

Feed intake, digestive aspects and growth performances of Sicilo-Sarde lambs fattened through oat, vetch and ryegrass hay in the Tunisian North West



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SUMMARY

In the Mediterranean areas, oat hay is the most used roughage in sheep feeding. However, in some favorable regions, cultivated fodders as vetch and ryegrass can be produced and harvested green or kept as hay or silage to feed livestock. Then, this study aimed to evaluate the effect of using various types of hay (oat, vetch and ryegrass) on lamb's feed intake, nutrient digestibility, nitrogen balance and growth performances. For that, forty-eight male Sicilo-Sarde lambs (13.1 ± 1.9 kg of body weight, 60 days of age) were conducted in individual pens and fed hay and concentrate, both *ad libitum*. Lambs were divided, according to body weight (BW), into 3 homogeneous groups of 16 lambs each and were randomly assigned to one of three diets that were neither isoenergetic, isoproteic nor isofibrous and where the roughage was either oat hay (OH), vetch hay (VH) or ryegrass hay (RH). Then, each group was divided into two subgroups according to supplementation type, only conventional concentrate (CC), composed by 80% barley, 17% soya and 3% mineral vitamin supplement (MVS), or conventional concentrate plus 90 g of sunflower seed (SC). At the end of the growth trial, a digestibility assay occurred and the nitrogen balance was calculated. Total higher DM intake was recorded for VH-CC, VH-SC and RH-SC with an average of 540 g, however, the rest of groups had averagely consumed 471 g of DM. The diet had significantly affected the digestibility of DM, OM, CP and NDF. The DM, CP and NDF digestibility was higher with vetch and ryegrass hay compared to that of oat hay. The amount of daily nitrogen intake, fecal, urinary and retained nitrogen are highly affected by the diets and the higher nitrogen intake was attributed to vetch hay which is a legume. The lowest fecal nitrogen losses were observed in groups receiving either vetch or ryegrass hay. Urinary excretion also varies from 2 g/d for both groups receiving oat hay, to 3.9 g/d for VH-SC group. Nitrogen retention was slightly higher for groups that did not consume sunflower seeds compared to other ones. For all groups, the nitrogen efficiency exceeds 50% and the highest proportion was observed in RH-CC group with almost 62%. The diet had significantly affected the ADG and the total weight gain. It can be concluded that the intake of vetch and ryegrass hay resulted in higher nutrient digestibility while enhancing nitrogen retention. Moreover, the addition of sunflower seeds did not alter lamb's growth performances.

KEY WORDS

Vetch; ryegrass; digestibility; growth; lambs.

INTRODUCTION

In the countries surrounding the Mediterranean basin, sheep feeding is usually conducted on pastoral and natural resources, rangeland and stubbles (1, 2). The availability of such resources is uncertain throughout the year given the rainfall irregularity and consequently land degradation occurs (3). Then, to satisfy nutrient needs, intensive husbandry systems are developed, particularly during fattening phase. This system is based mainly on oat hay, silage or pastoral resources which nutritional value still low that limits animal performances (4). Then, the use of a great amount of concentrate is necessary given the low quality of forages. However, this system is more and more expensive, with a dramatically increased prices of raw ma-

terial of concentrate (corn and soybeans) which are often imported during latest years (5,2). However, the humid and sub-humid regions present an important fodder potential and must play a more determining role in ruminants feeding given they have cooling effect on the animal body, more palatable contain easily digestible nutrients, provide fresh effectively utilizable nutrients in natural form and slightly laxative. Traditionally, in these areas, oat hay is the most used roughage in sheep feeding. However, in these favorable conditions, green forages as vetch and ryegrass can be produced and grown green over 4 to 6 months (5,6). Thus, cultivated fodder in these regions can be harvested green or kept as hay or silage to feed livestock. In finishing lambs, the use of perennial ryegrass has been shown to improve product performance (7). Vetch also can be used either as a nitrogen fixing plant to improve soil fertility or as high-quality hay in ruminant diets (8). In addition, in these regions, the sunflower seed is mostly produced, hence, it could be introduced in animals' ration given it is considered rich in energy, since it has from 3.691 to 5.004 kcal of ME/kg (9).

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So, in this context, this work aimed to compare the growth performances and the digestibility aspects of post-weaned lambs receiving oat hay as the most widely used roughage, with that of lambs receiving vetch and ryegrass hay, which can also be produced in sub-humid zones favorable to various fodder crops with using sunflower seed as an energetic supplement that can enrich the ration and improve the growth of lambs.

MATERIAL AND METHODS

Experimental site characteristics

The experiment was conducted at Lafareg, the experimental farm of the National Institute of Agricultural Research of Tunisia (INRAT) located at 158 m above sea level, 09°11'E longitude and 36°44'N latitude. This region belongs to the sub-humid stage with 650 mm of annual precipitation. The major quantity of precipitation (80%) occurs between October and May. Yearly minimum and maximum temperatures averaged 8°C and 41°C, respectively. The experiment was carried out between February and May 2006 and lasted 97 days. The rainfall in the experimental site was 525 mm from September to May; the average temperature was 22°C, with average values of 12°C at morning (7h) and 23°C at 16h.

Animals, Experimental design and diets

Forty-eight male Sicilo-Sarde lambs (13.1 ± 1.9 kg of body weight, 60 days of age) were conducted in individual pens and fed hay and concentrate, both *ad libitum*. Before the experiment beginning, the lambs were treated against internal and external parasites. They were divided, according to body weight (BW), into 3 homogeneous groups of 16 lambs each and were randomly assigned to one of three diets where the roughage was either oat hay (OH), vetch hay (VH) or ryegrass hay (RH). Then, each group was divided into two subgroups according to supplementation type, only conventional concentrate (CC), composed by 80% barley, 17% soya and 3% mineral vitamin supplement (MVS), or conventional concentrate plus 90 g of sunflower seed (SC). Animals were allowed 15 days as adaptation to experimental conditions. The oat hay was considered as control feed compared to other hay types. The diets were neither isoenergetic, isoproteic nor isofibrous as shown in Table 1 that reported the chemical composition of all experimental feeds. During the whole period of experiment, all lambs had free access to water.

Feed intake and lamb' growth

Concentrate and hay were offered in separate troughs in two equal meals at 9 and 13h. The amount of offered and refused feeds were daily recorded throughout the experimental peri-

od before the morning feeding to calculate the daily intake. The lambs were weekly weighed just prior to feed distribution using an electronic scale (Douik Instruments; Société Douik Balance, Sousse, Tunisia) to calculate the average daily gains (ADG).

Digestibility and nitrogen balance

At the end of the growth trial, a metabolism trial was performed. Five lambs from each group were randomly chosen and moved into individual metabolic cages for digestibility measurement. They were allowed seven days as adaptation period and seven days of measurement of nutrient digestibility and nitrogen (N) balance. Hay and concentrate were offered twice a day. During this week of measurement, offered and refusals of feeds were daily recorded. Total daily faeces for each animal were also recorded, weighed mixed, and sampled and a total of 10% of each feces sample was stored for further analysis. For each animal, total daily amount of urine was collected in buckets, weighed and preserved with 50 ml of 10% sulphuric acid (H₂SO₄) to reduce ammonia loss. After homogenisation, aliquot fractions were pooled and conserved at -15°C for further analysis to determine the nitrogen content. The digestibility of the nutrients was measured as the difference between the amount of nutrient ingested minus the amount of nutrient excreted in the feces, expressed as a percentage of the nutrient ingested: 100 x (intake - excreted)/intake.

Laboratory analyses

The DM of all hay types, concentrate, and sunflower seed, feed refusals and feces was determined by drying at 75 °C until constant weight and then milled through 1 mm screen. Ash was determined at 550°C for 6 hours. CP content was determined by the Kjeldahl method on distributed feed, refusals, feces and urine. Neutral detergent fiber (NDF) was determined according to the method of Van-Soest et al. (10) using an ANKOM220 fiber analyzer (ANKOM Technology Corp, Macedon, NY, USA). All analyses were carried out according to the official methods of the AOAC (11).

Statistical analysis

For all studied parameters, the PROC GLM of SAS (12) was applied. For feed intake, digestive aspects, nitrogen balance and lamb's growth, a one-way analysis of variance for diet effects was applied using the following model:

$$Y_{ijk} = \mu + H_i + C_j + H_i * C_j + e_{ijk}$$

where: Y_{ijk} represents the responses of the lamb k on hay i to concentrate j ; μ = mean; H_i = Hay effect (i = oat, vetch or ryegrass); C_j = Concentrate effect (j = C alone or C + sunflower); $H_i * C_j$ = interactions between hay and concentrate; e_{ijk} : residual

The significance was declared at $p < 0.05$. The differences between groups were compared by the Duncan's test.

Table 1 - Feed chemical composition (%).

	Concentrate	Sunflower seeds	Oat hay	Vetch hay	Ryegrass hay
Dry matter	83	90	88	85	91
Ash	6.25	7.25	8.66	9.65	8.41
Crude Protein	18.95	19.28	7.45	10.58	5.71
NDF	45.29	55.89	44.91	66.94	74.23

NDF: neutral detergent fiber

Table 2 - Daily feed intake (g Dry Matter/d).

	OH-CC	OH-SC	VH-CC	VH-SC	RH-CC	RH-SC	SEM	P-value
Hay	167 ^b	174 ^b	269 ^a	182 ^b	188 ^b	144 ^b	4.36	0.02
Concentrate	314 ^{ab}	290 ^b	315 ^{ab}	330 ^a	280 ^b	379 ^a	8.05	0.04
Total	481 ^b	464 ^b	584 ^a	512 ^a	468 ^b	523 ^a	13.3	0.03

OH-CC: lambs receiving oat hay and concentrate; OH-SC: lambs receiving oat hay, concentrate and sunflower seeds; VH-CC: lambs receiving vetch hay and concentrate VH-SC: lambs receiving vetch hay, concentrate and sunflower seeds; RH-CC: lambs receiving ryegrass hay and concentrate; RH-SC: lambs receiving ryegrass hay, concentrate and sunflower seeds.

RESULTS

Feed Intake

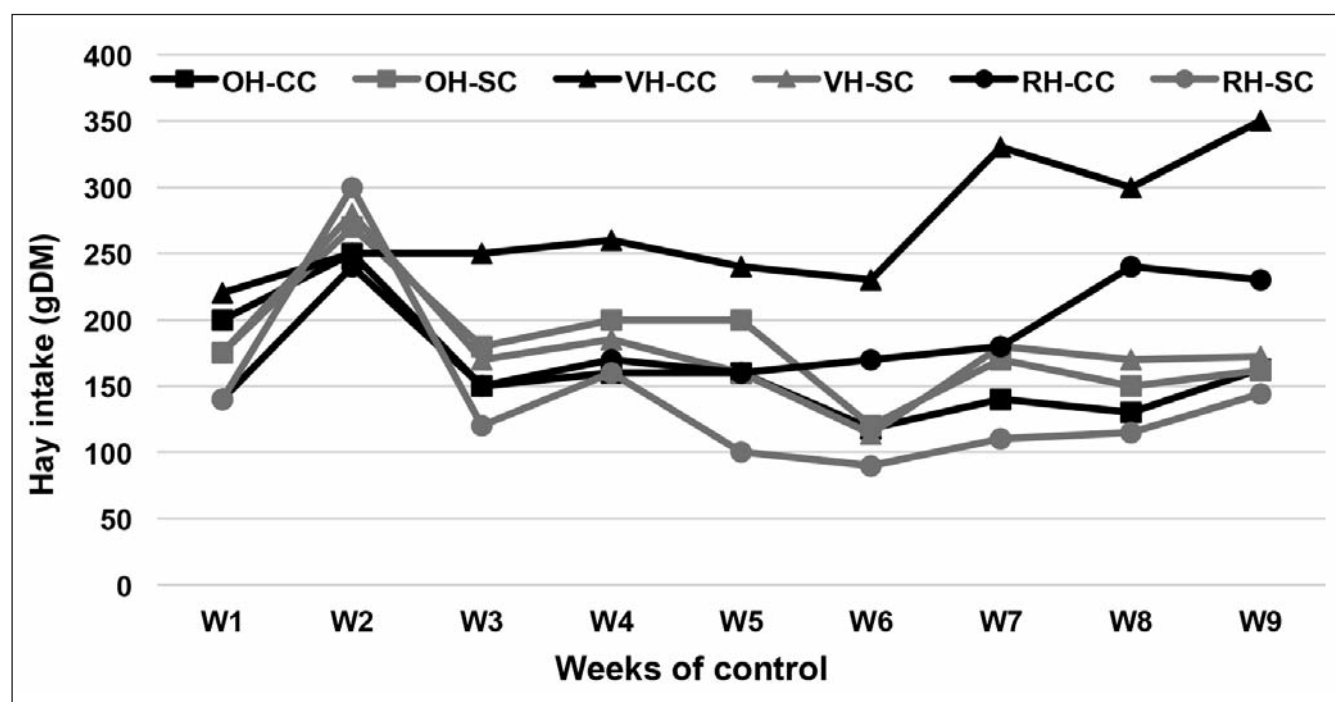
The DM intake of hay and concentrate are reported in Table 2. The intake of hay is generally low and did not reach 300 g even for the most consumed hay (vetch hay). Then, the higher value was recorded for VH-CC group (269 g) and the lowest value for RH-SC group (144g). For concentrate intake, the higher values were attributed to RH-SC and VH-SC groups. Consequently, total DM intake was recorded for VH-CC, VH-SC and RH-SC with an average of 540 g, however, the rest of groups had averagely consumed 471 g of DM.

The weekly evolution of hay and concentrate intakes for all groups is presented in Fig. 1 and 2, respectively. During the second week, hay intake reached its peak for all the groups except to the vetch group which had a relatively stable consumption that varied between 220 and 260 g of DM until the 6th week and which increased thereafter to reach its peak of 350 g DM during the 9th week. The intake dropped during the 3rd week to reach its minimum for the ryegrass group (151 g DM), then it varied between 175 and 240 g DM/d/lamb to reach 217 g/lamb in the 9th week. The lower intake values were recorded during the 6th week where they reached 90, 118, 120 and 144 g for the RH-

SC, OH-CC, OH-SC and VH-SC, respectively. Three weeks later, the intake varied between 110 and 190 g DM/lamb and it reached during the 9th week 144, 162, 163, 172 g of DM for RH-SC, OH-SC, OH-CC, and VH-SC, respectively. The average intake of concentrate varied between 290 and 380 g. At the 9th week, the concentrate intake was almost the same for all groups (310 to 320 g DM/lamb) except for RH-SC group (400 g DM). The peak of concentrate intake was reached during the 4th week for all groups and it reached values between 320 and 440 g DM, however, the VH-SC group showed two peaks during the 4th and the 7th week with 384 g and 387 g DM/lamb, respectively. The minimum concentrate intake values were recorded during the 1st week for all groups.

Nutrient digestibility and nitrogen balance

Diet had significantly affected the digestibility of DM, OM, CP and NDF (Table 3). The DM, CP and NDF digestibility was higher for groups receiving vetch and ryegrass hays compared to those fed oat hay. In fact, the highest value was recorded with the RH-CC (77.9%), followed by the VH-CC (76.4%), however, the lowest value was recorded for groups receiving oat hay. The supplementation type had not affected the nutrient di-

**Figure 1** - Weekly hay intake evolution.

OH-CC: lambs receiving oat hay and concentrate; OH-SC: lambs receiving oat hay, concentrate and sunflower seeds; VH-CC: lambs receiving vetch hay and concentrate VH-SC: lambs receiving vetch hay, concentrate and sunflower seeds; RH-CC: lambs receiving ryegrass hay and concentrate; RH-SC: lambs receiving ryegrass hay, concentrate and sunflower seeds.

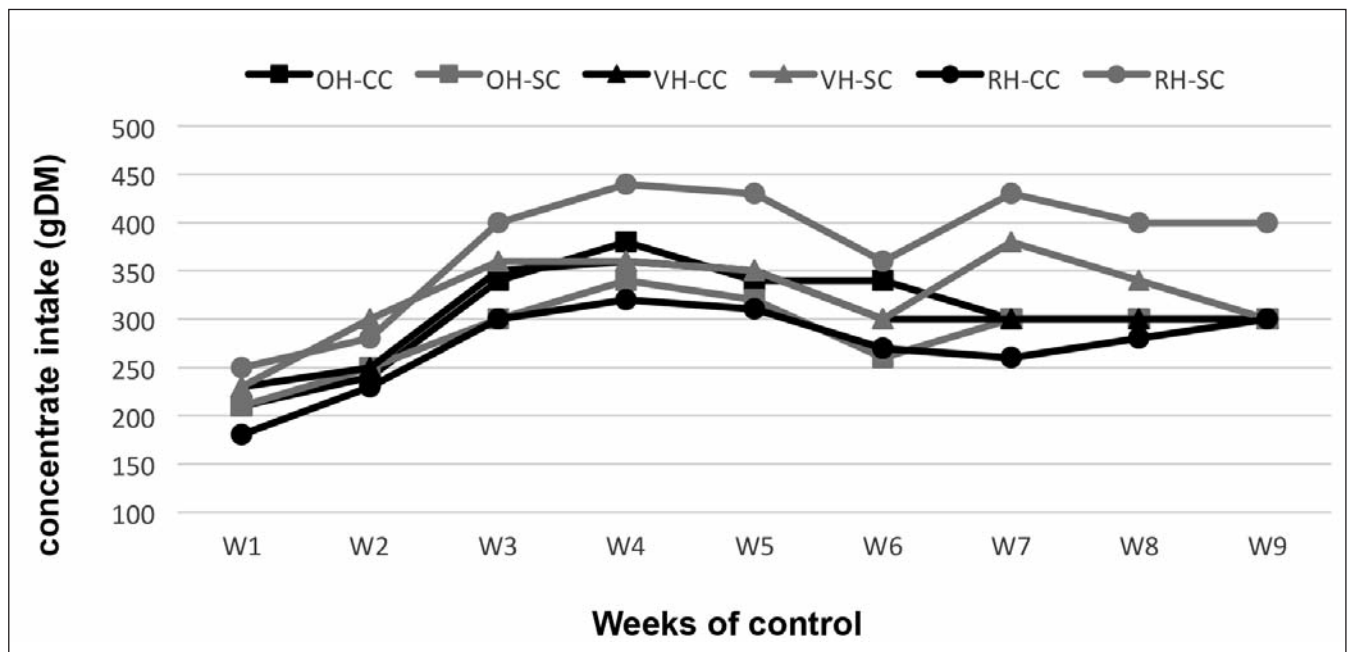


Figure 2 - Weekly concentrate intake evolution.

OH-CC: lambs receiving oat hay and concentrate; **OH-SC:** lambs receiving oat hay, concentrate and sunflower seeds; **VH-CC:** lambs receiving vetch hay and concentrate; **VH-SC:** lambs receiving vetch hay, concentrate and sunflower seeds; **RH-CC:** lambs receiving ryegrass hay and concentrate; **RH-SC:** lambs receiving ryegrass hay, concentrate and sunflower seeds.

Table 3 - Nutrient digestibility (%).

	OH-CC	OH-SC	VH-CC	VH-SC	RH-CC	RH-SC	SEM	P-value
DMD	60.9 ^b	66.7 ^b	76.4 ^a	74.9 ^a	77.9 ^a	74.1 ^a	1.56	0.04
OMD	63.5 ^b	68.7 ^b	77.6 ^a	75.9 ^a	79.0 ^a	75.4 ^a	1.12	0.03
CPD	69.8 ^b	68.2 ^b	78.2 ^a	75.2 ^a	77.9 ^a	74.6 ^a	2.2	0.005
NDFD	31.9 ^b	48.9 ^b	69.7 ^a	68.6 ^a	71.2 ^a	67.2 ^a	1.56	0.001

OH-CC: lambs receiving oat hay and concentrate; OH-SC: lambs receiving oat hay, concentrate and sunflower seeds; VH-CC: lambs receiving vetch hay and concentrate; VH-SC: lambs receiving vetch hay, concentrate and sunflower seeds; RH-CC: lambs receiving ryegrass hay and concentrate; RH-SC: lambs receiving ryegrass hay, concentrate and sunflower seeds; DMD: dry matter digestibility; OMD: organic matter digestibility; CPD: crude protein digestibility; NDFD: neutral detergent fiber digestibility.

Table 4 - Nitrogen balance (g/day).

	OH-CC	OH-SC	VH-CC	VH-SC	RH-CC	RH-SC	SEM	P-value
NI	13.7 ^b	13.7 ^b	17.3 ^a	15.5 ^{ab}	14.1 ^{ab}	15.3 ^{ab}	0.92	0.01
FN	4.1 ^a	4.2 ^a	3.8 ^{ab}	3.8 ^{ab}	3.1 ^b	3.8 ^{ab}	0.69	0.05
UN	2.0 ^b	2.0 ^b	3.5 ^a	3.9 ^a	2.3 ^b	3.5 ^a	0.53	0.03
RN	7.6 ^b	7.5 ^b	10 ^a	7.7 ^b	8.7 ^{ab}	7.9 ^b	0.89	0.01
Total loss/ NI (%)	44.5 ^{ab}	45.3 ^{ab}	42.2 ^{ab}	49.7 ^a	38.3 ^b	47.7 ^a	1.56	0.02
RN/NI (%)	55.5 ^{ab}	54.7 ^{ab}	57.8 ^a	50.3 ^{ab}	61.7 ^a	52.3 ^b	1.83	0.001

OH-CC: lambs receiving oat hay and concentrate; OH-SC: lambs receiving oat hay, concentrate and sunflower seeds; VH-CC: lambs receiving vetch hay and concentrate; VH-SC: lambs receiving vetch hay, concentrate and sunflower seeds; RH-CC: lambs receiving ryegrass hay and concentrate; RH-SC: lambs receiving ryegrass hay, concentrate and sunflower seeds; NI: Nitrogen intake; FN: Fecal nitrogen; UN: Urinary nitrogen; RN: Retained nitrogen; Total loss = FN+UN.

gestibility. For lambs fed vetch hay and ryegrass hay, DM and OM digestibility are lower for lambs receiving concentrate plus sunflower seed compared to those supplemented only with concentrate. However, for lambs fed oat hay, the DM and OM digestibility were improved with sunflower consumption. The highest organic matter digestibility is attributed to the RH-CC group with 79%. However, OH-CC and OH-SC groups recorded the lowest OM digestibility (63.5% and 68.7%). For the other groups, similar results were recorded with averages

of 75.4%, 75.9% and 77.6% for RH-SC, VH-SC and VH-CC, respectively.

The nitrogen balance parameters are shown in Table 4. The amount of daily nitrogen intake, fecal, urinary and retained nitrogen are highly affected by the diets and the higher nitrogen intake was attributed to VH-CC (10g/d) group fed vetch which is a legume ($P < 0.05$). The nitrogen distribution into fecal, urinary and retained nitrogen for all groups is shown in Fig. 3. The lowest fecal nitrogen losses were observed in groups receiving

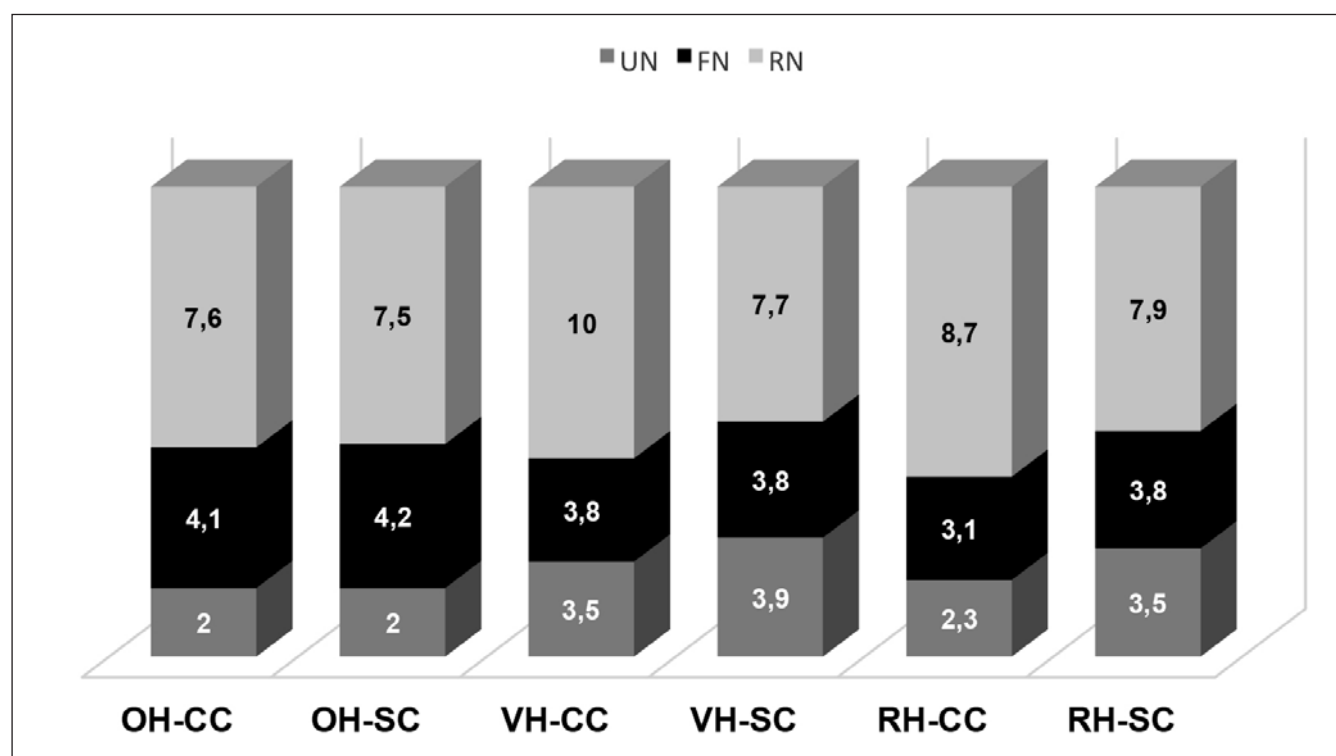


Figure 3 - Nitrogen balance.

OH-CC: lambs receiving oat hay and concentrate; **OH-SC:** lambs receiving oat hay, concentrate and sunflower seeds; **VH-CC:** lambs receiving vetch hay and concentrate **VH-SC:** lambs receiving vetch hay, concentrate and sunflower seeds; **RH-CC:** lambs receiving ryegrass hay and concentrate; **RH-SC:** lambs receiving ryegrass hay, concentrate and sunflower seeds; **UN:** Urinary nitrogen; **FN:** Fecal nitrogen; **RN:** Retained nitrogen.

either vetch or ryegrass hay. Urinary excretion also varies from 2 g/d for both groups receiving oat hay, to 3.9 g/d for VH-SC group. Nitrogen retention was slightly higher for groups that did not consume sunflower seeds compared to other ones. For the nitrogen efficiency, more than half of the nitrogen intake was retained for all groups, then it exceeds 50% and the highest proportion was observed in RH-CC group with almost 62%.

Lamb's growth performances

At the beginning of the experiment, all lambs showed an av-

erage BW varying between 12.6 and 13.7 kg. at the end of the growth trial, lambs reached an average BW of 16.4 kg. The diet had significantly ($P < 0.01$) affected the total weight gain and the ADG (Table 5). The weekly evolution of lamb's BW is presented in Fig. 4.

Hay type affected significantly the ADG and weight gain ($P < 0.01$). The higher ADGs are achieved by lambs that consume vetch hay (Table 6). Regardless of the type of hay, the supplementation type did not significantly affect the lamb's growth. However, the ADG was slightly higher for lambs fed

Table 5 - Lamb's growth performances.

	OH-CC	OH-SC	VH-CC	VH-SC	RH-CC	RH-SC	SEM	P-value
Initial BW (kg)	12.7	13	13.7	12.6	13.2	13.2	2.33	0.6
Final BW (kg)	17.2	16.9	19.3	18.2	16.4	17.9	2.6	0.02
Total Gain (kg)	4.5 ^b	3.9 ^a	5.5 ^b	5.4 ^b	3.2 ^a	4.7 ^a	1.03	0.03
ADG (g)	70 ^a	63 ^b	88 ^a	87 ^a	51 ^b	75 ^a	18.3	0.001

OH-CC: lambs receiving oat hay and concentrate; OH-SC: lambs receiving oat hay, concentrate and sunflower seeds; VH-CC: lambs receiving vetch hay and concentrate VH-SC: lambs receiving vetch hay, concentrate and sunflower seeds; RH-CC: lambs receiving ryegrass hay and concentrate; RH-SC: lambs receiving ryegrass hay, concentrate and sunflower seeds; BW: body weight; ADG: Average daily gain.

Table 6 - Lamb's growth performances according to hay type.

	Oat hay	Vetch hay	Ryegrass hay	SEM	P-value
Final BW (kg)	17.1 ^a	18.7 ^a	17.2 ^a	2.86	0.52
Total weight gain (kg)	4.2 ^a	5.5 ^b	4 ^a	1.22	0.03
ADG (g)	66 ^a	87 ^b	63 ^a	19.6	0.04

BW: body weight; ADG: Average daily gain.

sunflower seed compared to those receiving concentrate only especially for lambs fed the ryegrass hay (75 g/d Vs. 51 g/d). However, for lambs fed oat or vetch hay, there is no difference according to the supplementation type, the ADGs are almost similar.

DISCUSSION

Feed Intake

The hay intake did not exceed 300 g for all groups. These results are lower than those found by Atti (13) for lambs belonging to the same breed and conducted under similar conditions. In fact, these values were around 800 g/lamb from a diet composed by vetch-oat hay (85% DM; 8% CP) plus concentrate (89% DM; 18% CP). Similarly, higher results were observed (14) on fat-tailed Barbarine, Queue Fine de l'Ouest and Noir de Thibar lambs (700, 870 and 780 g DM/lamb/d, respectively). The differences in nutrient intake were probably due to the differences in diet's compositions. In fact, the high intake recorded for lambs receiving vetch hay compared to those fed by oat or ryegrass hay can be explained by the high CP content for the vetch hay as legumes which consequently affected the animal's appetite. The results of the current study corroborate with those of Tripathi et al. (15) reporting that with a diet based on fodder distributed ad libitum and an intake of concentrate varying from 15 to 25 g/kg BW, the total DM intake increased from 792 to 970 g DM/lamb/d accompanied by an increase in the concentrate intake (251 to 435 g DM/lamb/d) and a reduction in the quantity of forage (541 to 535 g DM/lamb/d). Indeed, for the RH-SC group, a high consumption of concentrate compared to the other groups generated a significant intake of total DM, on the other hand, the voluntary intake of hay is lower than that of the other groups.

Nutrient digestibility and nitrogen balance

The DM and OM digestibility for OH groups are close to those found by Atti et al (16) for lambs fed a diet composed by oat hay ad libitum and 500 g of concentrate (barley and soybean meal (19%)). Similar results were observed in lambs fed oat hay and concentrate (15). The results recorded for OH-SC are very close to those found by Ben Salem et al (17) for lambs receiving a diet composed by barley straw supplemented with barley grains and soybean meal (67.1% and 69.5% respectively). The CP digestibility varies between 68.2% (OH-SC) and 78.2% (VH-CC). For the same type of hay, the diets containing concentrate plus whole sunflower seed, the CP digestibility is slightly higher than that of diets containing only concentrate. The CP digestibility values observed for all diets are higher than those found by Tripathi et al. (15) when the proportion of concentrate distributed varies from 15 to 25 g/kg BW in weaned lambs (41.3 to 50.5 %). Moreover, for a concentrate distributed ad libitum, the CP digestibility value of 70% is slightly higher than those of the OH-CC and OH-SC groups but remains lower than those of the other groups. It is lower, for all groups, than those (79%) observed in lambs fed a diet in which soybean meal represents 16.3% (18). The NDF digestibility varies from 31.9% for OH-CC to 71.2% for the RH-CC. For diets using ryegrass hay, the NDF digestibility is higher compared to that of other used hays. Oat hay diets have the lowest NDF digestibility. This is related to its low NDF content compared to other types of hay. The NDF digestibility for OH-CC group is lower than that found by Tripathi et al. (15) for lambs fed a diet composed by forage and concentrate ad libitum (44.78%). The results reported by Irshaid et al. (18) are also superior (45.7%). however, for the rest of groups, the NDF digestibility was higher than the results cited above. The nitrogen retention values for all groups are higher than those (6.2 g/d) found for lambs receiving a diet in which sunflower meal rep-

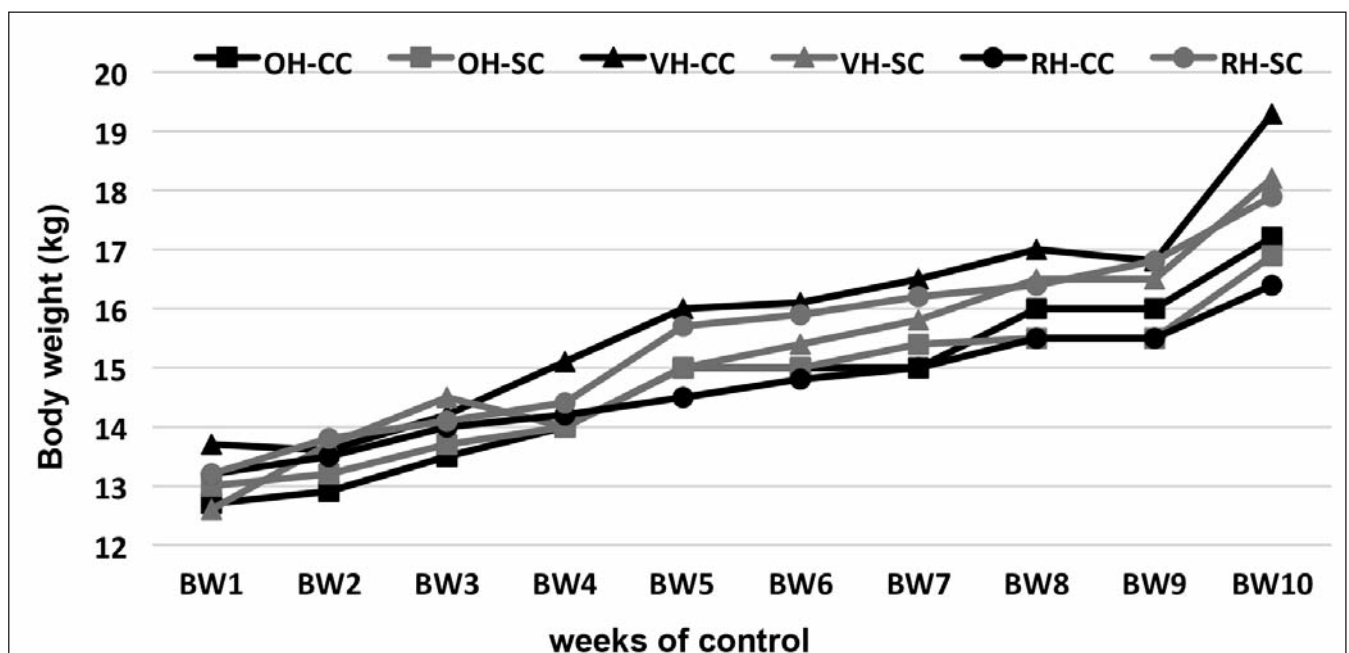


Figure 4 - Body weight evolution.

OH-CC: lambs receiving oat hay and concentrate; OH-SC: lambs receiving oat hay, concentrate and sunflower seeds; VH-CC: lambs receiving vetch hay and concentrate; VH-SC: lambs receiving vetch hay, concentrate and sunflower seeds; RH-CC: lambs receiving ryegrass hay and concentrate; RH-SC: lambs receiving ryegrass hay, concentrate and sunflower seeds.

resents 34.5% (18). On the other hand, for a proportion of 17.4% of sunflower meal plus 8.1% of soybean meal as well as that of 16.3% of soybean meal in the diet, the nitrogen retention values (7.5 and 7.2 g/d respectively) are very close to those of the OH-CC, OH-SC, VH-SC and RH-SC groups but lower than those of the VH-CC and RH-CC groups. The differences observed among groups could be due, mainly to the nitrogen intake. Indeed, the highest nitrogen intake is that of the VH-CC followed by that of the VH-SC group. For these both groups, the distribution of vetch hay richer in protein than the other two types of hay resulted in a higher value of nitrogen intake. Moreover, sunflower seed did not have the expected effect on the nitrogen intake despite its richness in protein. All differences recorded in digestibility parameters could be attributed to the different diet's composition.

Lamb's growth performances

Growth performance is relatively low compared to those of lambs belonging to the same breed (19) and fed ryegrass hay (83% DM, 6.3% CP) and concentrate (81% DM, 14.3% CP). They recorded an ADG of 114 g/d Vs. 51 g/d of the current study. Several hypotheses can explain this discrepancy. The breed is the same, but some factors can have an effect on the ADG in particular the weight at the beginning of the experiment, the duration of the experiment as well as the housing of the lambs. Precisely the density of groups which has an influence on the consumption of total dry matter as well as on the well-being and the animal behavior which will logically have an effect on the growth, although in Tunisia we neglect animal welfare and as far as the field of breeding is concerned, the experiments are not oriented towards this very important phenomenon which is studied by several authors (20, 21). In our study, the boxes and feeders reserved for each group were relatively small. The ADG and weight gain ($P < 0.05$) were probably affected by the diets' composition given all diets were neither isoenergetic, isoproteic nor isofibrous. Then, the higher ADGs were achieved by lambs that consume vetch hay (Table 6). This effect can be explained by the fact that the CP content is higher for vetch hay (10.58%) compared to oat and ryegrass hay which have a CP content of 7.45 % and 5.71%, respectively. On the other hand, the CP digestibility is relatively high for the groups that receive vetch hay (75.2% and 78.2%) as well as the total DM intake per lamb. As a result, the higher protein intake for VH-CC and VH-SC groups, resulted in higher growth performance compared to the other groups. This phenomenon of protein level effects is highlighted by Titi et al. (22) who found that a CP level of 16% resulted in higher growth performance than that of low and medium levels of 10% and 13% for Awassi lambs. For Tunisian local breed kids, it was reported that higher growth rates depend on the protein level of the ration (16). Regarding the effect of the supplementation type, the use of sunflower seed did not reveal significant differences on ADG and weight gain regardless the type of hay ($P > 0.05$). But, a slight difference in the ADG was observed for the lambs which consume the sunflower seed. These results confirm those of Rizzi et al. (23) for Sardinian lambs who showed that the addition of sunflower seed at doses of 100 and 200 g/lamb/d did not significantly affect ADGs and weight gains. Similarly, according to Santos-Silva et al. (24), for lambs grazing ryegrass, supplementation with whole seed sunflower has no significant effect on growth. Despite its richness in hemicellulose and crude protein, sunflower seeds did not have faded effects on lamb growth.

This could be explained by the fact that for young lambs (3 to 5 months), the digestion of whole sunflower seeds was not done efficiently and the animal does not benefit from this feed. Despite the whole sunflower seeds are relatively rich in CP (19.28%), it has no significant effect on growth rates and it is even observed that for groups receiving vetch and ryegrass hay, lambs receiving sunflower seeds-free diets have higher growth rates.

CONCLUSION

The fodder potential in humid and sub-humid regions presents a considerable opportunity for optimizing animals' performances. So, the fodder production in these regions is imperative considering the higher nutritional value compared to oat hay and the cost effectiveness. Then, the results gathered in the current study revealed that the fattening of lambs through vetch and ryegrass not only led to increased feed intake but also improved nutrient digestibility when compared to those fed oat hay. However, the consumption of sunflower seed did not alter lamb's performances.

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Author's Contribution

YY: conducted the experiment, analysed the data and wrote the first draft manuscript; **NA:** conceived and designed the experiment, analysed the data statistically and revised the manuscript. All authors read and approved the manuscript.

Conflict of interest

The authors declare that they have no conflict of interest.

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