 2005. Differential activities of plant polyphenols on the binding and internalization of cholera toxin in vero cells. *Journal Biology Chemistry* 280: 23303-23309. <http://dx.doi.org/10.1074/jbc.M502093200>.
- NATIONAL RESEARCH COUNCIL. 2001. *Nutrient Requirements of Dairy Cattle*. 7th rev. ed. ed. Natl. Acad. Press, Washington DC.
- NAKAMURA Y, TSUJI S, TONOGAI Y. 2003. Method for analysis of tannic acid and its metabolites in biological samples: application to tannic acid metabolism in the rat. *Journal Agricola Food Chemistry* 51(1):331–339. <https://doi.org/10.1021/jf020847+>
- NETO, J.A.S.; OLIVEIRA, V.S.; SANTOS, A.C.P.; VALENÇA, R.L. Metabolic disorders in ruminantes - A Review. *Revista Brasileira de Higiene e Sanidade Animal* (v.8, n.4) p. 157-186, out-dez (2014)157. <http://dx.doi.org/10.5935/1981-2965.20140141>.
- OLIVEIRA, R.A, NARCISO, C.D, BISINOTTO, R.S, PERDOMO M.C, BALLOU, M.A, DREHER, M, SANTOS J.E. 2010. Effects of feeding polyphenols from pomegranate extract on health, growth, nutrient digestion, and immune competence of calves. *Journal Dairy Science* 93(9):4280-91.
- PALOMBO, E.A .2006.Phytochemicals from traditional medicinal plants used in the treatment of diarrhoea: modes of action and effects on intestinal function. *Phytother Res* 20: 717-724.
- POTTER, D.K AND FULLER, H.L, 1968. Metabolic fate of dietary tannins in chickens. *The Journal of Nutrition*, 96, 187–191.
- PLUMLEE, K..H.; JOHNSON, B.; GALEY, F.D. 1998. Disease in cattle dosed orally with oak or tannic acid. In: *Toxic plants and other natural toxicants*, (Garland T. and Barr A.C.,eds.), CAB International, Wallingford, UK, pp. 549-553.
- RAI, S.N. AND SHUKLA, P.C. 1979. Effect of feeding deoiled salseed meal (DSSM) with urea and molasses diets to milch cows on quantity and quality of milk and blood metabolites. *GAU Research J.S*, 1479.
- SAS . 2001. *SAS User's guide: Statistics*, SAS Institute Inc., Cary, NC.

SINGH, B, BHAT, T.K AND SHARMA, O.P, 2001. Biodegradation of tannic acid in an in vitro ruminal system. *Livestock Production Science*, 68, 259–262. [https://doi.org/10.1016/S0301-6226\(00\)00227-X](https://doi.org/10.1016/S0301-6226(00)00227-X)

SPENCER, C.M.; CAI, Y.; MARTIN, R.; GAFFNEY, S.H.; GOULDING, P.N.; MAGNOLATO, D. et al. 1988. Polyphenol complexation some thoughts and observations. *Phytochemistry* 27 2397-240910.

STUKELJ, M.; VALENCAK, Z.; KRSNIK, M AND NEMEC-SVETE, A, 2010. The effect of the combination of acids and tannin in diet on performance and selected biochemical, haematological and antioxidant enzyme parameters in grower pigs. *Acta Veterinaria Scandinavica*, 52, 19-26.

SWAIN, T.; 1965. The Tannins. In: Bonner, J. and J. Varner (eds.), *Plant Biochemistry*. pp. 552–80. Academic Press, New York.

WAGHORN, G.C.; SHELTON, I.D.; MCNABB, W.C.; MCCUTCHEON, S.N. 1994. Effects of condensed tannins in *Lotus pedunculatus* on its nutritive value for sheep. 2. Nitrogenous aspects. *Journal Agr Sci* 123, 109-119. <https://doi.org/10.1017/S0021859600067836>

WAGHORN, G. 1996. Condensed tannins and nutrient absorption from the small intestine. Proc of the 1996 Canadian Society of Animal Science Annual Meeting, Lethbridge, Canada (Rode L.M., ed.). pp. 175-194.

WILSON, T.C. 1989. I. A quantitative determination of ellagic acid. II. Analysis of tannic acid and its interaction with protein. M.S. Thesis, Miami Univ., Oxford, Ohio 45056.