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Beneficial Effect of Supplementation of Flax and Hemp Seeds in the Diet of Alpine Goats on the Iron Content in Blood

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Authors' contributions

This work was carried out in collaboration between both authors. The authors of this manuscript worked together to design, conduct, analyze and interpret the findings of this experiment. Both authors read and approved the final manuscript.

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Short Communication

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ABSTRACT

Aim of this study was to evaluate the effect of diets enriched with flax and hemp seeds on iron blood content of lactating Alpine goats. A total of eighteen goats were equally divided in three groups: control and goats supplemented with flax and hemp. The goats were supplemented with control diet for 45 days (conditioning diet). The different treatments ended after 150 days in milk. At T0 (45 days in milk), and at T1 and T2 (100 and 150 days in milk, respectively), the blood from the goats were collected and analyzed for iron content. In control goats, the iron content increased by 23% from T0 to T2. In both treatments (flax and hemp), the iron in goat blood resulted increased by 36% and 62% with flax, and by 33% and 67% with hemp (at T1 and T2, respectively). These results are surprising when it is considered the high phytate content of seeds of these plants. It is likely the presence in flax and hemp seeds of compounds that stimulate the absorption of iron.

Keywords: Flax; hemp; seed; diet; goat; iron; blood.

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1. INTRODUCTION

With the diet, it is necessary to introduce a sufficient amount of microelements to maintain a number of metabolic processes that support the growth, development, and for a correct functioning of the organism [1]. Iron is a microelement which is present like coenzyme in various enzymes (oxidases, catalases, peroxidases, cytochromes, etc.) involved in important cellular processes such as respiration, synthesis of nucleic acids, differentiation and proliferation [2]. In blood is present the majority of the iron of an organism: the most part in erythroid cells (75% of the total) and in part bound to transferrin, which is the main physiological source of iron for red cells [3].

For adult goats, a daily intake of 75 mg is considered acceptable for lactating animal [4]. Deficiency is relatively rare in farm animals with anaemia being the standard symptom. However, in kids deficiencies can occur, especially due to low body reserves and exacerbated by the low iron content of goats milk during suckling [4].

Flax and hemp seeds are rich sources of protein for animal feed. They contain 20-25% protein, and this value is even greater in defatted flours (33-37%) [5,6]. The seed proteins of flax and hemp have an interesting amino acid profile rich in arginine and with a good content of sulfurated amino acids, a profile particularly suitable for the diet of young mammals [6]. However, flax and hemp seeds contain anti-nutritional compounds that reduce the absorption of protein and micronutrients [5,7-9]. In particular, it is high the phytate (inositol exaphosphate) content in the seeds and flour of flax (3-4%) and even more in hemp (> 5%) [5,7,8]. Phytic acid is particularly efficient in binding mineral elements (Fe, Zn, Ca, Mg) and render them insoluble [10,11]. It must however be emphasized that in ruminant about 72-74% of phytic acid is digested in the rumen [12-14]. Nevertheless, phytates residues may reduce the absorption of microelements.

The aim of this study was to estimate the effect of flax and hemp in the diet of Alpine goats on the level of iron in blood.

2. MATERIALS AND METHODS

Eighteen Alpine multiparous dairy goats similar for milk production during early lactation were randomly allotted in three pens (six animals per pen) at the experimental center of the Department of Agricultural and Environmental Sciences of University of Milan and fed with three experimental diets after the lactation peak yield.

In Table 1 are shown the supplemented diets. The flax or hemp seeds substituted the same amount (6.4% dry matter) of corn and soybean in order to maintain the same nitrogen concentration. The gross energy was 17.8, 18.4 and 18.3 MJ kg-1 DM for control, flax and hemp treatments, respectively.

The experiment focused on three time points during lactation (Fig. 1): T0, when all the goats were fed for 45 days with the same control diet; T1 and T2, when the animals (6 for treatment) were fed the three different diets (about 100 and 150 days in milk, respectively). The goats at the end of the experiment all arrive in health, regardless of treatment.

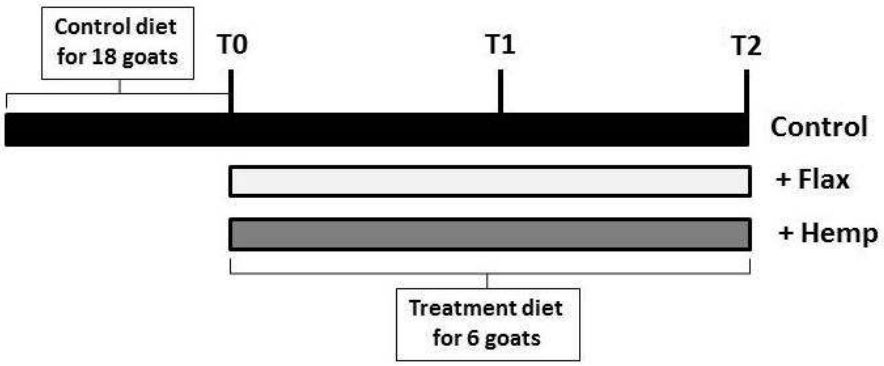

Fig. 1. Study design. Experimental plan used to evaluate the effect of diets containing flax and hemp seeds on iron content in goat blood

T0, T1 and T2 are 45, 100 and 150 days in milk, respectively

Table 1. Dietary treatments: Control (C), flax (F) and hemp (H)

Diet composition (% on dry matter)	Treatment		
	C	F	H
Permanent pasture hay	40	40	40
Lucerne hay	11	11	11
Maize meal and flaked	22.8	19	19
Soybean meal	5.5	2.9	2.9
Flax seeds	-	6.4	-
Hemp seeds	-	-	6.4
Soybean hulls	13.8	13.8	13.8
Carrob pulp	4.7	4.7	4.7
Molasses cane	0.4	0.4	0.4
Minerals and vitamins	1.8	1.8	1.8

Ten ml of blood samples were collected into EDTA from the jugular vein from each goat at T0, T1 and T2 and conserved for analysis. Blood samples were analyzed for Iron using Fe Spectroquant® (Merck, Germany) according to the manufacturer's protocol. In this method, only iron (II) ions are complexed with [3-(2-pyridyl)-5,6-bis(4-phenylsulfonic acid)-1,2,4-triazine (λ_{max} = 565 nm), but the presence of ammonium thioglycolate allows the mineralization of weak iron complexes, reduces iron (III) and acts as a buffer.

3. RESULTS AND DISCUSSION

Mean±SE of iron content in blood of goat is shown in Fig. 2. The goats at T0 (all animals not yet supplemented with flax or hemp) showed a level of iron in blood of 139.4±11.5 µg dL^{-1}. These levels of iron are similar to those reported in other works (135,2-143,3 µg dL^{-1} in young goats; 154,8 µg dL^{-1} in goats of Kashmir valley) [15,16]. In the control goats, the iron content increased by 23% from T0 to T2 (+32.1 µg dL^{-1} in 105 days of milk).

As evidenced in Fig. 2, the treatment goats presented iron levels in blood higher than the control goats. Supplementation of flax in the diet led to increases of iron of 36 and 62% at T1 and T2, respectively. In the hemp treatment, the iron content increased by 33% at T1 and 67% at T2. At the end of the experiment, the iron content was 225.6 and 232.4 µg dL^{-1} for flax and hemp treatments, respectively.

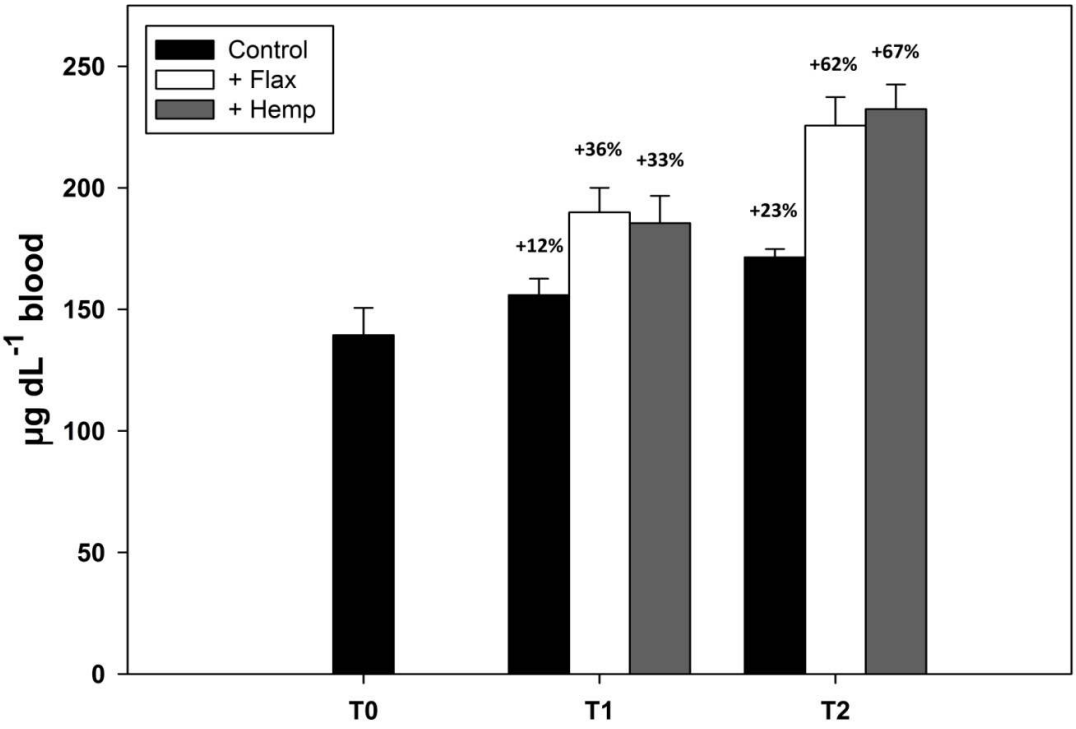

Fig. 2. Effect of different diet treatments (control, +flax seeds, +hemp seeds) on iron blood levels at different time intervals in goats

Data are the mean ± S.E.M of six different animals; variation respect to T0 are indicated

Considering that the availability of iron is particularly low from plant foods [17], it is noteworthy that there are plant sources that stimulate the absorption of iron. This result is even more surprising when it is considered the high phytate content in flax and hemp seeds [5,8]. However, it is known that some substances contained in vegetables can stimulate the absorption of iron (i.e. inulin) [18]. The presence of these substances in flax and hemp can be the subject of future research.

4. CONCLUSION

Considering the marked effect of diets containing flax and hemp seeds on the iron content of the blood of Alpine goats, these seeds represent a possible supplements in diets of young animals, that is, when the demand for iron is high and stocks are low (a phenomenon caused by the low iron content of the goat milk).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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