Veterinary Integrative Sciences 2023; 21(1): 037 - 047 DOI; 10.12982/VIS.2023.004

Vet Integr Sci

Veterinary Integrative Sciences

ISSN; 2629-9968 (online)

Website; www.vet.cmu.ac.th/cmvj

Research article

Effects of oil and grape seed tannin extract on intakes, digestibility, milk yield and composition of Saanen goats

Nguyen Thi Thu Ha[1], Duong Tran Tuyet Mai[1], Tran Thi Thuy Hang[2], Lam Phuoc Thanh[1*]

[1]Department of Animal Sciences, College of Agriculture, Can Tho University, Can Tho 94000, Vietnam
[2]Department of Agricultural Technology, College of Rural Development, Can Tho University, Hau Giang 95000, Vietnam

Abstract

An experiment was conducted as a 4×4 Latin square design using 4 lactating Saanen goats, 19 months old and 47.9±1.04 kg of body weight, to evaluate the effect of oil and grape seed tannin extract (GSTE) supplementation on feed intake, digestibility, milk yield and milk composition. Each experimental period lasted for 21 days including 16 days for adjustment and 5 days for sampling. Goats were fed a control diet (Ctrl) consisting of 60% concentrate and 40% fresh Para grass (dry matter, DM, basis) while other 3 treatments were supplementation of 2.5% soybean oil (SO); 2.5% soybean oil + tuna fish oil at 3:2 w:w (SFO); 2.5% soybean oil + tuna fish oil at 3:2 w:w + 0.8% GSTE (OCT). The results showed that oil and GSTE did not affect feed intake, digestibility, milk yield and composition of goats ($P > 0.05$). However, digestibility of EE was higher ($P < 0.05$) in SFO and OCT diets (85.4% and 84.7%, respectively) compared with Ctrl (76.2%). Combined data suggested that feeding 2.5% oil blend with or without 0.8% GSTE increased EE digestibility in goats without affecting intake, animal performance and milk composition.

Keywords: Digestibility, Grape seed tannin extract, Milk composition, Milk yield, Oil

Corresponding author: Lam Phuoc Thanh, Department of Animal Sciences, College of Agriculture, Can Tho University, Can Tho 94000, Vietnam, Tel: +84 9 7576 3555, Email: phuocthanh@ctu.edu.vn

Funding; This study was financially supported by the Vietnam National Foundation for Science and Technology Development (NAFOSTED) under Grant No. 106.05-2017.310.

Article history; *received manuscript: 30 May 2022,*
revised manuscript: 22 September 2022,
accepted manuscript: 30 September 2022,
published online: 10 November 2022

Academic editor; *Nguyen Trong Ngu*

INTRODUCTION

Nowadays, the quality of life is increasingly improved, thus people more concern about health food quality. According to Joyce et al. (2009), if consumers consume foods with high content of saturated fat, there is a risk of cardiovascular diseases. Consumption of conjugated linoleic acids (CLA), especially *cis*-9,*trans*-11 CLA from ruminant fat enhances resistance to breast, prostate and gastrointestinal cancers (Gebauer et al., 2011; Grądzka et al., 2013). Vegetable oils rich in linoleic acid, e.g., soybean oil, provide a substrate for vaccenic acid synthesis in the rumen. However, a conversion of unsaturated fatty acids into saturated fatty acids, or biohydrogenation (BH) in the rumen, is an undesirable process in terms of human health. Feeding approach could inhibit the last step in the ruminal BH process by adding condensed tannins (CT) (Thanh et al., 2022) or fish oil (Boeckaert et al., 2007) to the ruminant diet.

On the other hand, during late pregnancy and early lactation, the nutritional requirements for fetal growth and milk synthesis significantly increase, and goats cannot meet these energy requirements from feed. As a result, most goats enter a period of negative energy balance, and they will mobilize lipid and protein from empty body. The addition of oil to ruminant diets is a solution to increase the energy of the diet without increasing the percentage of concentrate (Silva et al., 2011). Because of the benefits by adding oil and CT in the ruminant diets as mentioned above, this study was carried out to evaluate the effect of oil supplementation with or without combination with grape seed tannin extract (GSTE) in the diet on intake, digestibility, ruminal fermentation, milk yield and composition of Saanen goats.

MATERIALS AND METHODS

Site and duration

The study was conducted from October 2021 to February 2022 at a private dairy goat farm in Hau Giang province and Laboratory of Ruminant Production Techniques, Department of Animal Sciences, College of Agriculture, Can Tho University.

Animals

Four lactating Saanen goats weighing 47.9±1.04 kg, milk yield of 1.19±0.14 kg/day, milking month of 2.50±1.29 and milk fat content of 4.28±0.23% were used to conduct this study. They were kept in individual wooden cages and fed twice a day at 7:00 and 17:00 h. The goats were had free access to water and had enough space to exer*cis*e. Prior to conduct the experiment, goats were fed freely a basal diet for 1 week to determine the maximum feed intake. On the last 2 days of the pre-feeding period, milk yield was recorded, milk composition and somatic cells were analyzed.

Experimental design and diets

Goats were assigned to a 4×4 Latin square experiment, each period consisted of 16 days for adjustment and 5 days for sampling. During the experimental period, all goats were fed a basic diet consisting of 40% fresh

Para grass (*Brachiaria mutica*) and 60% pelleted concentrate (dry matter basis). Treatments were 1) basic diet without oil and tannin inclusion as a control (Ctrl), 2.5% soybean oil (SO), 2.5% soybean oil and tuna oil (3:2 w:w; SFO) and SFO + 0.8% GSTE (OCT). Concentrate was fed to animals first, they were then received *ad libitum* Para grass. Diets were daily monitored to make sure that the goats exactly consumed ratios as designed.

Concentrate was mixed and pelleted one time a week. Oil and GSTE were mixed daily with concentrate before feeding the animals. Soybean oil and tuna fish oil (3:2 w:w) were added into the diet at 2.5% DM according to Thanh et al. (2018). Soybean oil was supplemented as a pure product while tuna oil was added as a crude oil. A commercial grape seed tannin extract was used in the current study as a source of CT, in form of proanthocyanidin (PA). The supplementation of GSTE at 0.8% DM was based on the finding of a study in dairy cows at our lab (unpublished data). Feed ingredients and chemical composition of the diets are showed in Table 1.

Table 1 Feed ingredients and chemical composition of the diets

Item	Treament[1]			
	Ctrl	SO	SFO	OCT
Ingredient, % DM				
Soybean meal	17.7	18.3	18.3	18.5
Ground corn	25.3	18.8	18.8	18.4
Rice bran	14.5	18.9	18.9	18.6
Para grass	40.0	39.0	39.0	38.7
DCP	1.50	1.50	1.50	1.50
NaCl	0.30	0.30	0.30	0.30
Mineral and vitamin mix	0.50	0.50	0.50	0.50
$CaCO_3$	0.17	0.18	0.18	0.17
Soybean oil		2.50	1.50	1.50
Tuna oil			1.00	1.00
Grape seed tannin extract				0.80
[2]Chemical composition, %DM				
DM	60.1	61.3	61.3	61.4
OM	90.5	90.2	90.2	90.3
CP	18.4	18.9	18.9	19.2
NDF	37.6	37.7	37.7	36.9
ADF	23.0	23.2	23.2	22.6
EE	3.10	5.76	5.76	5.33
CF	19.1	19.1	19.1	19.8
[3]NFC	31.5	27.8	27.8	28.9
GE, Mcal/Kg DM	3.87	3.78	3.78	3.78

[1]Ctrl: only basal diet, SO: 2.5% soybean oil, SFO: 2.5% soybean oil + tuna oil (3:2, w:w), OCT: 2.5% soybean oil + tuna oil (3:2, w:w) + 0.8% grape seed tannin extract. [2]DM: dry matter, OM: organic matter, CP: crude protein, NDF: neutral detergent fiber, ADF: acid detergent fiber, EE: ether extract, CF: crude fiber, NFC: non-fiber carbohydrates, GE: gross energy. [3]NFC = 100 − CP − NDF − EE − Ash (NRC, 2001)

Sampling, measurements and chemical analysis

Feeds offered and the residuals, feces and urine were collected continuously for 4 days (from d 17 to d 20 of each period). Feed samples were dried in a forced-air oven (FD 53, Binder, Germany) at 60°C for 72 h, milled through a 1-mm mesh (Cutting Mill SM100, Retsch, Germany) and stored at -20°C until further analyses of DM, OM, Ash, CP, CF and EE using the standard methods of AOAC (1990). The content of NDF and ADF was determined using the methods described by Van Soest et al. (1991).

Feces were totally collected to calculate nutrient digestibility. After recording the weight, 20% proportions of 24 h feces were dried, milled and stored for later chemical analysis similar to feed samples. Urine samples were daily treated with 10% H_2SO_4 to keep the final pH below 3 (Pathoummalangsy and Preston, 2008), then 20 mL of urine solution were collected. Urine samples were then pooled and analyzed nitrogen concentration. Nitrogen retention was calculated based on the data of nitrogen (N) intake, feces, urine and milk to determine N retention according to the formula: $N_{retention} = N_{intake} - (N_{feces} + N_{urine} + N_{milk})$.

Metabolizable energy intake (ME) was caculated following the equation of Bruinenberg et al. (2002). Non-fiber carbohydrates (NFC) = 100 – (CP + EE + NDF + Ash). Live weights were recorded at the initial and end of each period to calculate live weight change. Nutrient digestibility of diet was measured according to the method of McDonald (2010).

The dairy goats were milked daily at 7:30 and 17:30 h, and milk yields were recorded at each milking. Milk were sampled weekly in 2 consecutive milking days to analyze milk composition including total solid, lactose, protein, fat and solid not fat using a MilkoScan infrared automatic analyzer (MilkoScan Mars, Foss, Denmark). To count somatic cells in milk, milk samples were taken twice (morning and afternoon) at the beginning and the end day of each period. Milk samples were kept in Eppendorf at 1°C and immediately analyzed for somatic cell counts using a milk somatic cell analyzer (Adam-SCC, Nano Entek Inc, Korea).

Statistical analysis

A generalized linear model procedure was used to statistically analyze the experimental data. Statistical tests were performed using SAS OnDemand for Academics (SAS Institute Inc, Cary, NC, USA). Tukey's multiple comparison tests were used to assess the significant differences among treatment means. Statistical significance was declared at $P < 0.05$, whereas a tendency toward significance was considered at $0.10 > P \geq 0.05$.

RESULTS

Feed and nutrient intakes

Oil and GSTE supplement had no effects on DM intakes of feeds as well as the percentage of grass and concentrate in the diet ($P > 0.05$; Table 2). The EE intake of the oil treatments (70.6-80.5 g/day) was increased ($P < 0.05$) relative to 44.6 g/day in the Ctrl.

Table 2 Feed and nutrient intakes

Item[1]	Treatment[2]				P	SEM
	Ctrl	SO	SFO	OCT		
Feed intake, g DM/d						
Concentrate	906	845	804	792	0.318	85.7
Para grass	525	480	477	459	0.305	45.7
Soybean oil		35.9[a]	20.5[b]	20.4[b]	<0.001	2.65
Tuna oil			13.7[a]	13.8[a]	<0.001	1.32
GSTE				10.9	<0.001	0.77
Ratio of feed intake, %DM						
Concentrate	63.4	62.0	61.2	60.9	0.058	1.05
Para grass	36.6	35.3	36.2	35.6	0.397	1.09
Soybean oil		2.64[a]	1.56[b]	1.57[b]	<0.001	0.07
Tuna oil			1.04[a]	1.06[a]	<0.001	0.04
GSTE				0.84	<0.001	0.03
Nutrient intake, g/d						
DM	1,426	1,354	1,309	1,288	0.487	127
OM	1,291	1,186	1,147	1,121	0.245	112
CP	268	262	252	250	0.659	22.3
NDF	513	484	477	452	0.490	52.8
ADF	313	299	292	274	0.430	31.3
EE	44.6[b]	80.5[a]	77.2[a]	70.6[a]	0.006	9.40
CF	269	252	248	252	0.712	26.5
GE, Mcal/d	5.53	5.47	5.27	5.15	0.735	0.53
ME, Mcal/d	3.74	3.41	3.23	3.15	0.136	0.32

[1]DM: dry matter, OM: organic matter, CP: crude protein, NDF: neutral detergent fiber, ADF: acid detergent fiber, EE: ether extract, CF: crude fiber, GE: gross energy, ME: metabolizable energy intake. [2]Ctrl: only basal diet, SO: 2.5% soybean oil, SFO: 2.5% soybean oil + tuna oil (3:2 w:w), OCT: 2.5% soybean oil + tuna oil (3:2 w:w) + 0.8% grape seed tannin extract. [a,b]Means within a row with different superscripts are significantly different at P < 0.05.

Digestibility and digested nutrient

In this experiment, both oil and GSTE had no significant changes ($P > 0.05$) in digestibility and digested nutrient (except for EE; Table 3). EE digestibility increased when adding oil to the diet, especially the treatments containing tuna fish oil. The highest EE digestibility was in the SFO (85.4%) and the lowest one in the Ctrl (76.2%) ($P < 0.05$). Similarly, digested EE also increased ($P < 0.01$) in oil-added diets, the highest value in treatment SO (67.3 g/day) and higher two times compared with Ctrl (33.9 g/day).

Table 3 Nutrient digestibility

Item[1]	Treatment[2]				P	SEM
	Ctrl	SO	SFO	OCT		
Digestibility, %						
DM	75.6	74.8	73.3	73.3	0.614	2.85
OM	78.3	76.7	75.5	75.1	0.420	2.78
CP	83.2	84.6	83.5	82.1	0.303	1.61
NDF	64.3	63.4	60.5	60.1	0.451	4.22
ADF	59.6	56.4	54.1	51.2	0.291	5.69
EE	76.2^{b}	83.8^{ab}	85.4^{a}	84.7^{a}	0.022	3.25
Digested nutrient, g/d						
DM	1,076	1,014	958	946	0.297	95.6
OM	1,010	912	864	843	0.118	85.7
CP	223	221	211	206	0.545	18.8
NDF	329	306	289	272	0.265	37.1
ADF	185	169	158	140	0.140	23.1
EE	33.9b	67.3^{a}	66.2^{a}	59.8^{a}	0.005	8.74
DE	4.24	4.19	3.98	3.87	0.583	0.41

[1]DM: dry matter, OM: organic matter, CP: crude protein, NDF: neutral detergent fiber, ADF: acid detergent fiber, EEether extract, DE: digestible energy. [2]Ctrl: only basal diet, SO: 2.5% soybean oil, SFO: 2.5% soybean oil + tuna oil (3:2 w:w), OCT: 2.5% soybean oil + tuna oil (3:2 w:w) + 0.8% grape seed tannin extract. [a,b]Means within a row with different superscripts are significantly different at P < 0.05.

Nitrogen balance and live weight change

Supplementing oil alone or in combination with GSTE did not affect the N retention and live weight gain of the experimental goats (P > 0.05; Table 4). Although the trend is not significant, but it can be seen that when adding 0.8% GSTE to the diet, the amount of N excreted in the feces increased and the N excreted in the urine decreased compared with other old-added diets. In this study, we can be seen that meanwhile Ctrl and SO goats reduced weight (−20.7 vs. −44.3, respectively), goats in SFO and OCT treatments gained weight quite good with an average increase of 81.2 and 51.4 g/day, respectively (P > 0.05).

Table 4 Nitrogen balance and live weight change

Item	Treatment				P	SEM
	Ctrl	SO	SFO	OCT		
Nitrogen (N) balance, g/d						
Intake	42.9	41.9	40.3	40.0	0.660	3.58
Feces	7.25	6.47	6.65	7.12	0.627	0.95
Urine	8.92	8.08	7.64	6.64	0.587	2.28
Milk	7.21	6.77	5.58	6.48	0.621	1.73
Retention	19.5	20.6	20.5	22.3	0.784	7.53
% of N intake						
Feces	16.8	15.4	16.5	17.9	0.303	1.61
Urine	20.6	18.8	18.9	16.8	0.767	4.92
Milk	16.4	16.2	14.0	15.4	0.749	3.38
Retention	46.2	49.5	50.6	55.1	0.804	2.69
Live weight (LW) change						
Initial LW, kg	49.1	48.1	46.6	48.0	0.508	2.24
Final LW, kg	48.6	46.7	47.6	49.6	0.105	1.39
LW gain, g/d	-20.7	-44.3	51.4	81.2	0.293	94.6

Ctrl: only basal diet, SO: 2.5% soybean oil, SFO: 2.5% soybean oil + tuna oil (3:2 w:w), OCT: 2.5% soybean oil + tuna oil (3:2 w:w) + 0.8% grape seed tannin extract

Milk yield and composition

Milk yield, composition and somatic cell counts were not affected by the experimental diets ($P > 0.05$; Table 5). In this study, the goats showed quite high contents of fat (4.11-4.60%) and total solid (12.6-12.9%), but no significance was detected among the diets. Milk somatic cell counts of goats in this study was in the normal range, 790-1,467×10^3 cells/mL at the beginning and 687-1,069×10^3 cells/mL at the end of the experiment.

Table 5 Milk yield and composition

Item	Treatment				P	SEM
	Ctrl	SO	SFO	OCT		
Milk yield						
g/d	1,329	1,282	1,025	1,122	0.646	347
kg/kg DMI	0.91	0.93	0.78	0.82	0.772	0.21
Milk composition, %						
Fat	4.29	4.60	4.12	4.11	0.495	0.49
Protein	3.57	3.46	3.47	3.63	0.360	0.14
Lactose	4.56	4.61	4.66	4.54	0.299	0.09
Total solid	12.7	12.9	12.6	12.6	0.850	0.65
Solid not fat	8.71	8.60	8.67	8.72	0.756	0.17
Somatic cell, ×10^3/mL						
Initial	859	790	1,467	984	0.637	787
Final	1,035	687	999	1,069	0.655	466
Difference	176	-103	-468	85.6	0.208	398

Ctrl: only basal diet, SO: 2.5% soybean oil, SFO: 2.5% soybean oil + tuna oil (3:2 w:w), OCT: 2.5% soybean oil + tuna oil (3:2 w:w) + 0.8% grape seed tannin extract

DISCUSSION

That no change of total DM intake in this study was supported by some previous studies, in which soybean oil was supplemented at 2 to 5% DM in the diets of dairy goats (Bouattour et al., 2008; Mele et al., 2008; Hamzaoui et al., 2021) and cows (Qin et al., 2020). Nutrient intakes such as DM, OM, CP, NDF, ADF, GE, ME were not affected by the experimental diets. According to NRC (2001), total fat in the diet should not exceed 6–7% DM because higher these concentrations can lead to a decrease in DM intake. This was confirmed in the current study, where the highest concentration of EE in the diets supplemented oil at 5.76%.

Almeida et al. (2019) detected no effect of soybean oil supplementation (2% DM) on nutrient digestibility in Saanen dairy goats, and this was in agreement with our finding. The supplement of 2.5% dietary oil has no effect on feed intake and nutrient digestibility because dietary EE content was not high enough to have the adverse effect on rumen function and digestibility of the feed compounds, especially fiber fraction (Palmquist, 1994). The greater EE digestibility in SFO and OCT goats was expected in this study, because with the higher EE digestibility, the animals will have more energy to supply body requirements and compensate the daily loss of energy via milk.

Hamzaoui et al. (2021) reported that oil supplementation in the diet did not affect the N retention of goats, and our study detected the similar result. This may be explained partly that after dissociation of the tannin-protein complex, the tannins released in the abomasum can bind again to the non-degraded proteins in the rumen (Naumann et al., 2017), microbial proteins or endogenous proteins when they reach in the small intestine (Waghorn, 2008). Decreased protein degradation in the rumen by CT supplementation resulted in a reduction of NH_3-N concentrations, providing higher value for animals. Nitrogen available in the rumen, when exceeding the requirements for microbial growth, will be absorbed by the liver in the form of NH_3, then converted into urea and recycled or excreted in the urine. High rates of ruminal protein degradation increase N excretion via urine, which causes negative impact on the environment (Powell et al., 2011). Moreover, it decreases N utilization efficiency and animal performance (Kohn et al., 2005; Van Duinkerken et al., 2005) and fertility (Westwood et al., 2000; Tshuma et al., 2014).

Krishnamoorthy and Moran (2012) reported that oil has 2.25 folds higher caloric value compared with carbohydrate (9 calories/g and 4 calories/g, respectively), thus oil-supplemented diet had higher energy density resulting in higher energy intake at similar feed intake level. Oil addition has been reported to increase growth efficiency in goats and sheep (Candyrine et al., 2019). However, our study could not detect the significance of weight gain. Hamzaoui et al. (2021) suggested that soybean oil supplementation had no effect on the weight change of goats.

Milk fat content has been increased when soybean oil was supplemented to dairy goats (Bouattour et al., 2008; Mele et al., 2008). On the other hand, previous studies (Huang et al., 2008; Liu et al., 2020) showed that fat content in milk was decreased when dairy cows supplemented with 2.5 to 5.0% soybean oil. Other studies reported no changes in milk fat content in dairy cows (Jacobs et al., 2011) and dairy sheep (Gómez-Cortés et al., 2008) when they were fed

soybean oil. These conflicting results may be due to differences in species, physiological status, forage sources in the diet, and forage:concentrate ratio in the diet. Compared with dairy cows, dairy goats were considered to be less sensitive to milk fat inhibitory factors when vegetable oil were added to the diet (Bernard et al., 2008). That diet had no effect on milk somatic cell counts was consistent with the study of Huang et al. (2008) when dairy cows were supplemented grape seed extract at 80 mg/kg body weight. Nudda et al. (2015) also showed that grape seed supplementation at 300 g/day had no significant effect on somatic cells in sheep's milk.

CONCLUSIONS

Supplementation of 2.5% DM soybean oil alone or a mixture of soybean oil and tuna fish oil with or without 0.8% DM GSTE inclusion did not affect feed intake, digestibility, nitrogen retention, milk yield and composition of Saanen goats. Feeding 2.5% oil blend with or without 0.8% GSTE significantly improved EE digestibility in goats. Therefore, inclusion of 2.5% oil blend with or without 0.8% GSTE is a potential feeding approach to enhance beneficial fatty acids in milk without negative effect on animal performance.

AUTHOR CONTRIBUTIONS

Lam Phuoc Thanh, Tran Thi Thuy Hang; Conceptualization and design the experiment, investigation, supervision, editing and finalization
Nguyen Thi Thu Ha, Duong Tran Tuyet Mai; Investigation, methodology, formal analysis, manuscript preparation

CONFLICT OF INTEREST

We have no conflict of interest.

REFERENCES

Almeida, O.C., Ferraz, M.V.C., Susin, I., Gentil, R.S., Polizel, D.M., Ferreira, E.M., Barroso, J.P.R., Pires, A.V., 2019. Plasma and milk fatty acid profiles in goats fed diets supplemented with oils from soybean, linseed or fish. Small Rumin. Res. 170, 125-130.

AOAC, 1991. Official method of analysis. Association of Official Analytical Chemists, Maryland.

Bernard, L., Leroux, C., Chilliard, Y., 2008. Expression and nutritional regulation of lipogenic genes in the ruminant lactating mammary gland. In: Bösze Z. (Ed.), Bioactive components of milk (Advances in experimental medicine and biology), Springer, New York, pp. 67-108.

Boeckaert, C., Fievez, V., Hecke, D.V., Verstraete, W., Boon, N., 2007. Changes in rumen biohydrogenation intermediates and ciliate protozoa diversity after algae supplementation to dairy cattle. Eur. J. Lipid Sci. Technol. 109(8), 767-777.

Bouattour, M., Casals, R., Albanell, E., Such, X., Caja, G., 2008. Feeding soybean oil to dairy goats increases conjugated linoleic acid in milk. J. Dairy Sci. 91(6), 2399-2407.

Bruinenberg, M., Valk, H., Korevaar, H., Struik, P., 2002. Factors affecting digestibility of temperate forages from seminatural grasslands: a review. Grass Forage Sci. 57(3), 292-301.

Candyrine, S.C.L., Jahromi, M.F., Ebrahimi, M., Chen, W.L., Rezaei, S., Goh, Y.M., Abdullah, N., Liang, J.B., 2019. Oil supplementation improved growth and diet digestibility in goats and sheep fed fattening diet. Asian-Australas. J. Anim. Sci. 32(4), 533-540.

Gebauer, S.K., Chardigny, J.-M., Jakobsen, M.U., Lamarche, B., Lock, A.L., Proctor, S.D., Baer, D.J., 2011. Effects of ruminant trans fatty acids on cardiovascular disease and cancer: a comprehensive review of epidemiological, clinical, and mechanistic studies. Adv. Nutr. 2(4), 332-354.

Gómez-Cortés, P., Frutos, P., Mantecón, A.R., Juárez, M., de la Fuente, M.A., Hervás, G., 2008. Milk production, conjugated linoleic acid content, and in vitro ruminal fermentation in response to high levels of soybean oil in dairy ewe diet. J. Dairy Sci. 91(4), 1560-1569.

Grądzka, I., Sochanowicz, B., Brzóska, K., Wójciuk, G., Sommer, S., Wojewódzka, M., Gasińska, A., Degen, C., Jahreis, G., Szumiel, I., 2013. Cis-9, trans-11-conjugated linoleic acid affects lipid raft composition and sensitizes human colorectal adenocarcinoma HT-29 cells to X-radiation. Biochim. Biophys. Acta (BBA)-General Subjects. 1830(1), 2233-2242.

Hamzaoui, S., Caja, G., Such, X., Albanell, E., Salama, A.A., 2021. Effect of soybean oil supplementation on milk production, digestibility, and metabolism in dairy goats under thermoneutral and heat stress conditions. Animals. 11(2), 350.

Huang, C.Q., Gasser, R.B., Cantacessi, C., Nisbet, A.J., Zhong, W., Sternberg, P.W., Loukas, A., Mulvenna, J., Lin, R.Q., Chen, N., 2008. Genomic-bioinformatic analysis of transcripts enriched in the third-stage larva of the parasitic nematode Ascaris suum. PLoS Negl. Trop. Dis. 2(6), e246.

Jacobs, A.A., van Baal, J., Smits, M.A., Taweel, H.Z., Hendriks, W.H., van Vuuren, A.M., Dijkstra, J., 2011. Effects of feeding rapeseed oil, soybean oil, or linseed oil on stearoyl-CoA desaturase expression in the mammary gland of dairy cows. J. Dairy Sci. 94(2), 874-887.

Joyce, T., Wallace, A.J., McCarthy, S.N., Gibney, M.J., 2009. Intakes of total fat, saturated, monounsaturated and polyunsaturated fatty acids in Irish children, teenagers and adults. Public Health Nutr. 12(2), 156-165.

Kohn, R., Dinneen, M., Russek-Cohen, E., 2005. Using blood urea nitrogen to predict nitrogen excretion and efficiency of nitrogen utilization in cattle, sheep, goats, horses, pigs, and rats. J. Anim. Sci. 83(4), 879-889.

Krishnamoorthy, U., Moran, J. 2012. Rearing young ruminants on milk replacers and starter feeds. Food and Agriculture Organization of the United Nations, Rome.

Liu, E., VandeHaar, M., Lock, A., 2020. Effects of supplementing Holstein cows with soybean oil compared with palmitic acid–enriched triglycerides on milk production and nutrient partitioning. J. Dairy Sci. 103(9), 8151-8160.

McDonald, P., Edwards, R.A., Greenhalgh, J.F.D., Morgan, C.A., Sinclair, L.A., Wilkinson, R.G., 2010. Animal nutrition. Pearson, London.

Mele, M., Serra, A., Buccioni, A.,Conte, G., Pollicardo, A., Secchiari, P., 2008. Effect of soybean oil supplementation on milk fatty acid composition from Saanen goats fed diets with different forage: concentrate ratios. Ital. J. Anim. Sci. 7(3), 297-311.

Naumann, H.D., Tedeschi, L.O., Zeller, W.E., Huntley, N.F., 2017. The role of condensed tannins in ruminant animal production: advances, limitations and future directions. R. Bras. Zootec. 46, 929-949.

NRC, 2001. National research council: nutrient requirements of dairy cattle. National Academy Press, Washington D.C.

Nudda, A., Correddu, F., Marzano, A., Battacone, G., Nicolussi, P., Bonelli, P., Pulina, G., 2015. Effects of diets containing grape seed, linseed, or both on milk production traits, liver and kidney activities, and immunity of lactating dairy ewes. J. Dairy Sci. 98(2), 1157-1166.

Palmquist, D.L., 1994. The role of dietary fats in efficiency of ruminants. J. Nutr. 124(8), 1377S-1382S.

Powell, J., Aguerre, M., Wattiaux, M., 2011. Tannin extracts abate ammonia emissions from simulated dairy barn floors. J. Environ. Qual. 40(3), 907-914.

Qin, J., Xiang, M., Jia, M., Cheng, F., Zhang, L., Schmidt, B.V., Liu, J., Xie, S., 2020. Combined opportunistic and equilibrium life-history traits facilitate successful invasions of the Shimofuri goby (Tridentiger bifasciatus). Aquat. Invasions. 15(3), 514–528.

Silva, T.M., Oliveira, R.L., Barbosa, L.P., Neto, A.F.G., Bagaldo, A.R., Lanna, D.P.D., Silva, M.C.A.d., Jesus, I.B.d., 2011. Preliminary study on meat quality of goats fed levels of licury oil in the diet. Asian-Australas. J. Anim. Sci. 24(8), 1112-1119.

Thanh, L.P., Kha, P.T.T., Loor, J.J., Hang, T.T.T., 2022. Grape seed tannin extract and polyunsaturated fatty acids affect in vitro ruminal fermentation and methane production. J. Anim. Sci. 100(3), skac039.

Thanh, L.P., Phakachoed, N., Meeprom, C., Suksombat, W., 2018. Replacement of fish oil for sunflower oil in growing goat diet induces shift of ruminal fermentation and fatty acid concentration without affecting intake and digestion. Small Rumin. Res. 165, 71-78.

Tshuma, T., Holm, D.E., Fosgate, G.T., Lourens, D.C., 2014. Pre-breeding blood urea nitrogen concentration and reproductive performance of Bonsmara heifers within different management systems. Trop. Anim. Health Prod. 46(6), 1023-1030.

Van Duinkerken, G., André, G., Smits, M., Monteny, G., Šebek, L., 2005. Effect of rumen-degradable protein balance and forage type on bulk milk urea concentration and emission of ammonia from dairy cow houses. J. Dairy Sci. 88(3), 1099-1112.

Van Soest, P.V., Robertson, J.B., Lewis, B.A., 1991. Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. J. Dairy Sci. 74(10), 3583-3597.

Waghorn, G., 2008. Beneficial and detrimental effects of dietary condensed tannins for sustainable sheep and goat production—Progress and challenges. Anim. Feed Sci. Technol. 147(1-3), 116-139.

Westwood, C., Lean, I., Garvin, J., Wynn, P., 2000. Effects of genetic merit and varying dietary protein degradability on lactating dairy cows. J. Dairy Sci. 83(12), 2926-2940.

How to cite this article;

Nguyen Thi Thu Ha, Duong Tran Tuyet Mai, Tran Thi Thuy Hang, Lam Phuoc Thanh. Effects of oil and grape seed tannin extract on intakes, digestibility, milk yield and composition of Saanen goats. Veterinary Integrative Sciences. 2023; 21(1): 37- 47.