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El Otmani S., Ayadi M., Chentouf M.

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The effect of including lupin and triticale in dairy goat diet on performance and fatty acid profile of milk

S. El Otmani*, M. Ayadi and M. Chentouf

INRA, Regional Agricultural Research Center of Tangier
78 Av. Sidi Mohamed Ben Abdellah, Tangier 90010 (Morocco)
*e-mail: elotmani.samira@gmail.com

Abstract. In Northern Morocco mountainous, goat feeding is based on forest rangelands and characterized by strong seasonal variability responsible of the low productivity of herds. Feed improvement is necessary. Lupin and triticale are both available resources in region. This work aims to study the effect of lupin and triticale utilization in dairy goat diet on production performance and fatty acid profile of milk. During 115 days, 21 goats were divided in three lots of 7 each (Control, R2 and R3). The food ration was based on rangeland and ad-libitum oat hay and supplemented by 3 concentrate diets with respectively 0, 25, 50% of lupin and 0, 50, 25% of triticale. Milk production was quantified every two weeks and milk samples were collected monthly to determine fatty acid profile using gas chromatograph (CG). The monthly daily milk production was not affected by the introduction of lupin and triticale in the diet (P>0.05). The production was statistically the same in every month. Comparing to control group, fatty acids in milk of test groups are not affected by the diet. But in comparing test groups (R2 and R3), C12 fatty acid differs significantly (P<0.05). Groups of desirable fatty acids, unsaturated, monounsaturated and polyunsaturated, omega 3 and 6 are statistically similar in control, R2 and R3 groups (P>0.05). In conclusion, lupin and triticale introduction can reach 50% without adversely affecting production performance and fatty acid profile of goat milk.

Keywords. Lupin – Triticale – Dairy goat – Production – Fatty acid profile – Milk.

Effet d'incorporation du lupin et du triticale dans la ration des chèvres laitière sur la production et le profil des acides gras du lait

Résumé. *Dans les montagnes du Maroc du Nord, l'alimentation des caprins est basée essentiellement sur les parcours forestiers qui se caractérisent par une variabilité saisonnière. Ce qui explique la faible productivité de ce troupeau. L'amélioration du calendrier alimentaire s'avère nécessaire pour répondre aux besoins des animaux. Le lupin et le triticale sont deux ressources alimentaires disponibles dans la région. Durant 115 jours, 21 chèvres sont réparties en 3 lots (Témoin, R2, R3) de 7 chèvres. Leur ration de base est constituée du parcours et du foin d'avoine à volonté, supplémentée par 3 rations du concentré contenant respectivement 0, 25, 50% du lupin et 0, 50, 25% du triticale. La production laitière est quantifiée chaque 15 jours et des échantillons du lait sont prélevés mensuellement pour déterminer le profil des acides gras à l'aide du chromatographe à phase gazeuse (CG). D'après les résultats, la production laitière n'est pas affectée par l'introduction du lupin et du triticale dans la ration* (P>0,05). Comparativement au lot témoin, le profil des acides gras des lots test n'est pas affecté par l'alimentation. Mais en comparant les deux lots test (R2 et R3), l'acide gras C12 diffère significativement (P<0,05). Les groupes des acides gras désirables, insaturés, monoinsaturés, et poly-insaturés, oméga 3 et 6 sont similaires chez les trois lots (P>0,05). En conclusion, *le lupin et le triticale peuvent être introduits dans la ration de la chèvre laitière à un taux de 50% sans affecter les performances de la production et le profil des acides gras du lait.*

Mots-clés. *Lupin – Triticale – Chèvre laitière – Production – Profil des acides gras – Lait.*

I – Introduction

In the mountainous region of the North of Morocco, including the provinces of Tangier, Tetouan, Larache, Chefchaouen and Ouazzane, the goat population is estimated at 597,000 head and represents 37% of ruminant livestock in the region and 10% of the national goat population (Jout, 2014). This livestock plays a major economic role in contributing to more than 70% in household income (Chentouf *et al.*, 2011). However, feeding is mainly based on forest rangelands that provide 96% of the needs of animals in livestock of meat production (Ben Bati, 2006) and 49-78% of farms of milk production (Ben Bati, 2006; Mesbahi, 2006). This rangelands are characterized by a strong seasonal variability (Chentouf *et al.,* 2004), responsible of the low productivity of herds (Chentouf *et al.*, 2006). Therefore, improving the food calendar goats is necessary. Lupin and triticale are both food adapted and productive resources in the soil and climatic conditions of the region. These two resources can improve feed calendar of goat livestock. In this context, the objective of this study was to analyze the effect of incorporation of lupin and triticale in dairy goat milk diet on performance and fatty acid profile of milk.

II – Materials and methods

To determine the effect of the incorporation of lupin and triticale in the diet of dairy goat, a test was conducted in the experimental station of INRA-Tangier located at latitude 35°66'N and longitude 5°85'W. Twenty-one dairy goats during the lactation period are subdivided into 3 homogeneous groups in terms of milk production of 7 goats each (control, R2 and R3 groups). The basic ration of these three groups was rangeland and oat hay ad libitum. They were supplemented with three isoenergetic and iso-nitrogenous concentrates composed by grain barley, triticale, lupin, faba beans and a mineral-vitamin mixture. The control group received a concentrate without lupin or triticale. While the concentrates of the test groups contained 25%-50% and 50%-25% of lupin-triticale for R2 and R3 groups, respectively. During this study (115 days), milk production was recorded every two weeks by quantifying milk of 24 hours to determine performance of production and samples of milk were collected every month to determine fatty acid profile (FAP). These samples were extracted and esterified by Christie (1993) method. The FAP, the groups of fatty acids (saturated (SFA), monounsaturated (MUFA), polyunsaturated (PUFA), desirable (DFA) and unsaturated (UFA) fatty acids) and omegas 3 and 6 (ω3 and ω6) of milk were determined using gas chromatography (GC) Varian CP-3800 equipped with a flame ionization detector and a capillary column while using an analytical standard of C4 to C24 fatty acids. 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

During lactation, milk production experienced a decrease. Despite this evolution, the average milk production per month was statistically similar in the three groups, as no significant difference was recorded between the monthly average milk production of groups for 4 months of this study (P> 0.05; Table 1). Our result was consistent with Masson (1981) which reported that for goats in mid lactation, replacement of soy and pea with lupin has no significant effect on milk production. While Paccard *et al.* (2006) reported that lupin decreases milk production in dairy cows. Maâmouri *et al.*, (2012) reported that the introduction of green triticale in the diet of sheep increases daily milk production. During the first month of lactation, maximum production was recorded in the group receiving 50% of lupin and 25% of triticale with 655,31g / day. Despite the superiority of R3 group during the first and the second month of lactation, no effect of the diet was registered because of the heterogeneity of

milk production within the group. The average milk production recorded during these two months were similar to that cited by El Otmani *et al.* (2013) for beni Arousse goat breed (597,94g / d in intensive system), by Abader (1985) among the local population of northern Morocco in Chefchaouen with 530 g / d and Hassani (1997) among the population of Western rif with 630 g / day.

Table 1. Average milk production evolution of the three groups during the study

	1st month	2nd month	3rd month	4th month
Control	544	504	331	327
R2	518	510	290	259
R3	655	569	346	261
P value	0.10	0.82	0.51	0.42

2. Fatty acid profile

Fatty acid profile (Table 2), with the exception of lauric acid (C12) ($P<0.05$), in the milk of the three groups was not affected ($P>0.05$) by the incorporation of lupin and triticale in the goats ration. The C12 fatty acid was significantly different between the groups ($P<0.05$). Compared to the control group, contents of C12 fatty acid in milk of the two tests groups were similar, so that comparing the two tests rations, C12 differed significantly. Groups of desirable (DFA), unsaturated (UFA), monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids and omega 3 and 6 (ω6 and ω3) of the control and tests groups were statistically similar. Woods *et al.* (2009) reported that the lupin tends to decrease the amounts of saturated fatty acids (SFA) with short and medium chains, especially C16:0, and increased C18:0 and monounsaturated fatty acids (MUFA) which is different from our results. While the introduction of the green triticale increased the polyunsaturated fatty acids (PUFA), unsaturated fatty acids (UFA), stearic acid (C18:0), C18:1, C18:2 and linolenic acid (C18:3) in sheep milk (Maâmouri *et al.*, 2012).

Table 2. Fatty acids Groups (% of total fatty acids) in milk of the control and experimental groups (n = 7)

	Control (%)	R2 (%)	R3 (%)	SEM	P-value
C12	4.55^{ab}	5.19^{a}	4.17^{b}	0.86	0.02
DFA	43.2	41.6	44.5	4.57	0.40
SFA	91.7	92.1	91.4	3.38	0.98
MUFA	5.68	5.48	6.00	1.68	0.30
PUFA	2.65	2.43	2.60	0.78	0.46
UFA	8.34	7.92	8.61	2.13	0.66
ω3	0.87	0.77	0.77	0.48	0.89
ω6	1.55	1.46	1.63	0.60	0.86

^{a,b}: values followed by different letters are statistically different at 5%.

IV – Conclusion

The introduction of lupin and triticale in the diet of goat in lactation period has no negative effect on either production or on nutritional quality of milk. These two feed resources can be introduced with rates that can reach 50% DM of concentrate without risk in goat ration during lactation. Their introduction in goat ration will improve protein and energy intake of their nutritional calendar.

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