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Effects of the inclusion of detoxified argan press cake in the diet of dairy goats on milk production and milk quality

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Abstract: This study was carried out to assess the effect of the incorporation of detoxified argan press cake on milk yield, physicochemical composition, and microbial quality of raw Alpine goat milk produced in the Meskala-Essaouira region of southwestern Morocco. The detoxification method, adopted for the removal of saponin present in the argan press cake, succeeded in reducing these antinutrients from 4.56 to 0.4 mg/g, allowing it to be used as livestock feed. The average of milk production increased by 24% for the detoxified argan press cake (DAPC) group compared to the argan press cake and local diet groups. The diets and lactation stages had a significant effect ($P < 0.05$) on fat, protein, total solids, and salt in milk. Lactation stage and diet also had a significant effect ($P < 0.001$) on saponin concentrations in goat milk. Microbiological analysis showed that microbial flora of raw goat milk samples decreased with lactation stage. In terms of performance, DAPC could replace a conventional diet for goats without substantial detrimental effects.

Key words: Argan press cake, detoxified, goat, milk content

1. Introduction

Goat farming in Morocco is considered an important socioeconomic sector. The goat population occupies the 2nd place in Moroccan farming after the sheep population, estimated at around 5.3 million heads (1). Its milk production represents only 34 tons annually (1). This breeding represents an important source of income for breeders. However, ruminants in Morocco's arid and semiarid areas suffer from lack of forage production and water availability due to low precipitation (2). Therefore, animal performance is usually limited by forage availability. For these reasons, it was necessary to contribute to the development of native forage resources adapted to local climate and soil conditions as an alternative resource (3). Among such native resources, argan tree (*Argania spinosa*) is endemic in southwestern Morocco, which provides important byproducts (press cake and pulp) and is one of the few alternative forage resources for livestock in dry areas (4).

Argan press cake (APC), left as a byproduct after oil extraction from argan seed, has traditionally been used for livestock feeding in the arid and semiarid regions of Morocco. It constitutes a potential nutrient source for animals, especially during the dry season, and may reduce the negative effects of drought on livestock performance. Unlike other forages, APC has high levels of dry matter (91%), crude protein (48.4%), crude fiber (17.6%), and fat (18.9%). In addition, it contains significant levels of calcium (6.9 g/kg), phosphorus (6.4 g/kg), and potassium (10.4 g/kg) (5). On the other hand, it contains low levels of ash (3.6%) (6) and magnesium (3.3 g/kg) (5).

The high protein level in APC represents an important alternative to supply the protein requirements of Moroccan livestock, where protein is a limiting factor for animal production (7). APC contains not only proteins but also antinutritional factors such as saponins (4%) (8), which give it a bitter taste. The astringent and irritating flavor of saponins reduces feed intake (9). Animals fed with high levels of APC may present weight loss or digestive

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problems owing to the presence of saponin components, which prevents the permeability and reduces the motility of the intestines, as well as inhibiting active nutrient transport. Moreover, saponins affect various digestive enzymes, including trypsin and chymotrypsin, and are also reported to reduce protein degradation by forming sparingly digestible saponin–protein complexes (10).

Saponins appear to alter the quality of milk by transmitting an unpleasant taste and leading to severe diarrhea in young ruminants (11), eventually reducing animal performance. Detoxification of APC can be an effective strategy to reduce the incidence of saponin compounds.

Detoxified APC, developed at the National Institute of Agronomic Research (INRA) in Rabat (Morocco), is characterized by richness in nutrients compared to conventional diets, and it is a valuable method for untapped proteins. It is a strategic protein resource in filling the gap in feed rations in Moroccan livestock. The objective of this study was to evaluate the incorporation of detoxified APC in the diets of lactating dairy goats, and also the effect on milk quality and quantity.

2. Materials and methods

2.1. Experimental design, animals, and diets

The use of the animals and the experimental procedures were approved by the Animal Care Committee, Sheep and Goat Association (ANOC), Provincial Directorate of Agriculture Essaouira (DPAR), and National Institute of Agronomic Research, Rabat, Morocco.

The experiment lasted for 90 days in the Meskala area (31°30′N, 9°30′W), located 50 km from Essaouira (southwestern Morocco). The climate is typical Mediterranean with dry summers and humid winters, and the average annual rainfall is about 300 mm. The mean temperature for the hottest month is 33–35 °C while it is 6–7 °C for the coldest one.

Feeding trials were conducted on a farm using 18 goats of the Alpine breed, with average body weights ranging from 40 to 45 kg and the same lactation stages. The animals were allocated to three experimental groups receiving three nutritional diets, which were distributed twice daily (morning and evening), and they had free access to water. The first group was given a total ration consisting of detoxified APC, corn silage, alfalfa, wheat bran, ground carob, barley, and minerals/vitamins complement. The second group was fed with APC with no detoxification, corn silage, alfalfa, wheat bran, ground carob, barley, and minerals/vitamins complement. The last one was given a diet containing concentrate, corn silage, and alfalfa. The percentages and chemical compositions of each ingredient in all diets are shown in Tables 1 and 2. Milk samples were collected after 15 days to allow the animal to adapt to the new diets.

2.2. Preparation of detoxified argan press cake

After optimization of the detoxification method, the optimum conditions consisted of placing the APC in distilled water, boiled at 80 °C for 25 min, followed by drying at 40 °C in a hot air oven.

2.3. Milk production study

Milk production was determined weekly before feeding goats. During the suckling phase, the kids were separated from their dams 24 h before collecting the samples. Then the goats were milked at both morning (0800 hours) and evening (1600 hours) periods. The daily milk production was the sum of the two milkings (12). Milk sample products were collected aseptically from all animals. Raw milk was obtained by hand-milking directly into sterile bottles without preservative before being stored at 4 °C. All samples were analyzed immediately after arrival at the laboratory to carry out microbiological and physicochemical analysis.

Table 1. Chemical composition of various ingredients used in the diets.

Ingredients	DM (%)	CF (%DM)	CP (%DM)	Ash (%DM)	EE (%DM)	Saponin (mg/g DM)
Detoxified argan press cake	89.14	13.65	47.43	3.10	17.05	0.4
Nondetoxified argan press cake	93.02	16.72	48	4.75	23.45	4.56
Corn silage	85.81	17	8	7.30	3.02	-
Alfalfa	98.6	14.6	19.6	8.8	3.7	-
Wheat bran	88.2	12.3	15.4	7.1	1.7	-
Ground carob	91.3	7.4	6.4	4.9	2.4	-
Barley	85.57	7.67	10.90	1.80	1.86	-
Concentrate	87.77	12.06	19.18	6.80	3.17	-

DM: Dry matter; CF: crude fiber; CP: crude protein; EE: ether extract.

Table 2. Ingredients and chemical composition of the diets.

	DAPC	APC	LD
Ingredients (g/100 g of fresh matter)			
Detoxified argan press cake	20%	0	0
Nondetoxified argan press cake	0%	20%	0
Corn silage	16%	16%	50%
Alfalfa	17%	17%	35%
Wheat bran	15%	15%	0
Ground carob	16%	16%	0
Barley	14%	14%	0
Concentrate	0	0	15%
Minerals and vitamins	2%	2%	0
Composition			
Dry matter (%)	89.59	88.12	88.14
Crude protein (%)	17.95	18.05	15.6
Ash (%)	7.58	8.23	10.01
Crude fiber (%)	18.15	15.27	17.10
Ether extract (%)	3.22	4.53	1.78
FU/kg DM	0.86	0.86	0.79
Feed intake (kg DM/day)	1.75	0.90	1.25
P (%)	6.69	5.91	4.46
Ca (%)	7.5	6.8	5.3
Mg (%)	5.8	5.5	5.3
Zn (%)	2.5	3.00	2.00

FU: Feed unit; P: phosphorus; Ca: calcium; Mg: magnesium; Zn: zinc.

2.4. Milk microbiological analysis

Milk samples (1 mL) were aseptically pipetted into tubes containing 9 mL of sterile peptone water and mixed by shaking for 30 s; the milk dilutions selected ranged from 10^{-1} to 10^{-6}.

Total mesophilic aerobic flora counts were detected using plate count agar (PCA) medium incubated at 37 °C for 24 h. Total and fecal coliform enumerations were carried out on violet red bile lactose agar after an incubation period of 24 h at 30 °C and 44 °C, respectively. Lactic acid bacteria were counted on Rogosa and Sharpe agar media after incubation for 48 h at 30 °C. Staphylococci were determined on Baird Parker agar followed by incubation at 37 °C for 48 h. Sabouraud dextrose agar with chloramphenicol was used for yeast and mold counts and incubated at 30 °C for 48 h (13).

After incubation, all typical colonies were enumerated and recorded as colony forming units per milliliter of milk (CFU/mL).

2.5. Physical and chemical analyses

2.5.1. LACTOSCAN milk analyzer

The milk samples' composition (fat, solids-not-fat (SNF), density, proteins, lactose, salts, and freezing point), directly after collecting, was determined in triplicate using a calibrated autoanalyzer (LACTOSCAN milk analyzer) for goat milk (14).

2.5.2. pH milk analyzer

The pH of goat milk samples was measured using a digital pH meter (CyberScan pH 1500, Eutech Instruments).

2.5.3. Feed diets analysis

Samples of ingredients and feeds were ground (1 mm) and stored in airtight plastic containers at room temperature until further use. Dry matter (DM), ash, ether extract (EE), crude fiber (CF), and crude protein (CP) contents were determined according to the methods outlined by the AOAC (14).

2.5.4. Mineral composition

Samples of feed and milk were analyzed by atomic absorption spectrometry in flame air-acetylene for calcium (Ca^{2+}), magnesium (Mg^{2+}), iron (Fe^{2+}), copper (Cu^{2+}), and zinc (Zn^{2+}). The absorbance measurement was performed at a specific wavelength of 248.3 nm. Sodium (Na^{+}) and potassium (K^{+}) were determined using a flame photometer while phosphorus (P) content was determined by the reaction of the acidified solution of ammonium molybdate including ascorbic acid and antimony (15). The absorption was measured at 825 nm with a UV-visible spectrophotometer (Jenway 6405 UV/VIS spectrometer).

2.6. Extraction and determination of saponins

Extraction of saponins from samples of feed and goat milk was carried out according to the method of Charrouf (16). Total saponin content was spectrophotometrically determined according to the procedure previously described by Hiai et al. (17).

2.7. Statistical analysis

The effects of the diet and lactation week factors as well as their interaction on milk yield, raw milk composition, and total aerobic flora were assessed using the statistical method of analysis of variance (ANOVA). Since the week factor is a temporal one, and in order to take into account that two measurements taken at two nearer times are more likely to be similar than two others made at farther times, a repeated measurement model was considered for ANOVA to take into account temporal correlations. Also, to consider that measurements made on the same animal are likely to be more similar than those made on different animals, the animal factor was included in the model and was considered as random, whereas the two others (diet and lactation week) were considered as fixed factors, thus

leading to a mixed model. Different correlation structures were tried. The best structure was selected based on the Akaike information criterion (AIC). The results are shown as a mean ± standard deviation, and the pairwise comparison of means was evaluated using the test of the differences of the least squares means. Significant differences were considered at $P < 0.05$.

3. Results and discussion

3.1. Detoxification of argan press cake

The detoxification of APC by heating in water at 80 °C for 25 min and at a ratio of 1:12.5 g/mL (w:v) allowed to reduce its contents of saponin to 0.4 mg/g, a 91% decrease of saponin contents as compared to the initial saponin contents (4.56 mg/g). A combination of soaking and heating processes caused a high loss of saponin contents in the processed APC. The thermal treatments have greater effects on saponin degradation because the linkage bond between aglycone and the sugar chain would be broken (18), and the aglycone may also be decomposed when high energy is applied, such as with heating at higher temperatures. Therefore, thermolabile saponins degraded during heating (19).

3.2. Dietary treatments and intake

Ingredients percentage and chemical composition of the experimental diets are shown in Tables 1 and 2. The first experimental diet, called detoxified argan press cake (DAPC), contained 20% of the detoxified APC as protein and fatty matter source; corn silage, alfalfa, and wheat bran (16%, 15%, and 17%, respectively) as fiber sources; ground carob (16%) as carbohydrate source; and 2% of a vitamin and mineral complement. The second experimental diet, argan press cake (APC), contained the same ingredient percentage, except that the detoxified APC was replaced by crude APC (nondetoxified). The third diet was based on conventional feeds normally used by local farmers (local diet, LD), containing corn silage (50%), alfalfa (35%), and concentrate (15%). In this study, the DAPC and LD diets had high dry matter intake (DMI) (1.75 and 1.27 kg/day, respectively), while for the APC diet the DMI was 0.90 kg/day. The animals used in this feeding trial consumed the detoxified APC without any notable trouble. On the contrary, it was noticed that the group fed nondetoxified APC suffered from a loss of appetite and weight owing to the saponin content.

The first two experimental diets (DAPC and APC) contained more CP (17.95% and 18.05%, respectively) than LD did (15.6%). Mohaddach et al. (20) reported lower values of protein, which might be due to the percentage of APC (13%) in the diet that they used in their work.

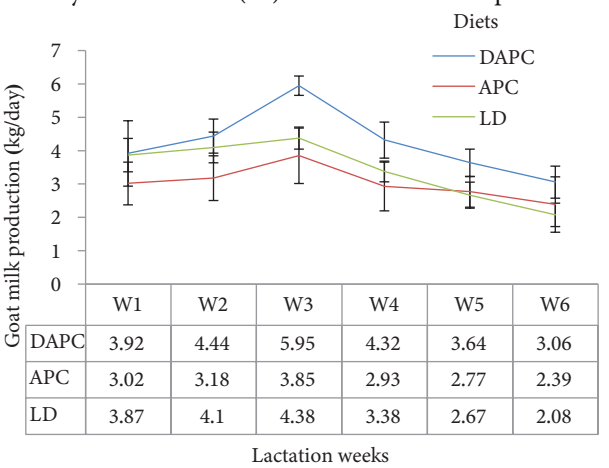
The DAPC contained more CF (18.15%) than the APC and LD diets (15.27% and 15.93%, respectively). On the other hand, DAPC contained less ash (7.58%) than the APC and LD diets (8.23% and 10.81%, respectively), on a DM basis (Table 2).

There were no differences in Mg content in the three different diets; however, contents of phosphorus (P), calcium (Ca), and zinc (Zn) were higher in the DAPC diet compared to the APC and LD diets (Table 2).

3.3. Milk production

Lactation is a physiological process requiring an increase in protein, energy, and fluid intake to satisfy the needs of milk production. The average amount of milk produced during the 6 weeks of lactation (daily milk yield for a period of 6 weeks) for the DAPC, APC, and LD diets was 177, 126, and 143 kg, respectively, meaning an increase of milk production of 24% after comparing the three groups. In addition, it is known that milk quantity is affected by several factors including breed, stage of lactation, milking system, and goat feeding. In our case, the results show that milk quantity was affected by feeding, which was in accordance with previously cited work by Zamberlin et al. (21). On the other hand, it is interesting to note that during the feeding trial the voluntary feed intake of APC goats was low compared to other groups due to the bitter taste of the APC, which led to a decrease in their milk performance.

The peak of lactation was reached at the 3rd week for all diets (Figure). The daily milk yield of dairy goats fed with DAPC was significantly higher ($P < 0.001$) than that of APC and LD with means of 4.22, 3.02, and 3.41 kg/day, respectively (Figure). These results are in accordance with those reported for the same breed by Lefrileux et al. (3.51 and 3.77 kg/day, respectively) (22). They are close to those found by Kouniba et al. (23) in the milk of the Alpine breed



	W1	W2	W3	W4	W5	W6
DAPC	3.92	4.44	5.95	4.32	3.64	3.06
APC	3.02	3.18	3.85	2.93	2.77	2.39
LD	3.87	4.1	4.38	3.38	2.67	2.08

Figure. Evolution of weekly milk production for the three diets. DAPC: Detoxified argan press cake diet; APC: nondetoxified argan press cake diet; LD: local diet. Each value is mean ± SD (standard deviation) of triplicate analysis.

(4 kg/day), but a lower value was found in goat's milk of the Moroccan local breed (2 kg/day).

3.4. Microbiological profile of raw goat milk

In general, microbial quality is important for milk preservation and/or transformation. The results obtained by an enumeration of the different microbial flora of raw goat milk samples are summarized in Table 3. The results show that goat milk collected from the DAPC and LD groups has more load microbial compared to the goat milk collected from the nondetoxified APC group. The total aerobic mesophilic flora number is considered as a sanitary indicator of raw milk quality. Raw milk was contaminated for the three diets; the load of total aerobic mesophilic flora during lactation weeks ranged between 0.05×10^5 and 1.5×10^5 CFU/mL for DAPC, 0.07×10^4 and 2×10^4 CFU/mL for APC, and 0.86×10^5 and 2.1×10^5 CFU/mL for LD. These values were low compared to those reported by Picoli et al. (24).

The fecal coliform levels ranged between 0.01×10^4 and 2×10^4 CFU/mL with an average of 0.65×10^4 CFU/mL for the DAPC diet, and between 0.04×10^3 and 9.3×10^3 CFU/mL with an average of 2.5×10^3 CFU/mL for the APC diet, whereas it ranged between 0.11×10^3 and 1.4×10^4 CFU/mL with an average of 4.5×10^3 CFU/ml for the LD diet. The presence of contaminating fecal microorganisms is indicative of poor hygienic conditions during milk production.

A previous Moroccan study showed that there are generally high levels of fecal coliforms in raw milk ranging from 3.4×10^4 to 2.4×10^6 CFU/mL, which is similar to the current study (25).

Picoli et al. (24) found an average of 1.5×10^7 CFU/mL of total coliforms, higher than the average levels that we found (10^5, 0.31×10^5, and 10^5 CFU/mL for DAPC, APC, and LD diets, respectively). This can be explained by the way milk is collected and handled, the stage of lactation, hygienic practices of milk production, and the disparity of regions.

The average staphylococcal load in raw milk samples was higher for LD (5.7×10^2 CFU/mL), followed by DAPC (3.6×10^2 CFU/mL) and APC (0.38×10^2 CFU/mL). These values are in accordance with the average level (3.02×10^2 CFU/mL) found for Alpine and Saanen breeds (26).

Lactic acid bacteria (LAB) were prevalent in the milk of the three diets (DAPC, APC, and LD). Higher levels of LAB were found in the DAPC diet, followed by the LD and APC diets, with average values of 6.8×10^5, 5.5×10^5, and 1.2×10^5 CFU/mL, respectively. Zantar et al. (27) reported lower values of LAB for milk of a Moroccan goat breed.

The average load of yeasts and molds was 10^4, 0.038×10^4, and 1.4×10^4 CFU/mL for the DAPC, APC, and LD diets, respectively. These values are higher than the average levels (4.9×10^3 CFU/mL) found in Moroccan raw milk by El Marnissi et al. (28).

Overall, the microbiota of raw milk can be influenced by the combination of several factors, including animal feeding systems with outside and inside grazing, seasonal variation, geographical farm location, bedding, and milking procedures. Since all the factors were stabilized, our results showed that the feeding factor had an effect on goat milk flora. Microbial counts in the DAPC and LD groups were higher than those of APC, likely due to the presence of saponins.

3.5. Physicochemical characteristics of goat milk

The yield and composition of goats' milk vary widely and are affected by several factors such as breed, stage of lactation, locality, age, milking system, and goat feeding. In our study, the results show that milk quality and quantity were affected by feeding. Table 4 shows the mean values of the physicochemical composition of goat milk as a function of the diet type and lactation week.

The results showed that the average pH values of the DAPC, APC, and LD diets were respectively 6.71, 6.68, and 6.62. These values are similar to those found in the milk of the same breed in Morocco (6.58 and 6.89) by Noutfia et al. (29).

The average density values of milk are 1.03, 1.02, and 1.02 g/cm^3 for the DAPC, APC, and LD diets, respectively. For freezing point, the average is at –0.45, –0.43, and –0.44 °C for the DAPC, APC, and LD diets, respectively. The results of all milk samples for density and freezing point levels showed no significant differences ($P > 0.05$) among the three diets.

The results for milk density are in line with the values reported by Costa et al. (2) for the Alpine breed (1.03 g/cm^3) and also the value of 1.02 g/cm^3 reported by Noutfia et al. (29) for the same breed in Morocco. The variability of density depends on the fat content, the increase in temperature, and food availability. For freezing point, the values are lower than those found by Mayer and Fiechter (–0.54 °C) in Austria (30).

The average protein content for the DAPC, APC, and LD diets was 4.38%, 3.08%, and 2.61%, respectively. Costa et al. (3) reported that the level of goat milk protein in the same breed was 3.09%; this value is in accordance with our APC diet but higher than that of the LD diet.

In this work, the average milk fat was 4.23% for the DAPC diet compared to only 3.27% and 2.97% for the APC and LD diets, respectively. These results showed the highly significant change between all treatments ($P < 0.001$) along lactation weeks. This finding may explain why goat milk lipid synthesis is affected by dietary triglycerides. Indeed, this parameter depends on weather conditions, lactation stage, and feeding. The values found in this study

Table 3. Microbiological analysis (mean ± SD) as function of diet type and lactation week.

Flora (cfu mL^{-1})	Lactation weeks							
	Diet	W1	W2	W3	W4	W5	W6	Mean±SD
Total aerobic flora	DAPC	$1.7 \times 10^5 \pm 1.5 \times 10^5$	$1.6 \times 10^5 \pm 1.4 \times 10^5$	$1.7 \times 10^4 \pm 1.5 \times 10^4$	$1 \times 10^4 \pm 1.1 \times 10^4$	$8.1.10^3 \pm 6.8.10^3$	$5.8 \times 10^3 \pm 4.6 \times 10^3$	$6.1 \times 10^4 \pm 5.4 \times 10^4$
	APC	$2 \times 10^4 \pm 2 \times 10^4$	$1.9 \times 10^4 \pm 1 \times 10^4$	$1.2 \times 10^4 \pm 7.1 \times 10^3$	$6.8 \times 10^3 \pm 4.8 \times 10^3$	$3.8.10^3 \pm 5.3.10^3$	$7 \times 10^2 \pm 6.4 \times 10^2$	$1 \times 10^4 \pm 7.9 \times 10^3$
	LD	$2.1 \times 10^5 \pm 1.6 \times 10^5$	$1.9 \times 10^5 \pm 2.3 \times 10^5$	$9.7 \times 10^4 \pm 1 \times 10^5$	$6.9 \times 10^4 \pm 9.2 \times 10^4$	$5.3.10^4 \pm 6.3.10^4$	$8.6 \times 10^4 \pm 1.2 \times 10^5$	$1.1 \times 10^5 \pm 1.2 \times 10^5$
Lactobacilli	DAPC	$1.8 \times 10^6 \pm 2.5 \times 10^6$	$1.6 \times 10^6 \pm 2.3 \times 10^6$	$1.7 \times 10^5 \pm 2.5 \times 10^5$	$1.7 \times 10^5 \pm 2.4 \times 10^5$	$1.8 \times 10^5 \pm 2.5 \times 10^5$	$1.6 \times 10^5 \pm 2.5 \times 10^5$	$6.8 \times 10^5 \pm 9.6 \times 10^5$
	APC	$1.9 \times 10^5 \pm 1.1 \times 10^5$	$1.1 \times 10^5 \pm 2 \times 10^5$	$1.3 \times 10^5 \pm 2.6 \times 10^5$	$1.3 \times 10^5 \pm 2.1 \times 10^5$	$1.1 \times 10^5 \pm 1.9 \times 10^5$	$6.1 \times 10^4 \pm 7.4 \times 10^4$	$1.2 \times 10^5 \pm 1.7 \times 10^5$
	LD	$1.6 \times 10^6 \pm 1 \times 10^6$	$1.1 \times 10^6 \pm 2 \times 10^6$	$4.7 \times 10^5 \pm 3.4 \times 10^5$	$1 \times 10^5 \pm 1 \times 10^5$	$3.8 \times 10^4 \pm 2.6 \times 10^4$	$2.6 \times 10^4 \pm 1.7 \times 10^4$	$5.5 \times 10^5 \pm 5.8 \times 10^5$
Total coliform	DAPC	$2.2 \times 10^5 \pm 1.6 \times 10^5$	$1.8 \times 10^5 \pm 1 \times 10^5$	$2.2 \times 10^5 \pm 9.2 \times 10^5$	$1.7 \times 10^4 \pm 1.3 \times 10^4$	$1.7 \times 10^3 \pm 1.1 \times 10^3$	$1.4 \times 10^4 \pm 8.8 \times 10^3$	$1 \times 10^5 \pm 1.3 \times 10^6$
	APC	$1.2 \times 10^5 \pm 1.3 \times 10^5$	$4.3 \times 10^4 \pm 5.1 \times 10^4$	$2.4 \times 10^4 \pm 2.4 \times 10^4$	$3.7 \times 10^3 \pm 3.6 \times 10^3$	$6.6 \times 10^2 \pm 5.7 \times 10^2$	$4 \times 10^2 \pm 5.1 \times 10^2$	$3.1 \times 10^4 \pm 3.4 \times 10^5$
	LD	$1.4 \times 10^5 \pm 1.3 \times 10^5$	$1 \times 10^5 \pm 6.3 \times 10^4$	$9 \times 10^4 \pm 5.6 \times 10^4$	$1.1 \times 10^5 \pm 1 \times 10^5$	$1 \times 10^5 \pm 1.1 \times 10^5$	$9 \times 10^4 \pm 1 \times 10^5$	$1 \times 10^5 \pm 5.1 \times 10^4$
Fecal coliform	DAPC	$2 \times 10^4 \pm 1.5 \times 10^4$	$1.6 \times 10^4 \pm 1 \times 10^4$	$1.3 \times 10^3 \pm 6.7 \times 10^2$	$1.5 \times 10^3 \pm 9.7 \times 10^2$	$1.3 \times 10^2 \pm 8.4 \times 10^1$	$1.4 \times 10^2 \pm 1 \times 10^1$	$6.5 \times 10^3 \pm 4.4 \times 10^3$
	APC	$9.3 \times 10^3 \pm 9.5 \times 10^3$	$3.7 \times 10^3 \pm 3.5 \times 10^3$	$1.6 \times 10^3 \pm 1.6 \times 10^3$	$3.8 \times 10^2 \pm 3.5 \times 10^2$	$5.8 \times 10^1 \pm 5.5 \times 10^1$	$4.7 \times 10^1 \pm 5.1 \times 10^1$	$2.5 \times 10^3 \pm 2.5 \times 10^3$
	LD	$1.4 \times 10^4 \pm 1.4 \times 10^4$	$1 \times 10^4 \pm 1 \times 10^4$	$9.1 \times 10^2 \pm 6.6 \times 10^2$	$7.1 \times 10^2 \pm 5.4 \times 10^2$	$6.6 \times 10^2 \pm 8.3 \times 10^2$	$1.1 \times 10^3 \pm 1.7 \times 10^3$	$4.5 \times 10^3 \pm 4.6 \times 10^3$
Staphylococcus	DAPC	$1.5 \times 10^3 \pm 1.2 \times 10^3$	$1.7 \times 10^2 \pm 1.3 \times 10^2$	$1.4 \times 10^2 \pm 1 \times 10^2$	$1.4 \times 10^1 \pm 1.2 \times 10^1$	$1.6 \times 10^2 \pm 9.8 \times 10^1$	$2 \times 10^2 \pm 1.8 \times 10^1$	$3.6 \times 10^2 \pm 2.5 \times 10^2$
	APC	$1.2 \times 10^2 \pm 2.3 \times 10^2$	$5.8 \times 10^1 \pm 9.6 \times 10^1$	$1.9 \times 10^1 \pm 3.2 \times 10^1$	$1.2 \times 10^1 \pm 2 \times 10^1$	$1 \times 10^1 \pm 1.5 \times 10^1$	$1.2 \times 10^1 \pm 1.6 \times 10^1$	$3.8 \times 10^1 \pm 6.8 \times 10^1$
	LD	$1.5 \times 10^3 \pm 1.6 \times 10^3$	$1.6 \times 10^3 \pm 1.2 \times 10^3$	$1.7 \times 10^2 \pm 1.6 \times 10^2$	$1.3 \times 10^2 \pm 1.7 \times 10^2$	$2.2 \times 10^1 \pm 8.2 \times 10^1$	$3 \times 10^1 \pm 6.8 \times 10^1$	$5.7 \times 10^2 \pm 5.4 \times 10^2$
Yeasts and molds	DAPC	$2.9 \times 10^4 \pm 2.1 \times 10^4$	$2.7 \times 10^4 \pm 1.8 \times 10^4$	$2.7 \times 10^3 \pm 2 \times 10^3$	$3 \times 10^3 \pm 2.3 \times 10^3$	$2.2 \times 10^2 \pm 1.8 \times 10^2$	$2.6 \times 10^2 \pm 1.7 \times 10^2$	$1 \times 10^4 \pm 7.2 \times 10^3$
	APC	$1.3 \times 10^3 \pm 2 \times 10^3$	$1 \times 10^2 \pm 1.6 \times 10^2$	$1.9 \times 10^2 \pm 1.9 \times 10^2$	$1.3 \times 10^2 \pm 1.4 \times 10^2$	$7.3 \times 10^1 \pm 4.8 \times 10^1$	$5.4 \times 10^2 \pm 5.3 \times 10^2$	$3.8 \times 10^2 \pm 5.1 \times 10^2$
	LD	$1.2 \times 10^4 \pm 1.7 \times 10^4$	$1.3 \times 10^4 \pm 1.9 \times 10^4$	$1.2 \times 10^4 \pm 1.6 \times 10^4$	$1.8 \times 10^4 \pm 2.7 \times 10^4$	$2.2 \times 10^4 \pm 3 \times 10^4$	$2 \times 10^4 \pm 2.3 \times 10^4$	$1.4 \times 10^4 \pm 2.2 \times 10^4$

LW: Lactation week; DAPC: detoxified argan press cake diet; APC: nondetoxified argan press cake diet; LD: local diet.
Each value is mean ± SD (standard deviation) of triplicate analysis.

Table 4. Physicochemical characteristics of goat milk as a function of diet type and lactation week.

		Lactation weeks (LW)							Statistical
Parameter	Diet	W1	W2	W3	W4	W5	W6	Mean±SD	Significance
D (g/cm³)	DAPC	1.03 ± 0.01	1.03 ± 0.01	1.03 ± 0.01	1.03 ± 0.01	1.03 ± 0.01	1.03 ± 0.09	1.03 ± 0.06	0.90 (ns)
	APC	1.03 ± 0.01	1.03 ± 0.01	1.03 ± 0.01	1.03 ± 0.01	1.02 ± 0.07	1.02 ± 0.05	1.02 ± 0.05	
	LD	1.03 ± 0.01	1.03 ± 0.01	1.03 ± 0.01	1.03 ± 0.01	1.03 ± 0.01	1.02 ± 0.05	1.02 ± 0.05	
	Mean ± SD	1.03 ± 0.05	1.03 ± 0.05	1.03 ± 0.06	1.03 ± 0.05	1.02 ± 0.07	1.02 ± 0.06	1.02 ± 0.05	
	Significance	0.79 (ns)							
MF (%)	DAPC	3.66 ±1.16	4.22 ± 0.61	3.26 ± 0.07	3.50 ± 0.81	4.92 ± 2.59	5.84 ± 1.66	4.23 ± 1.61	0.001 (***)
	APC	2.91 ± 0.65	3.49 ± 0.55	2.67 ± 0.34	2.82 ± 1.38	3.54 ± 0.74	4.19 ± 1.85	3.27 ± 1.11	
	LD	2.92 ± 0.17	2.96 ± 1.43	2.61 ± 0.32	2.84 ± 1.00	3.10 ± 0.61	3.39 ± 1.17	2.97 ± 0.87	
	Mean ± SD	3.16 ± 0.81	3.56 ± 1.04	2.85 ± 0.55	3.06 ± 1.07	3.85 ± 1.69	4.47 ± 1.82	3.49 ± 1.34	
	Significance	0.001 (***)							
L (%)	DAPC	4.24 ± 0.59	4.26 ± 0.35	3.93 ± 0.68	4.06 ± 0.57	4.19 ± 0.78	4.21 ± 0.36	4.15 ± 0.55	0.83 (ns)
	APC	4.23 ± 0.49	4.22 ± 0.36	3.97 ± 0.65	4.26 ± 0.66	4.22 ± 0.62	4.27 ± 0.55	4.19 ± 0.53	
	LD	4.27 ± 0.62	4.11 ± 0.90	4.04 ± 0.71	3.92 ± 0.79	4.08 ± 0.85	4.04 ± 0.26	4.08 ± 0.68	
	Mean ± SD	4.24 ± 0.54	4.20 ± 0.56	3.98 ± 0.64	4.08 ± 0.65	4.16 ± 0.71	4.18 ± 0.39	4.14 ± 0.58	
	Significance	0.79 (ns)							
Pr(%)	DAPC	4.25 ± 0.43	4.44 ± 0.26	4.13 ± 0.58	4.14 ± 0.58	4.48 ± 1.13	4.86 ± 0.91	4.38 ± 0.52	0.001 (***)
	APC	2.96 ± 0.56	3.20 ± 0.68	3.10 ± 0.55	3.16 ± 0.46	2.91 ± 0.61	3.20 ± 0.39	3.08 ± 0.20	
	LD	2.18 ± 0.53	2.98 ± 0.42	2.07 ± 0.48	2.83 ± 0.48	2.83 ± 0.49	2.81 ± 0.28	2.61 ± 0.55	
	Mean ± SD	3.13 ± 1.00	3.54 ± 0.80	3.10 ± 1.00	3.38 ± 0.75	3.41 ± 1.08	3.62 ± 1.07	3.36 ± 0.95	
	Significance	0.03 (*)							
SNF (%)	DAPC	8.13 ± 0.63	7.24 ± 0.59	8.15 ± 0.74	8.08 ± 0.79	8.01 ± 0.78	8.03 ± 0.33	7.94 ± 0.69	0.001 (***)
	APC	6.69 ± 0.17	7.06 ± 0.48	6.62 ± 0.26	7.69 ± 0.95	7.03 ± 0.82	7.35 ± 0.58	7.07 ± 0.68	
	LD	6.93 ± 0.27	8.08 ± 1.14	6.22 ± 0.14	7.32 ± 1.10	7.43 ± 1.00	7.64 ± 0.78	7.27 ± 0.97	
	Mean ± SD	7.25 ± 0.75	7.46 ± 0.87	7.00 ± 0.96	7.70 ± 0.95	7.49 ± 0.92	7.67 ± 0.62	7.43 ± 0.85	
	Significance	0.009 (**)							
FP(-°C)	DAPC	0.43 ± 0.05	0.46 ± 0.04	0.44 ± 0.04	0.44 ± 0.05	0.46 ± 0.02	0.48 ± 0.02	0.45 ± 0.04	0.79 (ns)
	APC	0.41 ± 0.01	0.44 ± 0.03	0.40 ± 0.01	0.48 ± 0.05	0.42 ± 0.02	0.46 ± 0.04	0.43 ± 0.04	
	LD	0.40 ± 0.04	0.32 ± 0.42	0.40 ± 0.04	0.55 ± 0.01	0.49 ± 0.09	0.48 ± 0.05	0.44 ± 0.19	
	Mean ± SD	0.41 ± 0.03	0.40 ± 0.24	0.41 ± 0.03	0.49 ± 0.10	0.45 ± 0.06	0.47 ± 0.07	0.44 ± 0.11	
	Significance	0.001 (***)							
Salt (%)	DAPC	0.55 ± 0.01	0.58 ± 0.04	0.57 ± 0.06	0.57 ± 0.07	0.58 ± 0.03	0.60 ± 0.03	0.57 ± 0.04	0.14 (ns)
	APC	0.55 ± 0.008	0.57 ± 0.03	0.53 ± 0.01	0.62 ± 0.07	0.54 ± 0.02	0.59 ± 0.04	0.57 ± 0.04	
	LD	0.54 ± 0.07	0.65 ± 0.09	0.54 ± 0.06	0.67 ± 0.15	0.60 ± 0.07	0.62 ± 0.06	0.60 ± 0.10	
	Mean ± SD	0.55 ± 0.04	0.60 ± 0.07	0.54 ± 0.05	0.62 ± 0.11	0.57 ± 0.05	0.60 ± 0.05	0.58 ± 0.07	
	Significance	0.01 (**)							
pH	DAPC	6.84 ± 0.32	6.71 ± 0.30	6.64 ± 0.25	6.62 ± 0.09	6.78 ± 0.17	6.66 ± 0.10	6.71 ± 0.21	0.08 (ns)
	APC	6.82 ± 0.11	6.81 ± 0.23	6.59 ± 0.04	6.65 ± 0.14	6.61 ± 0.12	6.62 ± 0.14	6.68 ± 0.16	
	LD	6.75 ± 0.22	6.68 ± 0.15	6.55 ± 0.14	6.65 ± 0.18	6.52 ± 0.02	6.58 ± 0.33	6.62 ± 0.20	
	Mean ± SD	6.81 ± 0.22	6.73 ± 0.23	6.59 ± 0.11	6.64 ± 0.13	6.64 ± 0.15	6.62 ± 0.20	6.67 ± 0.19	
	Significance	0.02 (*)							

***: $P < 0.001$, **: $P < 0.01$, *: $P < 0.05$, ns: not significant ($P > 0.05$).
D: Density; MF: milk fat; SNF: solid-not-fat; Pr: protein; FP: freezing point; L: lactose; LW: lactation week; DAPC: detoxified argan press cake diet; APC: nondetoxified argan press cake diet; LD: local diet.
Each value is mean ± SD (standard deviation) of triplicate analysis.

are close to those reported by Zantar et al. (27) and Costa et al. (3) in goat milk from the Alpine breed. In addition, saponins have a hypocholesterolemic power when they bind to cholesterol and bile salts, which has the effect of reducing the intestinal absorption of cholesterol because they bind to bile acids and cholesterol. Moreover, Aguiar et al. (31) reported that the inclusion of plants containing saponin, such as soybean, led to a reduction of milk-fat synthesis. However, other studies found that milk fat of cows fed diets supplemented with tea saponins increased (32). Generally, protein and fat are the most important components of goats' milk in cheese technology.

Lactose is the major carbohydrate in goats' milk and constitutes the substrate for lactic fermentation used by LAB, being one of the most stable milk components. In our case, the lactose levels in milk of all three diets were of the same magnitude (4.15%, 4.19%, and 4.08% for DAPC, APC, and LD diets, respectively). Thus, it seems that lactose is the least sensitive component of milk to dietary changes, as concluded by Walstra et al. (33). Our milk lactose contents are in good accordance with the finding of Mayer and Fiechter (4.06%–4.88%) (30). The milk's SNF content varied significantly ($P < 0.01$) between the three diets, with mean levels of 8.03%, 7.35%, and 7.64% for the DAPC, APC, and LD diets, respectively. These values are below the average values (8.9%) given by Park et al. (34).

Similarly, with the progress of lactation period, fat and SNF levels are reported to increase while lactose content decreases.

Furthermore, our data on milk yield and milk composition during the lactation period are negatively correlated; these results could be explained by the fact that when the milk yield increases the concentration of milk compound decreases. These results were in accordance with previous studies (27).

3.6. Milk mineral concentration

The means of milk mineral contents of lactating goats as related to diet type and lactation week are summarized in Table 5. Following previous studies, milk and dairy products supply all essential mineral elements needed for newborn development and growth.

The levels of minerals in goat milk vary depending on the breed, diet, dairy period, and performance, and the mineral contents in goat milk had substantial changes in the first 7 weeks of lactation (34).

In this work, animal feed and lactation week did not have a significant effect on the concentration of major elements in milk (K, Ca, and Mg). They had a significant effect ($P < 0.001$) on goat milk phosphorus (P) level, as well as on sodium (Na) level. The average contents of trace elements (Cu, Zn, and Fe) during lactation weeks kept the same values.

It is well known that phosphorus is a major element of milk with many important biological functions in the human body. The mean of phosphorus content was higher (119.45 mg/100 g) in the milk of the DAPC diet compared with that of the APC and LD diets (96.47 and 105.66 mg/100 g, respectively). These values are lower than those reported by Park et al. (34). The average sodium content followed the same trend. Nevertheless, the concentrations of the other compounds (K, Ca, Mg, Cu, and Zn) had slight variations between the three diets.

Trace elements are among essential substances such as hemoglobin and vitamin B_{12}. Milk iron is naturally low. In our case, the average values of milk iron are 0.08, 0.07, and 0.05 mg/100 g for the DAPC, APC, and LD diets, respectively. The iron concentration reported in the literature for goat milk was 0.07 mg/100 g (34).

3.7. Milk saponin contents

The influence of saponins on dairy milk production and composition has received limited research attention. However, no previous dietary approaches have been interested in the determination of saponins in milk; our work was the first that focused on the levels of saponin in milk.

The results showed the increase of saponin concentration in milk (Table 6) with the APC diet during the period of lactation. On the other hand, the milk collected from the DAPC diet contained only traces of saponin during the first 3 weeks of lactation, but there was a total absence of this compound in the milk of the LD diet. The bitter taste caused by saponin compounds from APC cake was the main limiting factor affecting milk acceptability for young ruminants, leading to severe diarrhea for them (11).

El Hadi (11) suggests that saponins from APC were very toxic intravenously but less active in the digestive tract, and, in high doses, would lead to hemolysis in animals. Therefore, detoxified APC can be used to maintain the milk quality value after its deterioration by press cake saponin.

3.8. Conclusions

Throughout this study, the detoxification method, adopted to remove the saponins present in APC, has been successful in reducing these antinutrients from 4.56 to 0.4 mg/g, which allowed APC to be used as animal feed.

The inclusion of the detoxified APC in goats' diets affects the milk production. Daily milking of goats fed with DAPC was significantly higher that of APC and LD diets. The microbiological quality of raw goat milk appears satisfactory, with lower contamination value counts in APC samples compared to DAPC and LD samples while the technological flora of local goat milk

Table 5. Milk mineral concentrations (mg/100 g) of goats as related to diet type and lactation stage.

Parameter	Lactation weeks								
	Diet	W1	W2	W3	W4	W5	W6	Mean±SD	Significance
P	DAPC	127.40 ± 25.81	146.80 ± 23.17	149.58 ± 37.27	117.92 ± 45.29	90.30 ± 46.01	84.67 ± 7.21	119.45 ± 40.26	0.02 (*)
	APC	92.56 ± 39.30	123.13 ± 18.31	127.53 ± 44.07	88.46 ± 30.98	70.39 ± 11.28	76.73 ± 6.22	96.47 ± 34.51	
	LD	100.25 ± 21.41	137.66 ± 117.1	141.68 ± 46.47	97.74 ± 30.80	77.38 ± 6.66	79.26 ± 11.81	105.66 ± 35.71	
	Mean ± SD	106.74 ± 31.96	135.86 ± 22.35	139.60 ± 41.27	101.37 ± 36.40	79.36 ± 27.30	80.22 ± 8.90	107.19 ± 37.77	
	Significance	0.001 (***)							
Na	DAPC	54.16 ± 9.51	75.83 ± 5.60	52.33 ± 7.71	58.83 ± 7.80	48.16 ± 6.24	67.00 ± 28.66	59.38 ± 15.77	0.002 (**)
	APC	43.33 ± 11.00	69.50 ± 7.81	50.33 ± 16.08	52.16 ± 6.46	49.33 ± 15.56	57.50 ± 31.20	53.69 ± 17.66	
	LD	40.33 ± 10.25	72.33 ± 178.1	48.83 ± 16.42	50.83 ± 14.78	43.83 ± 7.73	37.66 ± 17.20	48.97 ± 16.87	
	Mean ± SD	45.94 ± 11.42	72.55 ± 8.16	50.50 ± 13.23	53.94 ± 10.36	47.11 ± 10.30	54.05 ± 27.80	54.01 ± 17.17	
	Significance	0.001 (***)							
K	DAPC	143.83 ± 32.66	150.00 ± 22.40	153.66 ± 26.65	128.00 ± 5.83	148.33 ± 35.61	163.83 ± 14.17	144.61 ± 26.68	0.31 (ns)
	APC	135.66 ± 23.74	143.50 ± 37.58	143.66 ± 19.75	125.66 ± 18.59	131.83 ± 18.73	137.00 ± 37.50	136.22 ± 26.07	
	LD	128.16 ± 10.64	133.66 ± 171.8	148.50 ± 30.59	123.33 ± 20.30	145.50 ± 17.88	134.00 ± 9.05	135.52 ± 20.18	
	Mean ± SD	135.88 ± 23.58	142.38 ± 27.07	148.61 ± 24.83	125.66 ± 15.38	141.88 ± 25.00	138.27 ± 22.69	138.78 ± 23.91	
	Significance	0.09 (ns)							
Ca	DAPC	171.50 ± 80.37	198.83 ± 30.46	147.00 ± 37.30	152.66 ± 40.30	172.83 ± 57.39	172.66 ± 46.31	169.25 ± 50.50	0.45 (ns)
	APC	155.66 ± 99.80	173.83 ± 50.06	139.50 ± 62.40	144.33 ± 46.98	154.50 ± 53.19	155.16 ± 75.97	153.83 ± 63.17	
	LD	140.66 ± 56.16	177.33 ± 46.88	134.83 ± 60.96	140.00 ± 26.26	165.83 ± 51.99	166.66 ± 65.52	154.22 ± 51.63	
	Mean ± SD	155.94 ± 76.97	183.33 ± 42.26	140.44 ± 51.83	145.66 ± 36.86	164.38 ± 51.54	164.83 ± 60.10	159.10 ± 55.35	
	Significance	0.20 (ns)							
Mg	DAPC	17.29 ± 3.36	19.00 ± 2.52	17.50 ± 2.16	19.16 ± 4.26	17.33 ± 2.50	17.16 ± 4.21	17.90 ± 3.15	0.19 (ns)
	APC	15.33 ± 2.50	17.50 ± 2.88	16.33 ± 1.86	17.16 ± 1.60	16.66 ± 0.81	16.33 ± 2.58	16.55 ± 2.11	
	LD	16.16 ± 2.48	17.83 ± 2.56	16.16 ± 1.16	18.00 ± 2.00	14.83 ± 4.21	15.16 ± 5.91	16.36 ± 3.40	
	Mean ± SD	16.26 ± 2.76	18.11 ± 2.58	16.66 ± 1.78	18.11 ± 2.82	16.27 ± 2.90	16.22 ± 4.26	16.94 ± 2.99	
	Significance	0.07 (ns)							
Cu	DAPC	0.08 ± 0.09	0.07 ± 0.08	0.06 ± 0.10	0.08 ± 0.16	0.06 ± 0.08	0.06 ± 0.10	0.07 ± 0.10	0.55 (ns)
	APC	0.06 ± 0.09	0.04 ± 0.07	0.03 ± 0.08	0.06 ± 0.12	0.05 ± 0.08	0.05 ± 0.08	0.05 ± 0.08	
	LD	0.06 ± 0.08	0.05 ± 0.08	0.04 ± 0.11	0.05 ± 0.05	0.04 ± 0.06	0.04 ± 0.05	0.05 ± 0.07	
	Mean ± SD	0.07 ± 0.08	0.05 ± 0.07	0.04 ± 0.09	0.06 ± 0.11	0.05 ± 0.07	0.05 ± 0.07	0.05 ± 0.08	
	Significance	0.98 (ns)							
Zn	DAPC	0.59 ± 0.19	0.68 ± 0.28	0.61 ± 0.37	0.63 ± 0.19	0.61 ± 0.09	0.60 ± 0.20	0.62 ± 0.22	0.40 (ns)
	APC	0.53 ± 0.27	0.58 ± 0.26	0.56 ± 0.42	0.58 ± 0.21	0.51 ± 0.25	0.55 ± 0.29	0.55 ± 0.27	
	LD	0.51 ± 0.29	0.56 ± 0.23	0.55 ± 0.28	0.61 ± 0.26	0.40 ± 0.12	0.43 ± 0.25	0.51 ± 0.24	
	Mean ± SD	0.54 ± 0.24	0.61 ± 0.25	0.57 ± 0.34	0.61 ± 0.21	0.51 ± 0.18	0.52 ± 0.24	0.56 ± 0.25	
	Significance	0.83 (ns)							
Fe	DAPC	0.08 ± 0.02	0.08 ± 0.009	0.07 ± 0.01	0.09 ± 0.006	0.08 ± 0.01	0.08 ± 0.01	0.08 ± 0.01	0.001 (***)
	APC	0.07 ± 0.01	0.07 ± 0.01	0.05 ± 0.03	0.07 ± 0.01	0.07 ± 0.01	0.07 ± 0.01	0.07 ± 0.01	
	LD	0.06 ± 0.02	0.06 ± 0.02	0.05 ± 0.04	0.06 ± 0.02	0.06 ± 0.02	0.05 ± 0.02	0.05 ± 0.02	
	Mean ± SD	0.07 ± 0.02	0.07 ± 0.01	0.06 ± 0.03	0.07 ± 0.02	0.07 ± 0.01	0.06 ± 0.02	0.07 ± 0.02	
	Significance	0.65 (ns)							

***: $P < 0.001$, **: $P < 0.01$, *: $P < 0.05$, ns: not significant ($P > 0.05$).
APCD: Detoxified argan press cake diet; APC: nondetoxified argan press cake diet; LD: local diet; LW: lactation weeks; P: phosphorus; Na: sodium; K: potassium; Ca: calcium; Mg: magnesium; Cu: copper; Zn: zinc; Fe: iron.
Each value is mean ± SD (standard deviation) of triplicate analysis.

Table 6. Milk saponin concentrations (%) of goats as related to diet type and lactation stage.

		Lactation week (LW)							Statistical
	Diet	W1	W 2	W 3	W 4	W 5	W 6	Mean±SD	Significance
Saponins (%)	DAPC	$3 \times 10^{-5} \pm 8 \times 10^{-5}$	$1 \times 10^{-5} \pm 4 \times 10^{-5}$	$3 \times 10^{-5} \pm 8 \times 10^{-5}$	0 ± 0	0 ± 0	0 ± 0	$1 \times 10^{-5} \pm 4 \times 10^{-5}$	0.001 (***)
	APC	0.20 ± 0.23	0.58 ± 0.45	1.13 ± 0.73	1.56 ± 0.63	1.73 ±0.46	1.84 ± 0.54	1.17 ± 0.78	
	LD	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	
	Mean ± SD	0.06 ± 0.59	0.19 ± 0.80	0.52 ± 1.10	0.52 ± 1.28	0.57 ± 1.34	0.61 ± 1.40	0.78 ± 1.12	
	Significance	0.001 (***)							

***: P < 0.001, **: P < 0.01, *: P < 0.05, ns: not significant (P > 0.05).
DAPC: Detoxified argan press cake die; APC: nondetoxified argan press cake diet; LD: local diet; LW: lactation weeks.
Each value is mean ± SD (standard deviation) of triplicate analysis.

remains relatively important. Our research shows that the number of microbes of technological interest is very high, and this presents an economic and qualitative advantage for industrialists. During the manufacturing of cheese, fermentation could take place without the addition of the lactic ferment. Considering the physicochemical and mineral parameters of goat milk, our results showed significant differences between diets, and these parameters were also affected by stage of lactation (weeks). The detoxification method decreased the saponin in milk, making it acceptable for goat kids. Finally, detoxified APC appears to be a promising alternative for dry season feeding systems, thereby improving the livelihood of farmers in dry areas.

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