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Effect of catalytic and energy supplementation on kid performances grazing natural rangelands in north-west Tunisia

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Abstract. The effect of multi-nutrient blocks and energy concentrates supply on the performance of growing kids grazing natural rangelands in North-West Tunisia was investigated. Forty kids (average initial weight 13.8 ± 0.38 kg) of a local goat Tunisian breed were used. The trial included an adaptation period (1 month) to the intake of the shrubs in the natural rangeland and an experimental period (45 days). Kids were arranged in four groups each with 10 animals, and the four experimental treatments were allocated according to a completely randomised design. Experimental treatments were control (C) with kids browsing in the rangeland with no supplementation; kids receiving during the night a multi-nutrient block (with urea, molasses, vitamins and minerals) *ad libitum* (catalytic supplementation, CS); kids supplemented with 300 g barley (energy supplementation, ES); and kids supplemented with both multi-nutrient block and 300 g barley (CES). Kids were weighed three times through the experimental period. As compared with control group, average daily weight gain (ADG) was higher ($P < 0.001$) in animals receiving catalytic supplementation (94 ± 10.6 g/d *vs* 40 ± 5.6 g/d, for CS and C animals, respectively). The ADG was increased in kids receiving energetic supplementation (129 ± 6.6 g/d) in comparison with groups C ($P < 0.001$) and CS ($P = 0.005$), and growth was further improved by the combined supplementation with multi-nutrient blocks and barley ($P < 0.001$ for CS *vs* CES; $P = 0.003$ for CE *vs* CES), with animals in CES group reaching ADG of 166 ± 9.4 g/d. Catalytic and energy supplementation enhanced performance of growing kids browsing shrubby vegetation, and the inclusion of both supplements resulted in a synergic outcome.

Keywords. Growing kids – Daily weight gain – Multi-nutrient blocks – Barley supplementation.

Effet de la supplémentation catalytique et énergétique sur les performances des chevreaux pâturant sur maquis naturels du Nord-Ouest de la Tunisie

Résumé. *L'effet de la supplémentation des blocks multi-nutritionnels et du concentré énergétique sur les performances de croissance des chevreaux pâturant sur des maquis naturels du Nord-Ouest de la Tunisie a été étudié. Carante chevreaux (poids moyen initial 13,8 ± 0,38 kg) de race locale ont été utilisés. L'essai comprend une période d'adaptation à l'ingestion des arbustes sur le parcours de 1 mois et une période expérimentale de 45 jrs. Les chevreaux ont été répartis en quatre groupes (10 animaux/groupe), dont chacun lui correspond un traitement expérimental. Les traitements expérimentaux ont été: contrôle (C) avec des chevreaux pâturant sur les maquis sans recevoir aucune supplémentation; chevreaux recevant durant la nuit des blocks multi-nutritionnels (contenant urée, molasses, vitamines et minéraux)* ad libitum *(supplémentation catalytique, CS); chevreaux supplémentés avec 300 g d'orge (supplémentation énergétique, ES); et chevreaux supplémentés à la fois avec des blocks multi-nutritionnels + 300 g d'orge (CES). Durant la période expérimentale les chevreaux ont été pesés trois fois. Comparé avec le groupe contrôle, le gain moyen quotidien (GMQ) a été plus élevé ($P < 0,001$) chez les animaux recevant une supplémentation catalytique (94 ± 10,6 g/j* vs *40 ± 5,6 g/j, pour les animaux CS et C, respectivement). Le GMQ a été amélioré chez les chevreaux recevant une supplémentation énergétique (129 ± 6,6 g/j) en comparaison avec les groupes C ($P < 0,001$) et CS ($P = 0,005$). La croissance a été encore plus importante suite à la supplémentation combinée des blocks multi-nutritionnels et l'orge ($P < 0,001$ pour CS* vs *CES; $P = 0.003$ pour CE* vs *CES), avec un GMQ*

de 166 ± 9,4 g/d pour les animaux du groupe CES. La supplémentation catalytique et énergétique améliore la performance de croissance des chevreaux conduits sur parcours à végétation arbustive, l'inclusion simultanée des deux suppléments a résulté en un rendement synergique.

Mots-clés. *Chevreaux – Performance de croissance – Blocks multi-nutritionnels – Supplémentation énergétique.*

I – Introduction

In Tunisia, goat population accounts for approximately 1.3 million heads of which 0.75 million are breeding females. Goats in Tunisia represent a high diversity and heterogeneity, and most animals belong to local native breeds characterized by black coat, horns and long drooping ears (Nafti *et al*., 2009). Average adult weights are 40 and 60 kg for females and males respectively. Most farms are located in arid and deserted regions where goat meat is preferred over beef and lamb. Performance of goats raised on these areas is generally low and variable as animals are fed mainly on low quality roughages, including natural grazing on shrub lands. The main limiting factors of these natural vegetations are their low level of crude protein (CP) and large quantities of ligno-cellulosic material and phenolic compounds (Ammar *et al*., 2005). Therefore goats fed browse require a CP supplement that continuously provide adequate levels of ammonia for consistent growth of micro-organisms and synthesis of microbial protein (Sudana and Leng, 1986). Feed blocks are considered to be a good supplement to poor quality feeedstuffs, as they allow a balanced and synchronized supply of nutrients (*i.e.* energy, N, minerals and vitamins) to ruminants. In addition, feed block technology involves the use of inexpensive ingredients, such as agro-industrial feed by-products, and manufacturing equipment. Information on the benefits of catalytic and/or energy supplementation on kid performance under farm conditions in Tunisia is scarce. The overall objective of this study was to promote the use of urea-molasses multi-nutrient blocks as nutrient supplements simultaneously with energy supply for improving growth rate of kids under smallholders' farm conditions.

II – Material and methods

1. Studied area

The study was conducted in natural rangelands in North-West Tunisia during summer. The climate is Mediterranean with a mean annual rainfall of 900 mm and an average temperature of 21°C. The experimental rangeland was dominated by the browse species *Erica arborea* L., *Phillyrea angustifolia* L., *Arbutus unedo* L. and *Calicotome villosa* (Poir.) Link. In contrast with the shrubby vegetation, the herbaceous stratum is almost absent in the vegetation cover. Branches and twigs of the dominating shrub species were clipped with scissors harvesting a mixture of leaves and fine green stems (diameter < 2 mm). In the laboratory, leaves and stems were manually separated from the original samples and then foliage samples were immediately oven-dried at 40ºC and subsequently, ground to pass a 1-mm screen.

2. Animals

Forty kids (13.8 ± 0.38 kg initial weight) of a local goat breed were used. Kids were arranged in four groups each with 10 animals, and the four experimental treatments were allocated according to a completely randomised design. Experimental treatments were control (C) with kids browsing in the rangeland with no supplementation; kids receiving during the night a multi-nutrient block (complex catalytic feed mixture) *ad libitum* (catalytic supplementation, CS); kids sup-

plemented with 300 g barley (energy supplementation, ES); and kids supplemented with both multi-nutrient block (*ad libitum*) + 300 g barley (CES). Feed or multinutrient blocks (catalytic feed mixture) composition was (g/kg): wheat bran (430), molasses (100), urea (100), salt (100), phosphate (50), mineral and vitamin (20), commercial cement (150) and quicklime (50). Average daily intake of feed blocks was estimated to be approximately 86 g. Animals of the different groups were adapted for one month to grazing in the natural rangeland, receiving (except for the control group) the corresponding supplement (catalytic blocks and/or whole barley). The multi-nutrient blocks were consumed over a period of 6-8 h during the day, while barley was ingested in less than 1 h after the supplement was offered. After the grazing period, all animals were housed and offered the corresponding supplement. During the experimental period (45 days) kids were in the pasture for 11 h daily (from 06.00 to 17.00 h) and weighed every two weeks in order to calculate the average daily gain (ADG) by difference. Age and initial weight (average) of animals in the different groups are shown in Table 1.

Table 1. Age and initial weight of kids used with four experimental treatments

Experimental treatments	Age (days)	SD	Initial weight (kg)	SD
Control	115.2	11.0	13.9	2.8
Catalytic supplementation, CS	104.7	22.5	14.1	3.0
Energy supplementation, ES	111.0	23.4	13.4	2.1
CES (CS+ES)	123.4	9.5	13.7	1.9

3. Chemical analysis

Dry matter (DM, method ID 934.01), ash (method ID 942.05) and crude protein (CP, method ID 984.13) contents of multi-nutrient blocks, barley and browse species (leaves and young twigs) were determined following the methods of AOAC (1999). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) contents were determined with the ANKOM fibre analyzer (Ammar *et al*., 1999) using the reagents described by Van Soest *et al*. (1991). Extractable condensed tannins (CT) were measured for browse species using the butanol–HCl assay (Porter *et al*., 1986) with the modifications of Makkar (2003) and using purified quebracho tannin as standard.

4. Statistical analysis

Statistical differences between experimental groups (C, CS, ES, CES) in average daily gain (ADG) were evaluated at by one way analysis of variance (Steel and Torrie, 1980), with feeding regime as the only source of variation.

III – Results and discussion

Many Mediterranean shrubs represent a greater proportion of the diet as nutritive value (or availability) of grass drops. However, usually browse may be insufficient to match animal requirements, mainly for the low CP of some shrubby species (Cabiddu *et al*., 2000). In the present study CP content was particularly low in the foliage of *E. arborea* and *A. unedo* (Table 2). Studies reported earlier on *E. australis* (Ammar *et al*., 2004) and other Mediterranean shrubs (Rodriguez *et al*., 1973; Cabiddu *et al*., 2000; Frutos *et al*., 2002) recorded similar results. Such finding can be probably due to high proportions of mature leaves in the sample, especially when collected in summer. CP contents in leaves of these browse species collected in spring were higher than that reported herein (Ammar *et al*., 2005). As expected, the CP content was higher in the foliage of

the legume *C. villosa*. This can be attributed to the ability of leguminous plants to fix atmospheric nitrogen. The relatively high fibre (NDF and ADF) contents observed in the foliage of browse plants is in agreement with values reported in the literature (Ammar *et al*., 2004, Ammar *et al*., 2005). Likewise, CT contents were particularly higher in the foliage of *E. australis* and *A. unedo* consistently with the results pointed out in the literature (Cabiddu *et al*., 2000; Frutos *et al*., 2002, Ammar *et al*., 2004) Nevertheless, a virtual absence of CT was observed in the foliage of *C. villosa* and *P. angustifolia* (Table 2). On the other hand, multi-nutrient blocks are characterized by high level of CP (370 g/kg DM) and low level of fibre.

Table 2. Chemical composition (g/kg dry matter) of feedstuffs and condensed tannin contents (CT, g/kg dry matter) of foliage of dominated shrubs in the rangeland area

Browse and supplements	OM	CP	NDF	ADF	CT
Erica arborea	960	65	540	410	570
Phillyrea angustifolia	948	93	460	375	20
Arbutus unedo	942	50	440	282	380
Calicotome villosa	940	201	580	212	15
Multi-nutrient blocks	730	370	178	97	ND
Whole barley	950	100	218	135	ND

Growth performance of kids in the different experimental groups is presented in Table 3. In the absence of any supplementation (energy and/or catalytic), ADG of control group (C) was 40 ± 5.6 g/d. Our result was in agreement with the finding of Galina *et al*. (1993) who reported that goats raised on shrub rangelands rich in fibrous forages showed low growth rates with live weight gains of no more than 50 g/day. This low performance was supported mainly by the protein supplied by the legume tree leaves as suggested by Puga (1998). Therefore, dry season supplementation seems to be a necessary strategy in many parts of the world (Collier and Beede, 1985, Hogan and Liang, 1991, Santra *et al*., 2002, Torres-Acosta *et al*., 2006). In the present trial, supplementation with feed blocks or barley increased significantly ($P<0.01$) the growth rate of local kids compared with the control group. Experimental CS kids showed an average growth of 94 g (±10.6). Similar results have been reported in kids (Galina *et al*., 2000) and lambs (Van-Houtert *et al*., 1995, Van-Houtert and Sykes, 1996, Umoh and Halilu, 1992, Santra *et al*., 2002) grazing in dry or semi-arid environments. The improvement in ADG of supplemented animals may result from an increased voluntary intake, which may result from an improved ruminal environment and an enhanced digestibility of roughages (Santra *et al*., 2002, Hossain *et al*., 2003, Kabir *et al*., 2004, Torres-Acosta *et al*., 2006). Furthermore, the protein requirements of CS kids for growth seemed to be met by a greater provision of microbial protein whose synthesis is enhanced by the supply of non-protein nitrogen from urea contained in the feed blocks (Galina *et al*., 2000).

Table 3. Effects of catalytic and/or energy supplementations on the average daily gain (ADG, g/d) of kids browsing on shrub rangelands

Experimental treatments	Control	Catalytic supplementation, CS	Energy supplementation, ES	CES (CS+ES)
Average daily gain	40^{a}	94^{b}	129^{c}	166^{d}
SEM	5.6	10.6	6.6	9.4

Means with different superscript letters indicate statistically significant differences at $P<0.001$.

The ADG was increased in kids receiving energetic supplementation (129 ± 6.6 g/d) in comparison with groups C ($P < 0.001$) and CS ($P = 0.005$). The better growth performance of the ES kids over C and CS groups can be partly explained by the energy supply to the kids from barley in comparison with fibrous browse material and with multi-nutrient blocks. Microbial protein synthesis in the rumen could be also improved in response to the increased energy supply, thus resulting in a greater flow of protein to the duodenum. This result is, however, in discrepancy with results reported by Galina *et al*. (2000) who showed that catalytic supplementation (200 g/d) to kids fed on shrub lands was more efficient, in term of body gain weight, than a commercial concentrate. This discrepancy could be attributed mainly to the differences in the composition and amount of multi-nutrient blocks ingested (86 g/d *vs* 200 g/d) in each experimental trial. Similarly, an improvement of growth rate of cattle fed fibrous forages and supplied with corn and rice polishing has been reported in the literature (Galyean, 1996; Poppi and McLennan, 1995). As expected, growth was further improved by the simultaneous supplementation of multi-nutrient blocks and barley ($P < 0.001$ for CS *vs* CES; $P = 0.003$ for CE *vs* CES), with animals in CES group reaching ADG of 166 ± 9.4 g/d. This combination may have contributed to a more a favourable nitrogen to energy ratio for bacterial protein synthesis (Leng, 1991), more balanced in the amounts supplied to the micro organisms and probably with a more synchronized availability of nitrogen and energy.

IV – Conclusion

This trial has proven that grazing on shrub rangelands alone may be not enough to sustain appropriate growth local kids during the dry season when nutrient availability was limited. The large difference in terms of average daily gain between supplemented and non-supplemented groups evidences that supplementation is economically feasible and necessary to assure farm viability. Furthermore, our results proved that the combined use of energy with non-conventional supplementation from multi-nutritional blocks allowed animals to perform a levels closer to their real genetic potential for growth.

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