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The effect on milk production and composition of incorporating lupin and triticale into dairy goat diets

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Abstract. In northern Morocco, goat feeding is based on rangelands that would not satisfy nutritional needs. Feed improvement is necessary. Lupin and triticale are both available resources in the region. The objective of this work is to study the effect on milk production and composition of utilizing lupin and triticale in dairy goat diets. During 115 days, 21 goats were divided into three lots of 7 each (Control, R2 and R3). The basic food ration was based on rangeland and *ad libitum* oat hay and supplemented with 3 concentrate diets with 0, 25, 50% of lupin and 0, 50, 25% of triticale, respectively. Milk production was quantified every two weeks and milk samples were collected monthly to determine chemical composition (fat, protein, lactose and defatted dry extract) using an infrared method. Milk production was not affected significantly by concentrate ration ($P>0.05$). Milk production was estimated at 446.5 g/d, 416.8 g/d and 495.0 g/d for the control, R2 and R3, respectively. Protein content, lactose, and defatted dry extract were not affected by lupin and triticale introduction. But fat was significantly higher with 50% DM of lupin ($P < 0.05$). Recorded fat was 3.44%, 3.00% and 4.33% for the control, R2 and R3, respectively. Lupin and triticale can be introduced into dairy goat diets without negative effects on milk production and composition.

Keywords. Lupin – Triticale – Dairy goat – Milk production – Milk composition.

Effet de l'incorporation du lupin et du triticale dans la ration sur la production et la composition du lait des chèvres laitières

Résumé. *Au Nord du Maroc, l'alimentation des caprins est basée presque exclusivement sur l'exploitation des ressources sylvo-pastorales. L'amélioration du calendrier alimentaire s'avère nécessaire, pour répondre aux besoins des animaux. Ce travail a étudié l'effet de l'incorporation dans la ration du lupin et du triticale, deux ressources alimentaires disponibles dans la région, sur les performances de production et la composition du lait des chèvres laitières. Durant 115 jours, 21 chèvres ont été réparties en 3 lots (Témoin, R2, R3) de 7 chèvres chacun. Leur alimentation est basée sur le parcours et le foin d'avoine à volonté, supplémentés par 3 rations de concentré contenant 0, 25, 50% du lupin et 0, 50, 25% du triticale, respectivement pour les lots Témoin, R2 et R3. La production laitière a été mesurée tous les 15 jours et des échantillons du lait ont été prélevés mensuellement pour déterminer la composition chimique du lait par la spectrométrie dans le proche infrarouge. La production laitière journalière et les teneurs du lait en protéines, lactose, et extrait sec dégraissé n'ont pas été affectées par l'introduction du lupin et du triticale. Par contre la teneur en matière grasse du lait du lot R3 a été significativement supérieure à celle des lots témoin et R2 (4,33%, 3,44% et 3,00%; $P<0,05$). Le lupin et le triticale peuvent être introduits dans la ration de la chèvre laitière sans affecter négativement la production et la composition du lait.*

Mots-clés. *Lupin – Triticale – Chèvre laitière – Production laitière – Composition du lait.*

I – Introduction

In the mountainous region of the North of Morocco (Tangier-Tetouan), goat population represents 37% of ruminant livestock and contributes to more than 70% in household income (Chentouf *et al.*, 2011). However, feeding is mainly based on forest rangelands and characterized by strong

seasonal variability (Chentouf *et al.* 2004) responsible of the low productivity of herds (Chentouf *et al.,* 2006). Lupin and triticale are two potential feed resources in the region that can improve feed calendar of goat livestock in the region. In this context, the objective of this study was to analyze the effect of incorporation of lupin and triticale in dairy goat diet on milk production and composition.

II – Material and methods

The study was conducted in INRA experimental station of Tangier located at latitude 35°66' N and longitude 5°85' W. During 115 days, 21 goats were divided into 3 groups (control, R2 and R3 lots) of 7 goats each. The basic food ration of these lots was based on rangeland and ad-libitum oat hay and was supplemented by three types of iso-energetic and iso-nitrogenous concentrate composed by barley grain, triticale, lupin, faba beans and a mineral-vitamin supplement.The rates of lupin - triticale incorporation were 0% -0%, 25% -50% and 50% -25% dry matter of concentrate respectively for control, R2 and R3 lots. During lactation period, milk production was recorded every two weeks by quantifying milk production of 24 hours to determine milk yield. Milk samples were collected every month to determine the chemical composition of milk (fat content, protein content, lactose and defatted dry extract) using infrared method by MilkoScan ™ Minor ®. Statistical analysis of data to determine means and variance analysis of one factor (ANOVA 1) was performed using Excel 2007 and SAS (2001) programs.

III – Results and discussion

1. Milk production

The average daily milk production was estimated to 446.5 g/d, 416.8 g/d and 495.0 g/d respectively for control, R2 and R3 lots (Table 1). This production was not significantly affected by ration of concentrate (P> 0.05). The registered milk production was less than cited by El Otmani *et al.* (2013) (597.9 g/d) with Beni Arousse North Moroccan local breed.

During lactation period, estimated at 120 days, milk production average was around 58.6 kg, 54.8 kg and 65.8 kg / lactation respectively for control, R2 and R3 lots (Table 1). As daily milk production, this production per lactation was not significantly affected by introduction of lupin and triticale (P>0.05) (Table 1). The registered milk yield was similar that cited by El Otmani *et al.* (2013) with the local breed of northern Morocco Beni Arousse in the extensive system with 60.5 kg/lactation and by Hassani (1997) with 59 kg/lactation in Western rif population.

Table 1. Average milk yield per day and per lactation of tests lots (R2 and R3) and control lot (n = 7)

Lot	Lupin-Triticale in concentrate	Daily milk production (g / d)	Milk production per lactation (kg/120d)
Control	0%-0%	446.47	58.60
R2	25%-50%	416.83	54.80
R3	50%-25%	494.97	65.77
Probability	0.52	0.44	
Signification	NS	NS	

NS: not significant (P>0.05).

2. Milk composition

Protein content, lactose, and defatted dry extract in goat milk of each lot were not affected by the introduction of lupin and triticale in dairy goat diet (Table 2). However fat content in milk in lot R3 (50% lupin and 25% of triticale) were higher than Control and R2 lots and respectively 4.33%, 3.44% and 3.00% (P<0.05).

This superiority can be explained by the estimated fat content in lupin grain that is 93 g / kg of crude lupin (Moss *et al.,* 2001). Fat induces a more important liberation of acetate in rumen, known as a precursor of milk fat. Similar results were reported by by Masson (1981) in goats and Brunschwig and Lamy (2001) and Froidmont and Bartiaux-Thill (2003) in cows.

Table 2. Milk chemical composition of control, R2 and R3 lots (n = 7)

%	Lupin-Triticale in concentrate	Fat (%)	Protein (%)	Lactose (%)	Defatted dry extract (%)
Control	0%-0%	3.44[b]	3.87	4.62	9.36
R2	25%-50%	3.00[b]	4.08	4.62	9.59
R3	50%-25%	4.33[a]	4.24	4.64	9.69
Probability		0.02	0.52	0.99	0.44
Signification		S	NS	NS	NS

[a,b]: values followed by different letters are statistically different at 5%.

S: significant (P<0.05); NS: not significant (P>0.05).

No differences were observed in lactose and defatted dry extract contents produced during lactation between control, R2 and R3 lots (Table 3). However, fat and protein production per lactation were significantly higher, with a rate R3 lot compared to those observed in control and R2 groups (P < 0.05; Table 3). Produced fat was estimated to 1.91, 1.65 and 3.08 kg/lactation respectively for control, R2 and R3 lots. This superiority is mainly due to the high content of lupin in fat.

No differences were observed between the three lots regarding protein milk content, however protein production during lactation was higher in R3 lots than Control and R2 lots and respectively 2.23, 2.19 and 2.97 kg/lactation.

This high content of protein per lactation in lot R3 (Table 3) receiving 50 % of lupin and 25 % of triticale is explained by lupin effect on increase of total protein, casein, αS1 - casein and αS2 - casein in milk of dairy goats (Morales *et al.*, 2008).

Table 3. Chemical composition of milk produced during lactation of control, R2 and R3 lots (n = 7)

	Lupin-Triticale in concentrate	Fat/Lactation (kg/lactation)	Protein/ Lactation (kg/lactation)	Lactose/ Lactation (kg/lactation)	Defatted dry extract / Lactation (kg/lactation)
Control	0%-0%	1.91[b]	2.23[b]	2.75	5.48
R2	25%-50%	1.65[b]	2.19[b]	2.53	5.20
R3	50%-25%	3.08[a]	2.97[a]	3.26	6.79
Probability		0.02	0.04	0.21	0.09
Signification		S	S	NS	NS

[a,b]: values followed by different letters are statistically different at 5%.

S: significant (P<0.05); NS: not significant (P>0.05).

IV – Conclusion

The incorporation of lupin and triticale in dairy goats' diet with respective proportions of 50% - 25% DM of ration concentrate improves milk fat content about 26% and protein produced per lactation. Their incorporation in goats' dairy diet is recommended to improve the animals' food calendar and their productivity.

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