Effect of the Short-Term Incorporation of Different Proportions of Ensiled Artichoke By-Product on Milk Parameters and Health Status of Dairy Goats

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Abstract: The use of local agricultural by-products for animal feed is an alternative that reduces livestock production costs and allows food production of greater environmental sustainability. The aim of this experiment was to study the effect of the inclusion in the dairy goat ration of artichoke by-product silage (ABS) at three levels (25%, 40% and 60%), on a dry matter basis on the milk yield, composition and quality, and on the metabolic profile of dairy goats. Thirty-six Murciano-Granadina dairy goats in mid-lactation were divided into four groups with homogeneous characteristics. Each group was assigned a diet: a control treatment (C) that consisted of a conventional diet of alfalfa hay and concentrate, and three other treatments that included 25, 40 and 60% ABS: ABS25, ABS40 and ABS60. Small differences were observed in the milk yield and quality and the health status of the animals. Only ABS60 presented a slightly lower milk yield (~20% compared to control group), without relevant differences in the milk composition and mineral profile. Regarding the lipid profile, ABS40 was the treatment with the best milk quality, due to a higher content of polyunsaturated fatty acids (4.37%) and lower atherogenicity (1.90) and thrombogenicity indices (3.05), without differences from C. It was concluded that the maximum inclusion level of ABS in dairy goats’ diet should be equal to 40%.

Keywords: lipid profile; CLA; mineral profile; silage by-products; metabolism

1. Introduction

Animal feeding represents 50–65% of the costs of a livestock farm [1]. Food production for livestock involves a high consumption of limited natural resources, such as land, water and fossil fuels. Moreover, some ingredients of animal rations, such as soybean, often come from far away, with the consequent costs and risk of contamination from transport. All of these activities have a negative impact on the animal production sector, both economically and environmentally. One solution to these problems could be the use of local by-products for animal feeding.

Spain is one of the main artichoke-producing countries worldwide. Production is concentrated in the southeast region of the Iberian Peninsula, where in 2018, artichoke production exceeded 260,000 tons [2]. Only 50% of the harvested artichoke is used for human consumption, as the rest is made up of the bracts, stems of flower buds and inedible parts [3]. The farming of artichoke for the food market entails a great availability of these by-products, which can be used in animal feed.

In general, the composition of these by-products is similar to bean pods, characterized by a moderate content of neutral detergent fiber (NDF; 400-600 g/kg) and metabolizable
energy (ME; 1.72–1.90 Mcal/kg DM) and a medium-high crude protein concentration (CP; 160–200 g/kg; [4]), so the by-products could partially replace forages and protein concentrates in the diet, such as alfalfa or soybean cake. Artichoke by-product silage (ABS) has the appropriate fermentative conditions to ensure the nutritional quality and safety necessary to be part of the small ruminant ration [5,6], and can be preserved for long periods of time (up to 200 days according to Monllor et al. [6]). The references found in the literature about the effect of ABS consumption on milk quality and composition, as well as on the health status of the animals, are scarce [7–9]. Only Monllor et al. [10] and Muelas et al. [11] published studies about the use of ABS in dairy goats, where they observed that the inclusion of up to 25% in the diet had no effect on the milk yield and quality or on the sensory properties of yogurt made with milk from those animals. Jaramillo et al. [8] observed the same effects in Manchega ewes fed with this by-product silage at up to 30% of the TMR. Moreover, it is noted that the addition of agroindustrial by-products in the ruminant diet can affect the lipid profile of milk [12–18], contributing to its improvement by increasing polyunsaturated fatty acids (PUFA), such as vaccenic and rumenic acid [16].

The objective of this experiment was to study the effect of the inclusion of 25, 40 and 60% of ABS in the ration of Murciano-Granadina dairy goats on the milk yield, composition and quality, along with the health status of the animals, to determine the best level of inclusion of this by-product without harming the performance and health of the animals.

2. Materials and Methods

2.1. Animals and Facilities

Murciano-Granadina lactating goats used in this experiment were housed in the teaching and experimental farm of the Miguel Hernández University, with straw litter, access to outdoor pens, free access to water and an adequate feeding space for all animals (at least 35 cm/animal). The animals were fed twice a day, at 8:00 and 14:00, and milked once a day (Cassee milking parlor, 2 × 12 × 12, GEA, Bönen, Germany), as is usual in the region. This study was approved by the Ethical Committee of Experimentation of the Miguel Hernández University (code UMH.DTA.GRM.01.15).

2.2. Experimental Design

From a group of 100 goats that were in mid-lactation (fourth month) fed with a conventional diet (control, C), pre-experimental sampling was carried out and 36 animals were selected, with an average body weight (BW) of 41.9 ± 6.24 kg, a parity of 2.5 ± 0.484 lactations, an average milk yield of 2.25 ± 0.71 kg/day and a somatic cell count (SCC) of 5.63 ± 0.39 Log cells/mL. The animals were divided into four groups with homogeneous characteristics in terms of the cited variables.

A short-term experiment was carried out to study the effect of including ABS in the ration at three levels: 25% (ABS25), 40% (ABS40) and 60% (ABS60), expressed on a dry matter basis of the total ration. Artichoke by-product came from the canning industries of the region. All rations were calculated according to the formulation recommendations of Fernández et al. [19], with a calculated intake level of 2.2 kg DM/day, so that the four rations were isoenergetic and isoproteic. Table 1 shows the amounts of the ingredients in each diet, as well as their composition. The experiment lasted four weeks. It began with the pre-experimental control, which served to prepare four homogeneous groups. The first two weeks served as an adaptation phase to the diets, and in the following two weeks, three controls were carried out in the beginning, middle and end of the experiment, where BW, intake and milk yield were recorded, in addition to the collection of milk and blood samples.
Table 1. Ingredients and chemical composition of experimental diets.

| Item                        | C   | ABS25 | ABS40 | ABS60 |
|-----------------------------|-----|-------|-------|-------|
| Ingredients (g/100 g DM)    |     |       |       |       |
| Alfalfa hay                | 37.5| 13.2  | 4.83  | -     |
| Grain mix                  | 62.5| 61.8  | 55.8  | 29.0  |
| Oats                       | -   | -     | -     | 10.2  |
| ABS                        | -   | 24.7  | 38.7  | 60.0  |
| Premix vitamins/minerals   | -   | 0.311 | 0.696 | 0.880 |
| Chemical composition        |     |       |       |       |
| DM (g/kg FM)               | 872 | 422   | 322   | 231   |
| g/kg DM                    |     |       |       |       |
| OM                         | 932 | 936   | 936   | 920   |
| EE                         | 65.3| 57.7  | 58.5  | 48.9  |
| CP                         | 162 | 160   | 157   | 145   |
| NDF                        | 399 | 321   | 371   | 459   |
| ADF                        | 218 | 183   | 205   | 294   |
| ADL                        | 63.1| 40.8  | 36.2  | 116   |
| TP                         | 3.87| 7.95  | 7.75  | 14.7  |
| IVDMD                      | 715 | 739   | 804   | 769   |
| ME                         | 2.66| 2.13  | 2.51  | 2.44  |
| VFA and fermentative metabolites (g/kg DM) | | | | |
| Lactate                    | n.d.| 23.5  | 3.66  |
| Acetate                    | n.d.| 3.12  | 8.74  |
| Propionate                 | n.d.| 3.70  | n.d.  |
| Butyrate                   | n.d.| 2.49  | 23.7  |
| Ethanol                    | n.d.| 4.13  | 8.85  |
| Ammonia N                  | n.d.| 4.01  | 8.95  |
| Fatty acids profile (g/100 g total fatty acids) | | | | |
| C6:0                       | 0.061| 1.49  | 0.163 | 7.94  |
| C12:0                      | 0.183| 0.156 | 0.225 | 0.057 |
| C14:0                      | 0.440| 0.300 | 0.435 | 0.251 |
| C16:0                      | 17.2 | 18.4  | 16.8  | 14.0  |
| C16:1cis9                  | 0.300| 0.388 | 0.303 | 0.235 |
| C18:0                      | 3.25 | 3.25  | 3.05  | 1.54  |
| C18:1cis9                  | 26.4 | 23.0  | 27.0  | 18.6  |
| C18:1cis11                 | 1.06 | 0.962 | 1.16  | 0.798 |
| C18:2n6                    | 44.0 | 41.5  | 41.9  | 29.4  |
| C18:3n3                    | 4.07 | 2.83  | 4.48  | 4.85  |
| C20:0                      | 0.463| 0.440 | 0.414 | 0.47  |
| C20:1n9                    | 0.323| 0.297 | 0.373 | 0.375 |
| C22:0                      | 0.457| 0.439 | 0.449 | 0.121 |
| C24:0                      | 0.336| 0.368 | 0.457 | 0.439 |
| SFA                        | 23.3 | 30.5  | 23.9  | 45.1  |
| MUFA                       | 28.2 | 25.0  | 29.1  | 20.3  |
| PUFA                       | 48.7 | 44.5  | 47.2  | 34.8  |

| Mineral profile             |     |       |       |       |
| Na (g/kg DM)                | 2.89 | 2.59  | 3.28  | 3.11  |
| Mg (g/kg DM)                | 2.66 | 2.57  | 2.62  | 2.86  |
| K (g/kg DM)                 | 13.5 | 17.7  | 19.7  | 23.5  |
| Ca (g/kg DM)                | 5.90 | 6.24  | 5.64  | 5.33  |
| P (g/kg DM)                 | 2.76 | 3.95  | 3.64  | 4.00  |
| S (g/kg DM)                 | 2.89 | 2.94  | 2.71  | 2.89  |
| Se (mg/kg DM)               | 0.198| 0.288 | 0.119 | 0.100 |
| Zn (mg/kg DM)               | 49.4 | 73.8  | 55.4  | 46.5  |
| Cu (mg/kg DM)               | 6.15 | 7.42  | 6.63  | 8.20  |
| Fe (mg/kg DM)               | 129  | 230   | 133   | 160   |
| Mn (mg/kg DM)               | 42.1 | 51.5  | 31.7  | 28.3  |

C: Control diet; ABS: Artichoke bracts silage; DM: Dry matter; FM: Fresh matter; OM: Organic matter; EE: Ether extract; CP: Crude protein; NDF: Neutral detergent fiber; ADF: Acid detergent fiber; ADL: Acid detergent lignin; TP: Total polyphenols; IVDMD: In vitro dry matter digestibility; ME: Metabolizable energy; VFA: Volatile fatty acids; SFA: Saturated fatty acids; MUFA: Monounsaturated fatty acids; PUFA: Polyunsaturated fatty acids; n.d.: Not detected. \[20\].
2.3. Variables Analyzed

The BW of the animals (kg) was determined by weighing on a scale with a precision of 100 g (APC, Baxtran, Spain). The composition of the rations was determined on a dehydrated sample at 60 °C according to the procedures included in the AOAC [21] for dry matter (DM, g/kg; method 930.5), organic matter (OM, g/kg DM; method 942.05), ether extract (EE, g/kg DM; method 920.39) and CP (g/kg DM; method 984.13). The contents of NDF (g/kg DM), acid detergent fiber (ADF, g/kg DM) and acid detergent lignin (ADL, g/kg DM) were analyzed following the method of Van Soest et al. [22]. The content of total polyphenols (TP, g/kg DM) present in the rations was analyzed by the Folin-Ciocalteu method reported in Kim et al. [23] on fresh samples. The determination of volatile fatty acids (VFA) such as acetic, propionic and butyric acid, as well as other metabolites of silage fermentation, such as lactic acid and ethanol, was carried out according to the method proposed by Feng-Xia et al. [24], using HPLC liquid chromatography (Agilent 1200, Santa Clara, CA, USA), with a C610H column of 30 cm and 7.8 mm ID (Supelcogel, Saint Louis, MO, USA) on fresh ration samples. The apparent in vitro dry matter digestibility (IVDMD, g/kg DM) was analyzed in duplicate using the method of Menke and Steingass [25]. Analysis of the fatty acid profile in the diets was carried out by direct methylation on the lyophilized samples, without prior extraction of the fat, according to Kramer et al. [26], using methylated C19:0 as the internal standard (Sigma-Aldrich, St. Louis, MO, USA). The identification and quantification of the fatty acid methylated esters (FAMEs) was carried out with a flame ionization detector (FID) coupled to a GC-17A gas chromatograph (Shimadzu, Kyoto, Japan), equipped with a CP Sil 88 column of 100 m, 0.25 mm ID and 0.20 mm internal coverage (Agilent, Santa Clara, CA, USA). As standard, a mixture of FAME (18912-1AMP, Sigma-Aldrich, Saint Louis, MO, USA) was used. The feed consumption was calculated by the difference between the feed offered and refused, determining the dry matter by dehydration in an oven at 105 °C for 48 h of a representative sample of the feed rejected by the animals of each treatment.

For the analysis of minerals in the diets and milk, previous digestion of the samples was carried out according to González Arrojo et al. [27]. ICP-MS (Inductively Coupled Plasma-Mass Spectrometry) Agilent 7700x (Santa Clara, CA, USA) ORS (Octapole Reaction System) equipment was used to determine the concentrations of Na, Mg, K, Ca, P, S, Se, Zn, Cu, Fe and Mn. An internal standard was used to correct for physical and/or matrix interferences from the ICP-MS equipment.

The milk yield of the goats was measured with a Lactocorder device (WMB, Balgach, Switzerland) attached to the long milk tube of the milking equipment. The same Lactocorder also collected 100 mL of representative milk sample from the entire milking of each animal, for subsequent analysis of SCC and macrocomposition. The SCC of the milk samples was determined by a DCC item of equipment (DeLaval Cell Counter, DeLaval, Tumba, Sweden), using an electronic fluoro-optical method. The results were transformed to Log10 (LSCC) to get a normal distribution. The analysis of the milk macrocomposition and urea content was carried out by mid-infrared spectroscopy equipment (MilkoScan FT2, FOSS, Hillerød, Denmark) calibrated for goat milk. The variables analyzed were fat, protein, true protein, casein, whey protein, lactose, total solids (TS), non-fat total solids (NFTS), useful total solids (fat + protein, UTS), ash and urea. The milk yield corrected for fat was calculated, according to the equation of Gravert [28]: FCM (3.5%) = 0.433 × Yield (kg/day) + 16.218 × Fat yield (kg/day), and the milk yield corrected for fat and protein by:

\[
\text{FPCM} = \text{Yield (kg/day)} \times (0.337 + 0.116 \times \text{Fat} \% + 0.06 \times \text{Protein} \%)
\]

Analysis of the milk fatty acid profile was carried out by extracting the fat by the Folch method with some variations, as detailed in Romeu-Nadal et al. [30]. The fatty acids were methylated according to the method of Nudda et al. [31]. The equipment, column and mix of fatty acid standards were those previously described in the analysis of the lipid profile of the ration samples. Atherogenicity (IA) and thrombogenicity (IT) indices were calculated, according to Ulbricht and Southgate [32], and desaturation indices (ID) for C14: 0, C16:
0 and C18: 0, according to Lock and Garnsworthy [33]. The mineral analysis method for milk samples was the same as that used for feed samples.

Blood samples were analyzed by enzymatic spectrophotometry for the determination of glucose (mg/dL), urea (mg/dL) and β-hydroxybutyrate (BHB, mmol/L).

2.4. Statistical Analysis

The variables were analyzed according to a mixed linear model with repeated measures (PROC GLIMMIX. SAS v9.2, 2012), introducing in the model the covariate of the data obtained in the pre-experimental sampling, according to the following equation:

\[ Y = \mu + D_i + S_j + D_iS_j + \text{cov}Y_0 + A_k + e, \]

where \( Y \) is the dependent variable, \( \mu \) is the intercept, \( D_i \) is the fixed effect of the diet (\( i = \text{C}, \text{ABS25}, \text{ABS40}, \text{ABS60} \)), \( S_j \) is the fixed effect of the sampling (\( j = 1, 2, 3 \)), \( D_iS_j \) is the interaction of the diet with the sampling, \( \text{cov}Y_0 \) is the effect of the value of \( Y \) in sampling 0, \( A_k \) is the random effect of the animal and \( e \) is the residual error. For each variable, the covariance model that presented better modelling of the data (lower Akaike Information Criterion and Bayesian Information Criterion) was used.

3. Results

3.1. Body Weight and Milk Yield

The goats from group C presented a higher BW throughout the experiment, which led to a higher mean value (\( p < 0.05 \)) than those from the ABS treatments, with no differences between them, as shown in Table 2. The feed consumption was similar in all groups, although slightly higher in C (2.21 ± 0.006 kg DM/day). The feed intake of ABS treatments was 1.84 ± 0.099 kg DM/day for ABS25, 1.73 ± 0.069 kg DM/day for ABS40 and 1.91 ± 0.153 kg DM/day for ABS60.

Table 2. Body weight, milk yield and composition and SCC, according to the effects considered.

| Variable                   | Diets               | Significance |
|----------------------------|---------------------|--------------|
|                            | C      | ABS25 | ABS40 | ABS60 | SEM  | Diet | Sampling | Diet × Sampling |
| Average body weight (kg)   | 44.2 a | 42.4 b | 42.3 b | 42.2 b | 0.565 | *   | *        | ***              |
| Milk yield (kg/day)        | 2.39 a | 2.33 a | 2.26 ab | 1.91 b | 0.139 | *   | ns       |                |
| LSCC (Log_{10} cell/mL)   | 5.57   | 5.71  | 5.58  | 5.59  | 0.103 | ns  | **       | ns              |
| FCM (kg/day)               | 2.55 a | 2.46 ab | 2.50 a | 2.00 b | 0.163 | *   | ns       | ns              |
| Fat (%)                    | 3.74   | 3.97  | 4.04  | 4.20  | 0.205 | ns  | ns       | ns              |
| Protein (%)                | 3.35   | 3.33  | 3.40  | 3.41  | 0.079 | ns  | ns       | ns              |
| FPCM (kg/day)              | 2.37 a | 2.30 a | 2.30 a | 1.87 b | 0.142 | *   | ns       | ns              |
| UTS (%)                    | 7.12   | 7.31  | 7.44  | 7.57  | 0.223 | ns  | ns       | *               |
| True protein (%)           | 3.12   | 3.10  | 3.16  | 3.17  | 0.070 | ns  | ns       | ns              |
| Casein (%)                 | 2.66   | 2.64  | 2.73  | 2.70  | 0.062 | ns  | ns       | ns              |
| Whey protein (%)           | 0.462  | 0.470 | 0.433 | 0.457 | 0.018 | ns  | **       | ns              |
| Lactose (%)                | 4.24   | 4.22  | 4.33  | 4.25  | 0.045 | ns  | *        | ***             |
| Total solids (%)           | 12.0   | 12.2  | 12.4  | 12.3  | 0.227 | ns  | ns       | ns              |
| NFTS (%)                   | 8.72   | 8.72  | 8.84  | 8.71  | 0.099 | ns  | ns       | *               |
| Ash (%)                    | 0.618 ab | 0.656 a | 0.598 ab | 0.568 b | 0.032 | *   | ns       | ns              |
| Milk urea (mg/L)           | 597    | 549   | 533   | 542   | 24.4  | ns  | ns       | ns              |

C: Control diet; ABS: Artichoke bracts silage; SEM: Standard error of the mean; LSCC: Log_{10} somatic cell count; FCM: Fat-corrected milk (3.5%); UTS: Useful total solids (fat + protein); TS: Total solids; NFTS: Non-fat total solids; ab: Least square means within a column with different letters that differ significantly. * \( p < 0.05 \); ** \( p < 0.01 \); *** \( p < 0.001 \); ns: non significant.

The milk yield was lower (\( p < 0.05 \)) in animals fed with the higher level of inclusion of ABS, with no differences between c and ABS25 and ABS40. Similarly, FCM and FPCM also presented a lower value in ABS60 (\( p < 0.05 \)). Regarding the milk’s macrocomposition, only the ash content presented significant differences (\( p < 0.05 \), although of little magnitude,
ABS25 being the one that held the highest value (0.656%) and ABS60 the lowest (0.568%). The inclusion of ABS in the diet of dairy goats did not affect the urea milk content ($p > 0.05$).

### 3.2. Milk Mineral Profile

As can be observed in Table 3, only minor differences were found in the Mn milk content. The Mn content was higher in ABS40 and ABS60 ($p < 0.05$).

#### Table 3. Milk mineral profile according to the effects considered.

| Mineral | Diets | SEM | Significance |
|---------|-------|-----|--------------|
| Na (g/kg MS) | C | 2.59 | ABS25 | 2.44 | ABS40 | 2.50 | ABS60 | 2.96 | 0.314 | ns |
| Mg (g/kg MS) | C | 0.888 | ABS25 | 0.896 | 0.864 | ABS60 | 0.921 | 0.069 | ns |
| P (g/kg MS) | C | 6.00 | ABS25 | 5.98 | 6.38 | ABS40 | 5.91 | 0.437 | ns |
| S (g/kg MS) | C | 2.45 | ABS25 | 2.43 | 2.60 | ABS40 | 2.41 | 0.118 | ns |
| K (g/kg MS) | C | 12.0 | ABS25 | 12.5 | 11.4 | ABS40 | 11.5 | 0.724 | ns |
| Ca (g/kg MS) | C | 8.85 | ABS25 | 8.79 | 8.87 | ABS60 | 8.39 | 0.533 | ns |
| Mn (mg/kg MS) | C | 0.203 | ABS25 | 0.236 | ABS40 | 0.328 | ABS60 | 0.316 | 0.017 ** |
| Fe (mg/kg MS) | C | 2.95 | ABS25 | 2.72 | ABS40 | 2.72 | 2.34 | 0.304 | ns |
| Cu (mg/kg MS) | C | 0.697 | ABS25 | 0.522 | 0.474 | ABS40 | 0.378 | 0.066 | ns |
| Zn (mg/kg MS) | C | 28.3 | ABS25 | 23.3 | 25.9 | ABS40 | 21.3 | 3.54 | ns |
| Se (mg/kg MS) | C | 0.102 | ABS25 | 0.104 | 0.112 | ABS60 | 0.094 | 0.009 | ns |

C: Control diet; ABS: Artichoke bracts silage; SEM: Standard error of the mean; ab: Least square means within a column with different letters that differ significantly. ** $p < 0.01$; ns: non-significant.

### 3.3. Lipid Profile of Milk

The milk lipid profile of the animals in this experiment is detailed in Table 4. C presented a higher value than the rest in C18:2 cis9, trans13, C18:2 trans8, cis13, C20:0 and C18:3n3. A higher level of C18:1 trans9 was also found in C, whereas the lower the percentage of ABS included in the diet, the lower was the content of this fatty acid. In contrast, the C15:0, isoC16:0, C16:1 trans5 and C17:1 cis9 contents increased in line with the quantity of ABS present in the diet. ABS25 presented a similar value to C ($p > 0.05$) in C12:0, C18:0, C18:1 trans15, 16, C18:1 cis12 and C18:2n6 fatty acids, with the proportion of these fatty acids in milk decreasing as the ABS inclusion level became higher. ABS40 presented a higher content of C18:1 trans6-8, C18:1 trans11, C18:1 trans12, C18:2 trans11, cis15 and C20:2n9 than the rest of the treatments.

#### Table 4. Fatty acid composition (g/100 g total fatty acids) measured in milk according to the effects considered.

| Fatty Acid | Diets | SEM | Significance |
|------------|-------|-----|--------------|
| C4:0 | C | 2.20 | ABS25 | 2.75 | ABS40 | 2.79 | ABS60 | 2.75 | 0.239 | ns |
| C6:0 | C | 3.10 | ABS25 | 3.58 | ABS40 | 3.78 | 3.48 | 0.361 | ns |
| C7:0 | C | 0.053 | ABS25 | 0.043 | 0.071 | ABS60 | 0.054 | 0.007 | ns |
| C8:0 | C | 4.25 | ABS25 | 4.41 | 5.18 | 4.00 | 0.882 | ns |
| C9:0 | C | 0.064 | ABS25 | 0.068 | 0.083 | ABS40 | 0.080 | 0.007 | ns |
| C10:0 | C | 13.3 | ABS25 | 14.8 | 15.3 | 14.4 | 2.02 | ns |
| C10:1 c9 | C | 0.039 | ABS25 | 0.035 | 0.040 | ABS40 | 0.034 | 0.006 | ns |
| C11:0 | C | 0.186 | ABS25 | 0.172 | 0.168 | ABS60 | 0.186 | 0.008 | ns |
| C12:0 | C | 3.20 | ABS25 | 2.94 | 2.77 | 2.66 | 2.66 | 0.144 ** |
| C12:1 c9 | C | 0.032 | ABS25 | 0.027 | 0.025 | ABS60 | 0.025 | 0.004 | ns |
| iso C13:0 | C | 0.017 | ABS25 | 0.021 | 0.021 | ABS60 | 0.021 | 0.003 | ns |
### Table 4. Cont.

| Fatty Acid Diet | C  | ABS25 | ABS40 | ABS60 | SEM  | Significance |
|-----------------|----|-------|-------|-------|------|--------------|
| anteiso         |    |       |       |       |      |              |
| C13:0           | 0.025 | 0.029 | 0.023 | 0.030 | 0.003 | ns           |
| iso C14:0       | 0.055 | 0.051 | 0.052 | 0.070 | 0.007 | ns           |
| C14:0           | 7.61  | 7.07  | 6.63  | 6.98  | 0.334 | ns           |
| iso C15:0       | 0.167 | 0.162 | 0.139 | 0.162 | 0.026 | ns           |
| anteiso         |    |       |       |       |      |              |
| C15:0           | 0.233 | 0.192 | 0.199 | 0.213 | 0.012 | ns           |
| C14:1 c9        | 0.074 | 0.050 | 0.061 | 0.072 | 0.012 | ns           |
| C15:0           | 0.653 ab | 0.566 c | 0.605 bc | 0.689 a | 0.028 | ns           |
| C15:1           | 0.072 | 0.048 | 0.063 | 0.054 | 0.009 | ns           |
| iso C16:0       | 0.165 c | 0.201 b | 0.194 bc | 0.240 a | 0.013 | ***          |
| C16:0           | 21.6 | 20.7  | 20.0  | 23.3  | 2.03  | ns           |
| C16:1 c4        | 0.038 | 0.000 | 0.008 | 0.050 | 0.019 | ns           |
| C16:1 c5        | 0.024 b | 0.000 b | 0.000 b | 0.055 a | 0.013 | *           |
| C16:1 t6–7      | 0.106 | 0.072 | 0.115 | 0.092 | 0.062 | ns           |
| C16:1 t9        | 0.200 | 0.156 | 0.207 | 0.159 | 0.043 | ns           |
| C16:1 t10       | 0.028 | 0.015 | 0.029 | 0.001 | 0.016 | ns           |
| C16:1 t11–12    | 0.009 | 0.026 | 0.029 | 0.036 | 0.014 | ns           |
| C17:0           | 0.280 | 0.228 | 0.267 | 0.224 | 0.022 | ns           |
| C17:0           | 0.566 | 0.455 | 0.495 | 0.552 | 0.031 | ns           |
| C17:1 c6–7      | 0.040 | 0.054 | 0.050 | 0.049 | 0.007 | ns           |
| C17:1 c8        | 0.000 | 0.000 | 0.005 | 0.000 | 0.002 | ns           |
| C17:1 c9        | 0.095 b | 0.104 b | 0.116 b | 0.174 a | 0.014 | *           |
| iso C18:0       | 0.032 | 0.036 | 0.046 | 0.048 | 0.010 | ns           |
| C18:0           | 14.0 a | 13.8 a | 13.3 ab | 12.3 b | 0.657 | *           |
| C18:1 c4        | 0.070 | 0.048 | 0.068 | 0.060 | 0.010 | ns           |
| C18:1 t5        | 0.029 | 0.025 | 0.031 | 0.027 | 0.006 | ns           |
| C18:1 t6–8      | 0.197 a | 0.148 b | 0.187 a | 0.128 b | 0.013 | ***         |
| C18:1 t9        | 0.273 a | 0.232 b | 0.212 bc | 0.183 c | 0.017 | ***         |
| C18:1 t10       | 0.289 | 0.2000 | 0.110 | 0.167 | 0.079 | ns           |
| C18:1 t11       | 1.32 b | 1.22 b | 2.20 a | 0.881 b | 0.250 | *           |
| C18:1 t12       | 0.478 ab | 0.419 b | 0.510 a | 0.282 c | 0.024 | ***         |
| C18:1 t13–14    | 0.060 | 0.148 | 0.124 | 0.000 | 0.059 | ns           |
| C18:1 t15–16    | 0.425 a | 0.407 a | 0.350 b | 0.331 b | 0.014 | ***         |
| C18:1 c9        | 18.5  | 16.5  | 17.4  | 18.1  | 2.56  | ns           |
| C18:1 c11       | 0.056 | 0.051 | 0.042 | 0.007 | 0.044 | ns           |
| C18:1 c12       | 0.582 a | 0.537 a | 0.565 a | 0.462 b | 0.026 | **          |
| C18:1 t13       | 0.128 | 0.114 | 0.124 | 0.104 | 0.010 | ns           |
| C18:1 t15       | 0.207 | 0.204 | 0.195 | 0.178 | 0.009 | ns           |
| C18:2           | 0.268 a | 0.189 b | 0.194 b | 0.193 b | 0.015 | **          |
Table 4. Cont.

| Fatty Acid | Diets | SEM | Significance |
|------------|-------|-----|--------------|
|            | C     | ABS25 | ABS40 | ABS60 |
| C18:2 t8.c13 | 0.100 a | 0.081 b | 0.071 b | 0.074 b | 0.006 * |
| C18:2 c9.t12 | 0.157 | 0.101 | 0.095 | 0.093 | 0.017 ns |
| C18:2 t11.c15 | 0.011 b | 0.006 b | 0.027 a | 0.012 b | 0.004 ** |
| C18:2 n6 | 2.62 a | 2.56 ab | 2.88 a | 2.25 b | 0.171 * |
| C20:0 | 0.229 a | 0.214 b | 0.187 c | 0.209 b | 0.007 ** |
| C18:3n6 | 0.017 | 0.026 | 0.026 | 0.025 | 0.006 ns |
| C20:1 c9 | 0.013 | 0.001 | 0.007 | 0.007 | 0.006 ns |
| C20:1 c11 | 0.037 | 0.061 | 0.057 | 0.049 | 0.006 ns |
| C18:3n3 | 0.182 a | 0.146 b | 0.151 b | 0.134 b | 0.012 * |
| CLA c9.t11 | 0.446 | 0.433 | 0.631 | 0.401 | 0.187 ns |
| CLA t9.c11 | 0.044 | 0.041 | 0.041 | 0.037 | 0.006 ns |
| CLA t10.c12 | 0.025 | 0.020 | 0.018 | 0.033 | 0.010 ns |
| CLA t12.14 | 0.016 | 0.013 | 0.014 | 0.022 | 0.006 ns |
| C20:2n6 | 0.0031 | 0.040 | 0.036 | 0.038 | 0.007 ns |
| C20:2n9 | 0.0000 b | 0.000 b | 0.000 a | 0.000 b | 0.001 * |
| C20:3n9 | 0.073 | 0.073 | 0.054 | 0.057 | 0.008 ns |
| C22:0 | 0.024 | 0.026 | 0.018 | 0.024 | 0.007 ns |
| C20:4n6 | 0.146 | 0.145 | 0.142 | 0.164 | 0.011 ns |
| C23:0 | 0.025 | 0.030 | 0.023 | 0.028 | 0.006 ns |
| C22:2n6 | 0.000 | 0.016 | 0.015 | 0.005 | 0.008 ns |
| C24:0 | 0.048 | 0.0144 | 0.026 | 0.057 | 0.063 ns |

C: Control diet; ABS: Artichoke bracts silage; SEM: Standard error of the mean; abc: Least square means within a column with different letters that differ significantly. * p < 0.05; ** p < 0.01; *** p < 0.001; ns: non-significant.

These differences in the lipid profile translated into a higher content of PUFA and n6 acids in the milk of goats fed with the C and ABS40 diets compared to the ABS60 group (Table 5; p < 0.05). Regarding the indices related to the quality of the lipid profile in terms of the prevention of cardiovascular diseases, ABS40 presented a higher quality due to the lower values of AI and IT (1.90 and 3.05, respectively; p < 0.05). ABS60 showed higher desaturation activity of 18-carbon fatty acids compared to the C and ABS25 groups (p < 0.001).

3.4. Plasma Metabolite Profile

Table 6 shows the plasma metabolite values analyzed in the goats of the present experiment. Whereas no significant differences were found in glucose levels, there were in the plasma urea and BHB levels. Regarding urea, the animals from C presented a higher value than the rest (52.5 mg/dL; p < 0.001), and the urea content decreased as the ABS level of inclusion in the diet increased, so the animals from ABS60 presented the lowest value. Regarding the BHB content, the animals from the ABS25 treatment presented higher levels than those from C and ABS60 (p < 0.05).
Table 5. Grouped fatty acids (g/100 g total fatty acids) and indices related to cardiovascular health and desaturation activity in milk according to the effects considered.

| Variable       | C  | ABS25 | ABS40 | ABS60 | SEM | Significance |
|----------------|----|-------|-------|-------|-----|--------------|
| SFA            | 72.5 | 73.3  | 72.1  | 72.7  | 1.80 | ns           |
| MUFA           | 23.5 | 22.0  | 23.1  | 23.0  | 2.23 | ns           |
| PUFA           | 4.13 ab | 3.93 b | 4.37 a | 3.53 c | 0.192 *     |
| UFA            | 27.3 | 26.1  | 27.4  | 26.7  | 1.86 | ns           |
| SFA/UFA        | 2.65 | 2.83  | 2.68  | 2.74  | 0.255 ns |
| SCFA           | 23.1 | 25.6  | 27.1  | 24.8  | 3.57 | ns           |
| MCFA           | 36.4 | 34.2  | 33.4  | 36.7  | 1.44 | ns           |
| LCFA           | 39.9 | 40.1  | 39.2  | 37.9  | 2.77 | ns           |
| OBCFA          | 2.84 | 2.51  | 2.67  | 2.84  | 0.128 ns |
| ΣCLA           | 0.596 | 0.543 | 0.592 | 0.505 | 0.117 ns |
| n3             | 0.179 | 0.145 | 0.153 | 0.136 | 0.011 ns |
| n6             | 2.80 a | 2.77 ab | 3.06 a | 2.44 b | 0.173 *     |
| n6/n3          | 16.1 | 19.2  | 20.2  | 18.7  | 1.16 ns |
| Al             | 2.07 a | 2.09 a | 1.90 b | 2.10 a | 0.080 **    |
| TI             | 3.26 | 3.36 a | 3.05 b | 3.29 ab | 0.154 **    |
| DJ C14:0       | 0.009 | 0.007 | 0.009 | 0.011 | 0.002 ns |
| DJ C16:0       | 0.051 | 0.041 | 0.050 | 0.045 | 0.004 ns |
| DJ C18:0       | 1.56 b | 1.47 b | 1.66 ab | 1.78 a | 0.106 ***    |

C: Control diet; ABS: Artichoke bracts silage; SEM: Standard error of the mean; SFA: Saturated fatty acids; MUFA: Monounsaturated fatty acids; PUFA: Polyunsaturated fatty acids; UFA: Unsaturated fatty acids (MUFA + PUFA); SCFA: Short-chain fatty acids (C6:0 to C10:0); MCFA: Medium-chain fatty acids (C11:0 to C17:0); LCFA: Long-chain fatty acids (C18:0 to C24:0); AI: Atherogenic index; TI: Thrombogenic index; DI: Desaturation index; abc: Least square means within a column with different letters that differ significantly. *p < 0.05; **p < 0.01; ***p < 0.001; ns: non-significant.

Table 6. Plasmatic profile according to the effects considered.

| Variable       | C  | ABS25 | ABS40 | ABS60 | SEM | Significance |
|----------------|----|-------|-------|-------|-----|--------------|
| Glucose (mg/dL)| 44.8 | 46.3  | 47.0  | 44.5  | 1.44 | ns           |
| Urea (mg/dL)   | 52.5 a | 44.0 b | 39.5 bc | 35.1 c | 1.73 | ns           |
| BHB (mmol/L)   | 0.319 b | 0.524 a | 0.444 ab | 0.318 b | 0.054 | ns           |

C: Control diet; ABS: Artichoke bracts silage; SEM: Standard error of the mean; BHB: β-hydroxybutyrate; abc: Least square means within a column with different letters that differ significantly. *p < 0.05; **p < 0.01; ***p < 0.001; ns: non-significant.

4. Discussion

4.1. Body Weight and Milk Yield

Goats fed with ABS diets presented a slightly lower feed intake than those from C. This can be explained by the presence of fermentation metabolites in ABS diets and a higher TP content (Table 1), which reduced the food intake [34,35]. Another factor that could affect the outcome was the greater volume of the diet, as the inclusion of ABS increased the moisture content, as occurred in Monllor et al. [14] with a broccoli by-product and artichoke plant silages in dairy goats’ diet. However, as these differences in feed consumption were small, the differences in BW were not relevant.

Relative to milk yield, ABS60 presented a significant lower yield value (1.91 kg/day), without varying the fat and protein content, which led to lower FCM and FPCM contents (p < 0.05) in ABS60 than in the other treatments with ABS (2.00 and 1.87 kg/day). With the lowest levels of ABS (25 and 40%), significant differences versus C for milk yield, LSCC, FCM and FPCM were not observed, as occurred in Monllor et al. and Monllor et al. [10,36], with 25% of ABS or artichoke plant silage in the diet of dairy goats, respectively. The lack of effect of the ABS diet on milk composition is as reported by Muelas et al. [14].
4.2. Milk Mineral Profile

Although ABS40 and ABS60 had a higher level of Mn in milk, these differences were biologically irrelevant in comparison to C and ABS25. The milk mineral profile of the goats used in this experiment coincided with that shown by Stergiadis et al. [37] for typical goat milk.

4.3. Lipid Profile of Milk

Odd and branched chain fatty acids (OBCFA) are biomarkers of ruminal activity and have potential activity against metabolic diseases [38]. A higher OBCFA content in goat milk was observed as the ABS consumption rose. This was due to the higher concentration of NDF in these diets, which according to Patel et al. [39], entails a greater generation of ruminal VFA, which is a precursor of the synthesis of OBCFA. On the other hand, the higher content of other fatty acids in milk, such as linoleic (C18:2n6) in C and ABS25, was related to a higher content of those fatty acids in the diet [40].

ABS40 was the treatment with the best milk lipid profile because of a higher content of vaccenic acid (C18:1 trans11) in milk, due to a higher content of oleic acid in the diet, which acts as a precursor for the activity of Δ9-C18-desaturase in vaccenic acid synthesis [40]. The higher TP concentration in the ABS40 diet also helped to reach higher values of vaccenic acid and PUFA due to the inhibitory effect on ruminal fatty acids' biohydrogenation [41]. Considering that, the milk from ABS40 treatment showed the lowest AI and TI, so a better quality in terms of prevention of cardiovascular diseases was reached with this ABS inclusion [42].

4.4. Plasma Metabolite Profile

The plasma metabolite profile observed in the animals of this study was adjusted to that considered optimal for the goat species [43]. The lower blood urea content in goats fed with a higher dose of ABS in the diet was due to the higher TP content, which reduces the protein rumen digestibility by forming non-degradable complexes [44], thereby reducing ruminal N ammonia production and consequent urea synthesis in the liver [45]. Another reason why the blood urea content was lower in ABS groups was the slightly lower level of CP content of those diets [46].

5. Conclusions

The use of ABS in the diet of dairy goats is a potential alternative because it does not have negative effects on the milk yield and quality, or the health status of the animals. Of the three levels of inclusion studied in this experiment, 40% was the one that represented a greater inclusion of the by-product without penalizing the milk yield. In addition, the milk lipid profile quality improved with the diet with 40% ABS due to higher PUFA and n6 contents and lower AI and TI. In conclusion, the maximum inclusion level of ABS in dairy goats’ diet should be 40%. More studies carried out over a longer period and including its use in different stages of lactation are required.

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References
1. Sánchez-Rodríguez, M. Gestión práctica y económica de una explotación caprina. In Jornada de Gestión Práctica y Económica de Explotaciones Caprinas y Ovinas; INTEROVIC Y SEOC.; Salón Internacional de la Avicultura y Ganadería: Seville, Spain, 2014.
2. Ministerio de Agricultura; Pesca y Alimentación de España (MAPA). 2019. Available online: https://www.mapa.gob.es/es/estadistica/temas/estadisticas-agrarias/agricultura/esyrce/resultados-de-anos-anteriores/default.aspx (accessed on 6 July 2021).
3. Ros, M.; Pascual, J.A.; Ayuso, M.; Morales, A.B.; Miralles, J.R.; Solera, C. Estrategias Sostenibles Para un Manejo Integral de los Residuos y Subproductos Orgánicos de la Industria Agroalimentaria; Proyecto Life+ Agrowaste; CEBAS-CSIC, CTC y AGRUPAL: Murcia, Spain, 2012.
4. García-Rodríguez, J.; Ranilla, M.J.; France, J.; Alaiz-Moretón, H.; Carro, M.D.; López, S. Chemical Composition, In Vitro Digestibility and Rumen Fermentation Kinetics of Agro-Industrial By-Products. Animals 2019, 9, 861. [CrossRef]
5. Meneses, M.; Martínez-Marin, A.L.; Madrid, J.; Martínez-Teruel, A.; Hernández, F.; Megías, M.D. Enrslability, in vitro and in vivo values of the agro-industrial by-products of artichoke and broccoli. Environ. Sci. Pollut. Res. 2020, 27, 2919–2925. [CrossRef]
6. Monllor, P.; Romero, G.; Muelas, R.; Sandoval-Castro, C.A.; Sendra, E.; Díaz, J.R. Ensiling Process in Commercial Bales of Horticultural By-Products from Artichoke and Broccoli. Animals 2020, 10, 831. [CrossRef]
7. Marsico, G.; Ragni, M.; Vicenti, A.; Jambrenghi, A.C.; Tateo, A.; Giannico, F.; Vonghia, G. The quality of meat from lambs and kids reared on feeds based on artichoke (cynara scolymus L.) bracts. Acta Hortic. 2005, 681, 489–494. [CrossRef]
8. Jaramillo, D.; Buffa, M.; Rodriguez, M.; Pérez-Baena, I.; Guamis, B.; Trujillo, A.-J. Effect of the inclusion of artichoke silage in the ration of lactating ewes on the properties of milk and cheese characteristics during ripening. J. Dairy Sci. 2010, 93, 1412–1419. [CrossRef]
9. Salmon, F.M.; El-Nomeary, Y.A.A.; Abdo, A.A.; Abd El-Rahman, H.H.; Mohamed, M.I.; Ahmed, S.M. Utilization of artichoke (Cynara scolymus) by-products in sheep feeding. Am. Eurasian J. Agric. Environ. Sci. 2014, 14, 624–630.
10. Monllor, P.; Romero, G.; Sendra, E.; Atzori, A.S.; Díaz, J.R. Short-Term Effect of the Inclusion of Silage Artichoke By-Products in Diets of Dairy Goats on Milk Quality. Animals 2020, 10, 339. [CrossRef] [PubMed]
11. Muelas, R.; Monllor, P.; Romero, G.; Sayas-Barberá, E.; Navarro, C.; Díaz, J.R.; Sendra, E. Milk Technological Properties as Affected by Including Artichoke By-Products Silages in the Diet of Dairy Goats. Foods 2017, 6, 112. [CrossRef] [PubMed]
12. Liotta, L.; Randazzo, C.L.; Russo, N.; Zumbo, A.; Di Rosa, A.R.; Caggia, C.; Chiofalo, V. Effect of Molasses and Dried Orange Pulp as Sheep Dietary Supplementation on Physico-Chemical, Microbiological and Fatty Acid Profile of Comisana Ewe’s Milk and Cheese. Front. Nutr. 2019, 6, 1. [CrossRef] [PubMed]
13. Campione, A.; Natalello, A.; Valenti, B.; Luciano, G.; Rufino-Moya, P.J.; Avondo, M.; Morbidini, L.; Pomente, C.; Krol, B.; Wilk, M.; et al. Effect of Feeding Hazelnut Skin on Animal Performance, Milk Quality, and Rumen Fatty Acids in Lactating Ewes. Animals 2020, 10, 588. [CrossRef] [PubMed]
14. Monllor, P.; Muelas, R.; Roca, A.; Atzori, A.S.; Díaz, J.R.; Sendra, E.; Romero, G. Long-Term Feeding of Dairy Goats with Broccoli By-Product and Artichoke Plant Silages: Milk Yield, Quality and Composition. Animals 2020, 10, 1670. [CrossRef]
15. Nudda, A.; Cannas, A.; Correddu, F.; Atzori, A.S.; Lunesu, M.F.; Battacone, G.; Pulina, G. Sheep and Goats Respond Differently to Feeding Strategies Directed to Improve the Fatty Acid Profile of Milk Fat. Animals 2020, 10, 1290. [CrossRef] [PubMed]
16. Correddu, F.; Lunesu, M.F.; Buffa, G.; Atzori, A.S.; Nudda, A.; Battacone, G.; Pulina, G. Can Agro-Industrial By-Products Rich in Polyphenols be Advantageously Used in the Milk and Nutrition of Dairy Small Ruminants? Animals 2020, 10, 131. [CrossRef] [PubMed]
17. Altomonte, I.; Salari, F.; Licitra, R.; Martini, M. Use of microalgae in ruminant nutrition and implications on milk quality—A review. Livest. Sci. 2018, 214, 25–35. [CrossRef]
18. Halmemies-Beauchet-Filleau, A.; Shingfield, K.J.; Simpura, I.; Kokkonen, T.J.; Jaakkola, S.; Toivonen, V.; Vanhatalo, A. Effect of incremental amounts of camellia oil on milk fatty acid composition in lactating cows fed diets based on a mixture of grass and red clover silage and concentrates containing camellia expeller. J. Dairy Sci. 2017, 100, 305–324. [CrossRef]
19. Fernández, C.; Sánchez-Séiquer, P.; Navarro, M.; García, C. Modeling the Voluntary Dry Matter Intake in Murciano-Granadina Dairy Goats; 1st Joint Seminar of the FAO-CIHEAM Sheep and Goat Nutrition and Mountain and Mediterranean Pastures Subnetworks; CIHEAM-IAMZ: Granada, Spain, 2003; p. 96.
20. INRA. Alimentation des Bovins, Ovins et Caprins; Jarrige, R., Ed.; INRA: Paris, France, 1988; p. 471.
21. AOAC. Official Methods of Analysis, 16th ed.; Cunniff, P., Ed.; Association of Official Analytical Chemists: Washington, WA, USA, 1999.
22. Van Soest, P.J.; Robertson, J.B.; Lewis, B.A. Methods for dietary neutral detergent fibre and nonstarch polysaccharides in relation to animal nutrition. J. Dairy Sci. 1991, 74, 3583–3597. [CrossRef]
23. Kim, D.-O.; Jeong, S.W.; Lee, C.Y. Antioxidant capacity of phenolic phytochemicals from various cultivars of plums. Food Chem. 2003, 81, 321–326. [CrossRef]

24. Liu, F.-X.; Fu, S.-F.; Bi, X.-F.; Chen, F.; Liao, X.-J.; Hu, X.-S.; Wu, J.-H. Physico-chemical and antioxidant properties of four mango (Mangifera indica L.) cultivars in China. Food Chem. 2013, 138, 396–405. [CrossRef]

25. Menke, K.H.; Steingass, H. Estimation of the energetic feed value obtained from chemical analysis and in vitro gas production using rumen fluid. Anim. Res. 1988, 23, 103–116.

26. Kramer, J.K.G.; Fellner, V.; Dugan, M.E.R.; Sauer, F.D.; Mossoya, M.M.; Yurawecz, M.P. Evaluating acid and base catalysts in the methylation of milk and rumen fatty acids with special emphasis on conjugated dienes and total trans fatty acids. Lipids 1997, 32, 1219–1228. [CrossRef]

27. González-Arroyo, A.; Soldado, A.; Vicente, F.; Fernández-Sánchez, M.L.; Sanz-Medel, A.; de la Roza-Delgado, B. Changes on levels of essential trace elements in selenium naturally enriched milk. J. Food Nutr. Res. 2016, 4, 303–308.

28. Gravert, H.O. Dairy Cattle Production; Elsevier Science: New York, NY, USA, 1987; p. 234.

29. Schau, E.M.; Fet, A.M. LCA studies of food products as background for environmental product declarations. Int. J. Life Cycle Assess. 2008, 13, 255–264. [CrossRef]

30. Romeu-Nadal, M.; Morera-Pons, S.; Castellratamiento, A.I.; López-Sabater, M.C. Comparison of two methods for the extraction of fat from human milk. Anal. Chim. Acta 2004, 513, 457–461. [CrossRef]

31. Nudda, A.; McGuire, M.; Battacone, G.; Pulina, G. Seasonal Variation in Conjugated Linoleic Acid and Vaccenic Acid in Milk Fat of Sheep and its Transfer to Cheese and Ricotta. J. Dairy Sci. 2005, 88, 1311–1319. [CrossRef]

32. Ulbricht, T.L.; Southgate, D.A. Coronary heart disease: Seven dietary factors. Lancet 1991, 338, 985–992. [CrossRef]

33. Lock, A.; Garnsworthy, P. Seasonal variation in milk conjugated linoleic acid and D9-desaturase activity in dairy cows. Livest. Prod. Sci. 2003, 79, 47–59. [CrossRef]

34. Huhtanen, P.; Rinne, M.; Nousiainen, J. Evaluation of the factors affecting silage intake of dairy cows: A revision of the relative silage dry-matter intake index. Animals 2007, 1, 758–770. [CrossRef] [PubMed]

35. Decandia, M.; Sitzia, M.; Cabiddu, A.; Kababya, D.; Molle, G. The use of polyethylene glycol to reduce the anti-nutritional effects of tannins in goats fed woody species. Small Rumin. Res. 2000, 38, 157–164. [CrossRef]

36. Monllor, P.; Romero, G.; Atzori, A.S.; Sandoval-Castro, C.A.; Ayala-Burgos, A.J.; Roca, A.; Sendra, E.; Díaz, J.R. Composition, Mineral and Fatty Acid Profiles of Milk from Goats Fed with Different Proportions of Broccoli and Artichoke Plant By-Products. Foods 2020, 9, 700. [CrossRef] [PubMed]

37. Stergiadis, S.; Nørskov, N.P.; Purup, S.; Givens, I.; Lee, M.R.F. Comparative Nutrient Profiling of Retail Goat and Cow Milk. Nutrients 2019, 11, 2282. [CrossRef]

38. Pfeuffer, M.; Jaudszus, A. Pentadecanoic and Heptadecanoic Acids: Multifaceted Odd-Chain Fatty Acids. Adv. Nutr. 2016, 7, 730–734. [CrossRef]

39. Patel, M.; Wredle, E.; Bertilsson, J. Effect of dietary proportion of grass silage on milk fat with emphasis on odd- and branched-chain fatty acids in dairy cows. J. Dairy Sci. 2013, 96, 390–397. [CrossRef] [PubMed]

40. Ferlay, A.; Bernard, L.; Meynadier, A.; Malpuech-Bruguière, C. Production of trans and conjugated fatty acids in dairy ruminants and their putative effects on human health: A review. Biochimie 2017, 141, 107–120. [CrossRef]

41. Corredru, F.; Fancello, F.; Chessa, L.; Atzori, A.; Pulina, G.; Nudda, A. Effects of supplementation with exhausted myrtle berries on rumen function of dairy sheep. Small Rumin. Res. 2018, 170, 51–61. [CrossRef]

42. Ganguly, R.; Hasanally, D.; Stamenkovic, A.; Maddaford, T.G.; Chaudhary, R.; Pierce, G.N.; Ravandi, A. Alpha linolenic acid decreases apoptosis and oxidized phospholipids in cardiomyocytes during ischemia/reperfusion. Mol. Cell. Biochem. 2017, 437, 163–175. [CrossRef] [PubMed]

43. Rivas, J.; Rossini, M.; Colmenares, O.; Salvador, A.; Morantes, M.; Valerio, D. Effect of feeding on the profile metabolic goats in canary in the tropics. In Proceedings of the 4th Symposium of the Latin American Association in Animal Science, Quevedo, Ecuador, 13–15 November 2014; pp. 125–132.

44. Ghasemi, S.; Naserian, A.A.; Valizadeh, R.; Tahmasebi, A.M.; Vakili, A.R.; Behgar, M. Effects of pistachio by-product in replacement of lucerne hay on microbial protein synthesis and fermentative parameters in the rumen of sheep. Anim. Prod. Sci. 2012, 52, 1052. [CrossRef]

45. McMahon, L.; McAllister, T.; Berg, B.; Majak, W.; Acharya, S.; Popp, J. A review of the effects of forage condensed tannins on ruminal fermentation and bloat in grazing cattle. Can. J. Plant. Sci. 2000, 80, 469–485. [CrossRef] [PubMed]

46. Rapetti, L.; Bava, L. Feeding management of dairy goats in intensive systems. In Dairy Goats Feeding and Nutrition; Cannes, A., Pulina, G., Eds.; CABI Editorial: Wallingford, UK, 2008; p. 221.