

Evaluating Corn Silage as Supplement: Its Effect on The Performance, Milk Production and Milk Composition in Local Goat

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Abstract

The effect of corn silage supplementation on performance, milk production, milk composition and carcass characteristics of local lactating goat in Kurdistan region of Iraq was evaluated. Twenty lactating goats with a five -day-old kid was divided into four treatment groups: one group was fed concentrate and straw, while the other 3 groups fed to the goats were given 800 g/head/day (T1), 1600 g/head/day (T2) and 2400 g/head/day (T3) of corn silage for a period of 75 days. There was a significant increase in average milk yield, percentage of milk fat and lactose, total weight gain and carcass size and grade with increased consumption of corn silage. The highest level of inclusion (T3), however, had hinger feed conversion ratio, which shows reduced biological efficiency. The control group had the highest percentage of milk protein, which would seem to indicate a dilution effect. T3 achieved greatest production responses, whereas T2 achieved greater milk production responses with no significant difference in feed efficiency. Milk composition was stable during the experiment, indicating that corn silage can be successfully used in dairy goat. Overall, moderate supplementation with corn silage (T2) is the most efficient and feasible for farmers who have a small number of animals in resource-constrained areas.

Keywords: Corn silage, lactating goats, milk production, feed conversion ratio, carcass characteristics

1. Introduction

In regions where intensive crop farming is not feasible, such as the arid and semi-arid areas of Iraq, including the Kurdistan region, small ruminant farming forms a fundamental part of agricultural activities, with goats playing a particularly important role. Goats are valued for their ability to produce high-quality meat and milk, and they are well adapted to thrive on marginal lands while efficiently utilizing low-quality feed resources [1] [11] [6]. However, feed costs constitute the largest expense in livestock production and have a direct impact on the animals' productivity [22].

Forage is an important part of ruminant diets as it supplies fiber needed to maintain a stable rumen environment, improve health and production [17]. Low quality and lack of traditional forages in many developing countries further limits ruminant livestock production [12]. Conserved forages like silage have arisen as an important means of guaranteeing a quality consistent feed available throughout the year, and it's because of their starch [13] [20]. This will then increase the feed consumption, milk yield and milk protein percentage, as well as growth [12]. Studies have confirmed its potential for incorporation into goat rations; for example, replacing 20% of the dry matter in lactating goat rations with corn silage has been demonstrated to be a satisfactory replacement and a cost-effective approach, especially in areas where dry forages are limited [25]. Goats have been shown to gain body weight linearly with increased inclusion of corn silage in the diet, as well [12].

The aim of the present study is to assess the performance and milk quality of locals when corn silage is offered to them as a dietary supplement. In particular, this study will seek to establish the effect of different percentages of corn silage supplement on feed intake, growth performance and the yield and composition of milk.

2. Material and method

The experiment was carried out in Palasan village located in the governorate of Duhok in northwestern part of Iraq in 2026 for evaluating the effect of corn silage supplementation on lactating goats. Twenty goats and a five -day-old kid were selected and were fed as per [20]. All the animals shared the same environment and had access to water. The animals were divided into four treatments, T1 (control group) and T2 (800 g of corn silage/head/day on basal diet), T3 (1600 g of corn silage/head/day on basal diet), T4 (2400 g of corn silage/head/day on basal diet) with five replications. The experiment period lasted for 75 days with 14 days of adaptation. The chemical composition of experiment diet presented in table (1) and physical properties and in vitro digestion of the corn silage table (2). The quantities of milk produced after manually milking the animals were recorded around 9:00 AM, after the newborns had been isolated the previous evening (isolating newborns from 8:00 PM to 9:00 AM the following day). Samples of the milk were analyzed by an eco-milk analyzer. The data was collected for carcass characteristics using a portable

ultrasound device (ESAOTE Pie Medical AQUILA-410853) with a 3.5 MHz linear array transducer used for image acquisition, animal performance and carcass characteristics. The collected data was analyzed using the computer software named SPSS version 25 (SPSS Inc., Chicago, IL, USA) under 1-way factorial ANOVA in an CRD design. The difference between the average data compared was confirmed using Duncan's or Tukey test at the significance level of probability $P \leq 0.05$.

Table 1: Chemical composition of experiment diet

Concentrate	Corn Silage	Composition
90.25	33.51	DM%
9.75	66.49	Moisture %
16.57	8.43	Crude Protein %
56.27	54.32	NFE
7.08	24.69	Crude Fiber %
3.08	7.53	Fat %
6.98	5.03	Ash %
21.07	59.89	NDF %

DM: Dry Matter. NFE: Nitrogen Free Extract, NDF: Neutral Detergent Fiber

Table 2: Corn silage physical characteristics and invitro digestion

Value	Parameters
347.21	Bulk density kg/m^3
68.51	Kernel Processing score

	%
60.74	Particle Size distribution %
71.36	Lactic Acid g/kg DM
3.64	pH
56.7	IVDM %
58.05	IVOM%
26.38	NDF digestibility %

IVDM: in vitro digestion of dry matter, IVOM: in vitro digestion of organic matter, NDF: Neutral detergent fiber.

3. Results and Discussion

3.1 Effect of corn silage supplement on growth performance

The results in the table (3) show a positive dose response on weight gain to an increasing proportion of corn silage. Weight gain (kg) and average daily gain (g) all increased with the increase in the inclusion rate of corn silage, from 0.92 kg in the control group (0% corn silage) up to 1.22 kg in the T3 group (highest inclusion rate of corn silage), and 12.29 g to 16.33 g, respectively. This was statistically significant and indicated that diets containing more corn silage would improve growth results. [19] noted that weight gain in Suffolk lambs fed corn silage was 27% higher than in sorghum silage fed lambs. [28] found significantly higher growth performance in lambs fed whole-crop corn silage and [10] showed significantly higher daily gain and feed conversion ratio for lambs fed microbially inoculated corn silage. [21] found that the goats which were fed using 75% maize silage had the highest average daily gain

(68.55g/day) and the best feed conversion ratio (4.91).[12] found that goats on 60% WPCS diets had higher ADG than those on grass silages. Energy is diverted from body tissue accretion to milk production, especially during early to mid-lactation when weight loss is common, as is the case for lactating goats [16] [3]. [25] found no negative impacts on body weight and improved antioxidant status when feeding 20% corn silage to the lactating goats, indicating a health-promoting effect without negatively impacting on production. The dose increasing corn silage was included to improve energy intake and performance in lactating goats and shows that benefits are readily apparent in the form of sustained and improved milk production, milk composition and metabolic efficiency, rather than similar weight gain.

Table 3: Initial weight, final weight, total weight gain, and average daily gain of lactating goats supplemented with corn silage

P-value	±SE	Treatments				Parameters
		T3	T2	T1	Control	
		49.00	49.20	49.20	49.00	Initial weight kg
		50.23	50.37	50.13	49.92	Final weight
0.033*	0.049	1.22 ^a	1.17 ^{ab}	0.93 ^b	0.92 ^b	Total Weight Gain kg. treatment .75 days

0.046*	0.658	16.33 ^a	15.60 ^{ab}	12.40 ^b	12.29 ^b	Average daily gain (g). treatment
		1530.00	1230.00	930.00	630.00	Total Feed Intake kg/treatment/75d

a,b,c Means with differing superscripts within the same row are significantly different (P<0.05).

3.2 Effect of corn silage supplement on milk production, composition and FCR:

The table (4) shows that there was a definite and positive dose-response relationship of the dietary treatments (T1 to T3) with respect to average milk production, milk composition and lactating goats compared to the Control. The average milk production was significantly higher in the T3 (2.08 kg/day) as compared to the Control (1.68 kg/day) with the highest production recorded in T2 and T3. The relevance of this finding is well substantiated by some of the document's studies. In particular, goats fed a hybrid maize silage mixture showed higher actual daily milk yields, which is consistent with the better performance of T2 and T3 [24]. Likewise, [9] with lactating ewes observed that lactating ewes on corn silage produced significantly more milk than those on either of the other diets, suggesting that

starch content and energy availability due to starch fermentation, perhaps operating in the T2 and T3 ewes may explain this effect. As per milk composition, it was found that T3 having the highest fat percentage of 3.53%, followed by T2 (3.08%), and the Control and T1 had less fat percentage. This is in agreement with [18] who reported that goats receiving corn silage had significantly higher percentages of milk protein and lactose, where the percentage of lactose increased from 4.71% (Control) to 5.17% (T3). Moreover, corn silage diets led to an increase in milk fat and total solids, as confirmed by [24]. An interesting trade-off is noted with Protein %, with the control having a higher score (3.50%) and the T1-T3 having slightly lower, but statistically significant, differences. This could be linked to the dilution effect observed by [7] in which more milk will dilute certain components.

Feed Conversion Ratio (FCR) increased gradually from control (1.00) to T3 (1.96) which means that T3 gave the highest milk production but the lowest efficiency in milk/feed conversion. This is in agreement with [8], who reported that high-concentrate diets in Murciano-Granadine goats resulted in higher intake but may also lead to negative energy balance, which raises the metabolic costs. Another reference mentioned in this document is to the work by [27], where evidence is presented of the genetic expression in high-FCR animals being correlated with high tissue repair metabolism that explains the T2 and T3 inefficiencies. Interestingly, [4] reported that high-moisture corn silage had no adverse effect on feed efficiency, indicating that the type and composition

of the diet (such as T3, which was a more balanced mix, and a more balanced formulation) is critical to the FCR results. The increasing FCR although the T3 diet increases output, the control diet is probably higher in the proportion of concentrates and will have superior biological efficiency.

Table 4: Milk production, milk composition, feed intake, and feed conversion ratio (FCR) in local lactating goats fed corn silage-supplemented diets

P-value	±SE	Treatments				Parameter
		T3	T2	T1	Control	
0.000*	0.020	2.08 ^a	2.02 ^b	1.69 ^c	1.68 ^d	Average Milk Production (kg. day ⁻¹) (75 days)
Milk Composition %						
0.000*	0.051	3.53 ^a	3.08 ^b	2.94 ^c	3.02 ^b	Fat %
0.000*	0.021	3.45 ^b	3.40 ^c	3.41 ^c	3.50 ^a	Protein
0.000*	0.043	5.17 ^a	5.09 ^b	4.89 ^c	4.71 ^d	Lactose
		6.79	6.73	6.74	6.84	pH

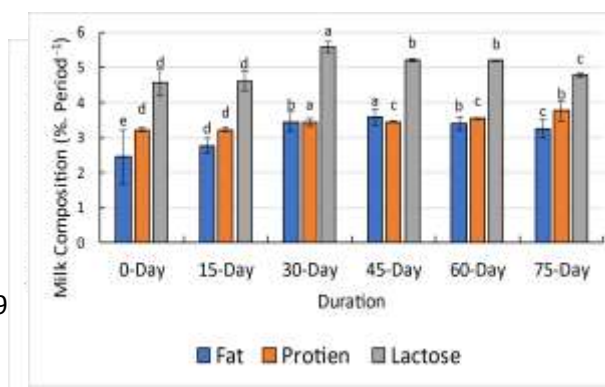
		153 0.0 0	123 0.0 0	93 0.0 0	63 0.0 0	Total Feed Intake kg/tre atmen t
		1.9 6	1.6 2	1.4 7	1.0 0	FCR (Milk)

a,b,c Means with differing superscripts within the same row are significantly different ($P < 0.05$).

Figure (1) shows the milk production of lactating goats during the experimental period. If the lactation plateau or a gradual increase in the lactation phase indicates a steady supply of nutrients and successful adapting to the diet. When the feed is well formulated with sufficient protein and physically effective fiber to avoid rumen acidosis, corn silage can support or stimulate goat milk production as the experiment progressed. The first statement on the dynamics of lactation curve is well supported. A study of Baladi dairy goats recorded a high lactation rebound (+36%) when the goats were transferred to high nutritive value pastures during mid-lactation, which suggests a good reactivity in response to a feed improvement. study also established the normal decline during the end of lactation. The researchers observed that during the reproduction phase, the milk yields decrease showing the highest priority given to the body reserves recovery [14]. Study which found that neutral detergent fiber (NDF) from forage had a quadratic effect on milk production, with the greatest productions obtained with the content of 28% of fiber [15]. Study on replacing corn with cassava root silage demonstrated maintenance of production

when alternative starch sources were used, concluding that even when intake decreased, goats managed to obtain sufficient nutrients from the diet to maintain milk production and composition. This supports that corn silage can maintain production when properly balanced [26].

The data in Figure (2) shows the milk composition parameters (fat, protein and lactose percent) of lactating goats during the experimental period when fed a diet of corn silage. The stability of these components over time indicates that corn silage could be a good addition to the dairy goat diet without negatively affecting milk quality. Fat content seems to be fairly constant; protein and lactose percentages have slight variations and stay within physiological limits for dairy goats. The results are documented by published studies. In a study, [25], concluded that feeding 20% of dry matter corn silage replacement diet to Mahabadi lactating goats did not significantly affect milk yield or milk composition, but the milk composition was found to contain more antioxidants and less polyunsaturated fatty acids. The consistency of milk component percentages is also supported by [2] who reported no changes in milk composition when lactating goats were fed with corn silage treated with enzymes capable of breaking lignin.



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du **Figure (2):** Milk composition during experiment duration

3.3 Effect of corn silage supplement on carcass characteristics:

The data in table (5) presented corn silage was increased in the diet, there was a linear increase in several carcass characteristics measured in dairy goats with the greatest amount of corn silage (T3) having the best effect. Fat thickness did not reach significance, but T3 had the highest value (0.208 cm), with T2 the lowest value (0.168 cm), indicating that silage had a non-linear, dose-dependent effect on fat deposition. There was a significant difference between the T3 (1.758 cm²) rib eye area compared to the T2 (1.472 cm²) and control (1.528 cm²) which suggests that the provision of higher energy availability from corn silage results in greater rib eye area. In the same way, the yield grade for carcass, where T3 (2.480) was significantly higher than T2 (2.080). The data taken together suggest that supplementation with the highest amount of corn silage (T3) contributes to the best performance in terms of carcass quality, both in terms of the muscle area and of the overall muscle yield. The results agree with those of previous studies, which found that containing silage-based complete rations produced better carcass characteristics in small ruminants than those with forage and concentrate mixtures, probably because of the greater supply of fermentable energy and better partitioning of nutrients [23] [5]. Corn silage contains high starch and fermentable energy, which can affect the microbial populations and production of VFA in the rumen [25].

Including moderate silage (T2) may have affected rumen conditions in such a way as to temporarily result in a change in nutrient partitioning before it became ideal for tissue deposition at T3.

Table 5: Effect scorn silage supplement on the Fat thickness, rib area, and carcass yield grade

P-value	±SE	Treatments				Parameters
		T3	T2	T1	Control	
0.072*	0.010	0.208a	0.168b	0.192ab	0.192ab	Fat thickness cm
0.033*	0.066	1.758a	1.472b	1.662ab	1.528b	Rib eye area cm ²
0.072*	0.097	2.480a	2.080b	2.320ab	2.320ab	Carcass yield grade

^{a,b,c} Means with differing superscripts within the same column are significantly different ($p < 0.05$).

4. Conclusion:

Supplementation of corn silage significantly improved milk yield, milk composition, weight gain, and carcass characteristics in lactating goats, with the highest benefits observed at the highest inclusion level. However, increased intake beyond a moderate level (T3) led to reduced biological efficiency, while moderate supplementation (T2) provided

a balanced and effective strategy. These findings suggest that incorporating corn silage into the diet of dairy goats is a viable practice.

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