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Feed preference and nutrient digestibility of pelleted or silage form of olive cake as affected by concentrate supplementation

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Abstract. High fiber level of olive cake (OC) is the main limiting factor for its use in animal feeding. Effective industrial-scale destoning process improves its nutritive value but the level of destoned OC (SOC) to be included in the ruminant diets for safe and efficient feeding is yet unclear. Thus, this study was carried out to determine the voluntarily intake of SOC and nutrient digestibility of diet by offering the feed as free-choice. A total of ten, Karya female yearlings were divided into two groups and were fed maize silage-alfalfa hay mix, pellet or silage form of SOC with (Con+) or without concentrate (Con-), as free-choice for 3 weeks. The individual dry matter intake (DMI) was determined for each feedstuff that was offered *ad libitum*. The difference between two groups (with or without concentrate) was compared by independent *t* test. The silage-alfalfa mix, SOC silage and pelleted SOC intake of Con- and Con+ yearlings were 778 and 192; 158 and 56 (P<0.001); and 65 and 40 g/kg DM (*P* =0.06), respectively. The concentrate consumption of Con+ group was 712 g/kg DM. The Con+ yearlings consumed more DM and nutrients, and tended to (P=0.06) grow faster than Con- yearlings. The in vivo apparent DM, organic matter, crude fat, crude protein and non-fiber carbohydrates digestibility were higher in Con+ lambs, while fiber digestibility did not differ (P>0.05) with concentrate supplementation. The results indicated that yearlings had lower preference for SOC as compared to silage-alfalfa mix regardless of the presence of concentrate. The intake of OC was greater in the form of silage than pellet form.

Keywords. Digestibility – Free choice – Intake – Nutritive value – Lamb – Olive cake.

Préférences alimentaires et digestibilité des nutriments des tourteaux d'olive distribués sous forme de pellets ou d'ensilage, influencées par la supplémentation en concentré

Résumé. *Le niveau élevé de fibre dans les tourteaux d'olive (TO) est le principal facteur limitant pour les utiliser en alimentation animale. Un processus effectif de dénoyautage à l'échelle industrielle améliore leur valeur nutritive mais le niveau de tourteaux d'olive dénoyautés (TOD) à incorporer dans les régimes pour ruminants pour les nourrir de façon sûre et efficiente reste encore à définir. Ainsi cette étude a été menée afin de déterminer l'ingestion volontaire de TOD et la digestibilité des nutriments du régime en offrant cet aliment en libre choix. Un total de dix agnelles d'un an de race Karya ont été divisées en deux groupes et ont reçu un mélange d'ensilage de maïs-foin de luzerne, et des TOD sous forme de pellets ou d'ensilage avec (Con+) ou sans concentré (Con-), en libre choix pendant 3 semaines. L'ingestion individuelle de matière sèche (IMS) a été déterminée pour chaque ingrédient qui était offert ad libitum. La différence entre les deux groupes (avec ou sans concentré) a été comparée par t-test indépendant. L'ingestion de mélange ensilage-luzerne, d'ensilage de TOD et de TOD en pellets pour les agnelles Con- et Con+ a été respectivement de 778 et 192; 158 et 56 (P<0,001); et 65 et 40 g/kg MS (P =0,06). La consommation de concentré pour le groupe Con+ était de 712 g/kg MS. Les animaux Con+ consommaient plus de MS et de nutriments, et tendaient à une croissance plus rapide (P=0,06) que les animaux Con-. La digestibilité apparente in vivo de la MS, de la matière organique, de la matière grasse brute, de la protéine brute et des hydrates de carbone non fibreux, a été plus élevée chez les agnelles Con+, tandis que la digestibilité de la fibre n'a pas différé (P>0,05) avec la supplémentation en concentré. Les résultats indiquent que les animaux avaient une moindre préférence pour les TOD en comparaison au mélange ensilage-luzerne indépendamment de la présence de concentré. L'ingestion de TO était plus élevée sous forme d'ensilage que de pellets.*

Mots-clés. *Digestibilité – Libre choix – Ingestion – Valeur nutritive – Agnelle – Tourteau d'olive*.

I – Introduction

In Turkey, livestock production primarily relies on eroded rangelands, agricultural by-products (straw and bran) and to a lesser extent cultivated forages and supplemental grains, where the annual shortage of roughage is estimated to be 15 million tons (TUIK, 2015). Forage supply from rangelands is erratic with high seasonal and annual fluctuations in quality and quantity depending on the management and environmental factors. Feeding cereal grains to animals is costly and being increasingly challenged by the competition between humans and livestock (Hegarty, 2012). Grains can partly be replaced by agro-industrial byproducts in livestock diets without compromising yield and product quality (Ben Salem *et al.* 2014).

Industrial by-products, such as olive cake (OC) can help alleviating the feed gap for ruminants and reduce the feed cost in Mediterranean countries (Ben Salem *et al*. 2014). The OC has been proven to be successfully used both in feedlot and dairy production systems. However, the studies that evaluated the potential of OC in supporting ruminant production have reported inconsequential findings, depending on the nutritive value, inclusion level and substitution level of OC with forage or concentrate in diet, and species and production levels of livestock used in these studies (Abbeddou *et al.* 2015; Cıbık and Keles, 2016; Keles et *al.* 2017). Thus, determination of the voluntarily intake of OC by livestock can help designing successful feeding programs for ruminants.

II – Material and methods

1. Olive cake and feeds

Olive cake was obtained from an olive oil processing plant that performs two-phase oil extraction. Fresh OC was transported to another processing plant where the OC was stoned by using 3.5 mm industrial screen. The stoned olive cake (SOC) was immediately dried with an industrial-scale drier and was either pelleted or directly ensiled into the 120 L drums for a period 6 months without any additives. Four feeds that were compared in the present study as free-choice were; alfalfa-maize silage mix (40:60 in DM basis) as source of roughage, dried SOC, SOC silage and concentrate. Alfalfa hay and maize silage were mixed daily before offering to sheep. The nutritive values of offered feed are presented in Table 1.

Table 1. Nutritive value of feed offered to lambs (g/kg DM)

Feedstuff	OM	EE	CP	NDICP	ADICP	NDF	ADF	ADL	NFC	ME
Roughage	925	21	110	16	10	534	375	100	260	1.7
Concentrate	892	20	149	8	8	201	113	28	522	2.4
SOC silage	965	95	80	71	66	673	528	258	117	1.4
Pelleted SOC	953	94	81	73	67	641	486	214	137	1.6

OM = Organic matter; EE = crude fat, CP = crude protein, NDICP = neutral insoluble N, g/kg in CP; acid insoluble N, g/kg in CP; ADL = acid detergent lignin; NFC = non-fifer carbohydrates; ME = metabolizable energy, Mcal/kg.

2. Free-choice experiment

The feeding experiment was carried out with a total of 10 homogeneous female Karya yearlings with an average initial body weight of 28.7 ± 0,7 kg. Yearlings were randomly divided into two equal groups and each lamb was housed in individual pens (1.2 × 1.7 m) equipped with plastic bucket feeders (20 × 20 × 20 cm). Five of the individual pens had four buckets that contained either alfalfa+maize silage mix, SOC silage, pelleted SOC or concentrate (Con+), while the other five pens equipped with only three buckets containing the same feedstuff except the concentrate (Con-). Year-

lings had *ad libitum* access to fresh water at all times. All test feeds offered daily *ad libitum* after refusal was removed and weighed. The individual free-choice feed consumption of the yearlings was determined daily. The experiment continued for 3 w. Yearlings were weighed at the beginning and end of the experiment following being fasted for 12 h.

The free-choice feed offered and refusals were sampled and simultaneous fecal grab samples from each yearling were taken for 5 d in last w of the experiment. The 5-d individual offered and refusals feed and fecal samples were then equally pooled for each yearling. Nutrients intake of each of the free-choice feeds was calculated by multiplying its intake by its nutritive value for each animal. The daily total nutrients intake of each animal was the sum of individual free-choice nutrients consumption.

3. Analytical procedures

Samples of feeds, refusals and feces were dried to a constant weight in an air" forced oven at 55ºC for 48 h. Dried samples were then ground to pass a 2-mm screen (MF 10 B, IKA werke, USA), and analyzed for DM, ash, ether extract, crude protein (CP), NDICP and ADICP according to AOAC (1990). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were assayed according to the methods described by Van Soest *et al.* (1991) using with Ankom$^{200/220}$ Fiber Analyzer (Ankom Technology, Macedon, NY, USA), and expressed inclusive of residual ash. Lignin was determined by incubation of ADF residues in diluted H_2SO_4 for 3 hours. The ME was calculated according to NRC (2001). NFC was: 100-Ash-CP-EE-NDF. Apparent digestibility of nutrients was determined according to Van Keulen and Young (1977). Intake and apparent digestibility of nutrients of two groups compared by independent *t* test. The preference of form of SOC with or without concentrate were also analyzed 2 x 2 factorial model. Means was separated by Fisher's protected LSD test (SPSS, 2010).

III – Results and discussion

Intake, feed selection, nutrient digestiblity and performance of yearlings are presented in Table 2. Yearlings had greater DMI (P<0.01) when concentrate was offered along with the roughage, pelleted SOC and SOC silage but the increased intake was at the expense of reduced forage and pelletted SOC consumption (P<0.001). As a result of feed selection, yearlings consumed nearly 50% less fiber fractions but they had more CP, NFC and ME when concentrate was offered as free-choice (P<0.001). Because NDF concentration of diet and DMI was negatively correlated (Huhtanen *et al.* 2007) due to the filling effect of rumen (Allen, 2000), Con+ yearlings consumed more DM than Con- yearlings. But Huhtanen (2007) also hyphotesised that DMI is more related to NDF quality rather than its amount in grasses. In the present study, although DM, OM, EE, CP and NFC digestibilty of Con+ yearlings were higher than Con- yearlings (Table 2), both NDF and ADF digestibilites of the consumed feed were similar (P>0.05). The results on fiber digestibility and associated DMI in the current study may deviate from the findings of other studies that used conventional diets as the crosslinking effects between lignin and other fiber elements could differ in forage and agricultural by-product. Similar values of LWG and FCR of yearlings could be related to the productivity levels of native yearlings used in this experiment.

The form of the SOC altered the preference of yearlings (Table 3). The SOC silage consumption of the sheep that did not have access to concentrate was the highest (P<0.001), but it was similar (P>0.05) to peletted SOC when concentrate was offered. This finding suggests that SOC silage is more preferable by sheep than pelleted form of SOC.

Table 2. Intake, feed selection, nutrient digestiblity and performance of yearlings fed free-choice of forage, form of SOC with or without concentrate (in (DM)

	Without concentrate	With concentrate	SEM	P value
DM and feed intake				
Dry matter, g/d	1033	1166	27.4	0,009
Forage, g/kg	778	192	16.1	0.001
Pelleted SOC, g/kg	65	40	8.0	0.001
SOC silage, g/kg	158	56	6.0	0.001
Concentrate, g/kg	–	712	17.7	–
Nutrient intake, g/kg				
Organic matter	933	898	1.1	0.001
Ether extrat	45	35	0.5	0.001
Crude protein	104	142	1.1	0.001
NDIN, in CP	226	111	4.8	0.001
ADIN, in CP	177	90	4.4	0.001
NDF	565	284	7.3	0.001
ADF	410	172	6.5	0.001
NFC	219	437	5.0	0.001
ME, Mcal/Kg	1.8	2.1	0.02	0.001
Digestiblity, g/kg				
Dry matter	521	797	19.0	0.001
Organic matter	567	795	19.2	0.001
Crude fat	763	857	19.1	0.001
Crude protein	416	823	5.9	0.001
NDF	519	496	46.2	0.001
ADF	498	445	52.4	0.001
NFC	724	971	12.9	0.001
Performance				
LWG, g/d	70.0	90.0	6.50	0.063
FCR	14.8	13.4	0.95	0.327

Table 3. Preferance of form of OC by sheep

Form	Concentrate	İntake, g/kg DM
Pelletted SOC	+	40c
Pelletted SOC	-	65b
SOC Silage	+	56bc
SOC Silage	-	158a
SEM		7.088
P value		0.001

IV – Conclusions

The results indicated that the destoned olive cake either in the form of pellet or silage has limited potential use in ruminant diets as compared to high quality forages or grains. The optimum levels of SOC seems to be between 100 and 200 g/kg of diets. The inclusion level of SOC can possibly be higher if fed in silage form.

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