

The use of quinoa (*Chenopodium quinoa Willd*) as a new forage crop and its effect on performance, individual production and feed efficiency of ruminants

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Abstract:

In recent years, feed costs in the Israeli small ruminant sector have increased significantly, including a sharp rise in the prices of roughages and high-quality protein sources in feed rations. Therefore, there is a clear need to develop new forage crops that are resilient to climate change, possess high nutritional quality, and can improve production efficiency in the Israeli sheep and goat industry. Such crops would also allow greater diversification of forage species in crop rotations—currently based mainly on wheat and legume forages—thus helping to reduce disease, pest, and weed pressures, while enabling the inclusion of crops with higher water-use efficiency in dryland rotations. Quinoa (*Chenopodium quinoa*) grown as a forage crop has great potential to address these challenges.

The objective of the present study was to evaluate the use of quinoa hay as a primary roughage component in the fattening rations of lambs (Year 1), in the total mixed rations (TMR) of dairy goats (Year 2), and in the rations of high-yielding dairy ewes (Year 3). The study aimed to assess the effects of feeding quinoa hay on productivity, feed efficiency, and the quantity and quality of end products, compared with traditional roughages such as wheat hay and high-quality legume hays (clover and alfalfa).

Results from the individual feeding trial with lambs (Year 1) showed that feed intake, average daily gain, final body weight, and individual feed efficiency were all significantly higher in the treatment group (quinoa hay) compared to the control group (wheat hay). Carcass weight (kg) and intramuscular fat percentage were also significantly higher in the quinoa-fed lambs. In the dairy goat feeding trial (Year 2), milk yield and milk protein content were significantly higher in the quinoa group compared to the clover-fed control group. Somatic cell counts (SCC) in milk were significantly lower in the quinoa-fed goats, indicating better milk quality. In addition, feed efficiency in the quinoa group was 8% higher than in the control group. Similarly, in the dairy ewe feeding trial (Year 3), milk yield in the quinoa group was significantly higher than in the control group (clover), feed efficiency was 10.7% higher, and SCC were significantly lower in the quinoa-fed ewes. In all three feeding trials, the digestibility of the rations containing quinoa hay was significantly higher than that of the control rations.

The common outcome across all three feeding trials was an improvement in productivity (weight gain in lambs and milk yield in goats and ewes) and feed efficiency, compared with traditional forage crops (wheat and clover). These results are consistent with previous feeding trials in cattle, in which feeding quinoa hay to fattening calves and dairy cows also resulted in higher feed efficiency than feeding wheat hay. The improved productivity and feed efficiency observed in both small ruminants and cattle may be related to the higher digestibility of the quinoa-based rations. This increased digestibility could stem from the presence of saponins in quinoa. Saponins are known to influence rumen microbial populations by suppressing protozoa that prey on amylolytic bacteria, thereby reducing methanogenic activity and increasing the digestibility of concentrate components in the ration. Studies in the literature (including our preliminary trial with calves fed quinoa hay) have shown that saponins reduce methanogenic populations, leading to lower methane emissions and improved microbial efficiency—meaning less energy lost as gas and more energy directed toward microbial growth, which in turn serves as a nutrient source for the animal. Another consistent finding from the goat and ewe feeding trials concerns milk quality: the somatic cell count in the milk of quinoa-fed animals was significantly lower than in the control groups. This improvement may result from the presence of antioxidant and anti-inflammatory compounds in quinoa leaves, which are absent in wheat and clover.

Taken together, the feeding trial results demonstrate that quinoa hay improves productivity, feed efficiency, and even the quantity and quality of final products (milk quality and intramuscular fat content in meat). Combined with quinoa's favorable composition particularly its higher protein content, digestibility, cumulative yield, and suitability for year-round cultivation, these findings indicate that the use of quinoa as a forage crop in small ruminant feeding systems could enhance farm profitability and animal health. However, so far, quinoa hay feeding in Israel has mainly been practiced on farms that both grow and use the crop themselves. Quinoa hay has not yet been commercially priced or distributed through feed centers, making it difficult to precisely evaluate the economic profitability of replacing or combining quinoa with traditional roughages. We believe that once the experimental results are disseminated among farmers and stakeholders (especially feed centers), demand for quinoa will increase, cultivation areas will expand, and a market price will be established. This development could promote broader adoption of quinoa as a forage crop, contributing to feed resource diversification and improving resilience to expected climate changes in our region.