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Original article

Assessment of mineral profile in Algerian Arbia goats across reproductive phases: Implications for reproductive performance

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Abstract

The objective of this research is to analyze key mineral parameters in Algerian Arbia goats during different reproductive phases to evaluate the variation in these parameters and their influence on some reproductive performance. The study was conducted at the Technical Livestock Institute (I.T.E.L.V) of Ksar Chellala in Tiaret, Algeria, from October 2022 to May 2023. During all stages of reproduction (estrus period, pregnancy, and post-partum period), 21 primiparous and multiparous Arbia goats were studied, aged between one and ten years and weighing 24.19±6.08 kg at mating. Plasma calcium, phosphorus, magnesium, and iron, were estimated using the DIRUI CS-T180 Auto-chemistry Analyzer. Plasma sodium, potassium, and chloride levels were measured with ion-selective equipment (Easy Lyte ® Plus, MEDICA). In this study, mineral levels fluctuate in both groups: in primiparous and multiparous females, there is no appreciable difference ($p>0.05$) for electrolytes Na, K, and Cl throughout the various reproductive phases. However, P, Ca, and Fe concentrations were significantly lower ($p<0.05$) in the last month of pregnancy; also, Fe levels were significantly lower ($p<0.05$) in the post-partum phase. Nevertheless, the mineral plasma parameters during the late pregnancy stage and the age and weight of the goats at mating have a significant relationship. The multiparous kids (n=7) had a higher birth weight than the primiparous kids (n=8) (3.12±0.54 and 2.84±0.78, respectively). In Arbia goats, primiparous females were more fertile (100%), more productive (72.72%), and more prolific (114.28%) compared to multiparous females. Finally, it is found that parity influences the weight of the progeny at birth as well as the mineral concentrations at various stages of reproduction in Arbia goats. On the other hand, the reproductive characteristics of Arbia goats decline with parity.

Keywords: Arbia goats, mineral profile, parity, reproduction stages, reproductive characteristic

Introduction

The Arbia goat population is the most widely dispersed and is one of the most popular breeds for milk and meat production in Algeria because they are well adapted to their harsh semi-arid environment (Fantazi et al. 2017, Tefiel et al. 2018, Sahraoui et al. 2020). This breed of goats also represents the main native population in Algeria. It is reared mainly in mountainous areas, but the largest number is distributed in the steppe and Sub-Saharan zones of Algeria (Moustari 2008, Allaoua et al. 2021). To increase the production of these animals, controlling health and nutritional status is necessary.

Farm animals' reproductive systems are especially interesting since they not only support them reach a certain level of basic productivity but also ensure their survival. Thus, basic production is directly conditioned by frequent reproduction. Therefore, the quantity of milk and meat produced is directly influenced by regular reproduction. The emergence of reproductive dysfunction is mostly caused by errors in maintenance, nutrition, and technical variations; fecundity and fertility are the reproductive characteristics most affected (Pascal and Zaharia 2016).

Assessing the levels of different blood parameters has become a crucial and essential factor in evaluating an animal's productivity, health, metabolic processes, and nutrition, as well as in the diagnosis and prognosis of metabolic diseases (Gürdoğan et al. 2006, Karapehlivan et al. 2007, Tanritanir et al. 2009, Bagnicka et al. 2014, Doré et al. 2015, Vasava et al. 2016). However, determining blood levels of the various biochemical parameters in goats can be influenced by several factors, such as the different environmental factors and the different methods of management (Sharma et al. 2012), the geographical location with different climates (Elzein et al. 2016, Abd El-Hamid et al. 2017), the gender, season, age, breed (Mbassa et al. 1991, Azab et al. 1999, Anwar et al. 2012, Bagnicka et al. 2014, Donia et al. 2014, Ribeiro et al. 2016, Abd El-Hamid et al. 2017, Antunović et al. 2017) and the physiological periods of reproduction (Azab et al. 1999, Iriadam, 2007, Sadjadian et al. 2013, Donia et al. 2014, Manat et al. 2016, Soares et al. 2018).

Pregnancy, giving birth, and the neonatal period can all alter a small ruminant's offspring's and dams' metabolisms, respectively (Piccione et al. 2011, Zumbo et al. 2011). Since all metabolic processes change during these physiological phases to meet the needs of the fetus, placenta, and uterus as well as to regulate the production of milk, the specific changes that occur during pregnancy and lactation are crucial in clinical practice.

The maintenance of healthy reproductive processes is dependent on several minerals, including phosphorous (P), calcium (Ca), magnesium (Mg), iron (Fe), sodium (Na), potassium (K), and chloride (Cl) (Wilde 2006, Vázquez-Armijo et al. 2011). According to McGregor (1984), adult body weight is a significant economic element that affects the growth and production pattern of any goat activity. It mostly affects the growing behavior of young goats. Goat birth weight and body weight are valued characteristics since they positively correlate with development rate, age at maturity, and mature body weight (McGregor 1984). These factors affect the animal's ability to reproduce and be productive in the future (Paul et al. 2014). However, the birth weight and the growth of kids are mostly under the influence of breed and season (Mioč et al. 2011, Autukaite et al. 2020) then feeding, type of birth and sex (Mioč et al. 2011).

This research intends to investigate key mineral parameters in Algerian Arbia goats during different stages of reproduction, in order to determine how these factors vary and impact reproductive parameters.

Materials and Methods

Ethical approval

The protocol was approved by the Committee for Ethics in Animal Experimentation from U.S.T.H.B University of Algeria (Ref N°: 11125).

Experimental site

The present study was conducted in the region of Ksar Chellala, Tiaret, located in the west of Algeria (35°13′00″ Nord, 2°19′00″ Est). This area of Algeria is considered a semi-arid zone, with an altitude of 800 m, its climate has been characterized by a hot summer and cold dry winter.

Animals and management

The present study was carried out using a herd of 21 female Arbia goats selected from the Technical Livestock Institute (I.T.E.L.V); the goats were studied during all stages of reproduction (estrus period, pregnancy, and post-partum period), from October 2022 to May 2023. The animals were clinically healthy, primiparous and multiparous, aged between 1 and 10 years, and weighing 24.19±6.08 kg at mating.

Feeding livestock at the farm level considers the weight of animals, the physiological stages (maintenance, mating, gestation, lactation, and growth), using rough feed (barley/ oat hay, alfalfa hay, and straw), plus sources of energy and/or protein (barley grain, concentrated feed), depending on their viability on the farm

Table 1. Diet of goats studied at different stages of reproduction.

Period	Feeding
Flushing (15 to 20 days before mating)	− 0.6 kg of concentrated feed / head / day − 0.8 kg straw (wheat/barley) / head / day − Water as desired
1st month of pregnancy	− 0.6 kg of concentrated feed / head / day − 0.8 kg straw (wheat/barley) / head / day − Water as desired
Pregnancy (2nd, 3rd and 4th months)	− 0.5 kg of mixture (concentrated feed + grain barley) / head / day − 0.7 kg straw (wheat + barley) / head / day − Water as desired.
Steaming (20 days before whelping)	− 0.6 kg to 0.7 kg (concentrate) / head / day − 0.8 kg hay (barley-oats) / head / day − Water as desired
Lactation	− 0.7 kg to 0.8 kg (concentrate) / head /day − 1.2 kg hay (barley-oats) /head/day or 0.8 kg alfalfa hay. − Water as desired

(Table 1), the ration is distributed in two portions: morning and evening.

The composition of the concentrated feed used = (barley, soybean meal, limestone, salt, di-calcium phosphate from milling, trace element) + (vitamin A, E, D3 supplements).

Blood collection

Blood samples were collected from goats at various stages of their reproductive cycles, including the estrus period, early pregnancy (1-2 months), mid-pregnancy (3-4 months), late pregnancy (5 months), and post-partum, by puncturing the *vena jugularis.* The samples were then placed into Venoject® sterile vacuum tubes (Lithium Heparin, Italy) containing Li-heparin as the anticoagulants. After that, they were taken to Tiaret Institute of Veterinary Science's medical hematology-biochemistry lab. There, they were centrifuged in SIGMA Laborzentrifugen 2-15 Centrifuge at 3500xg for 10 min at room temperature, and the resulting plasma samples were stored at -20°C until analyzed.

Biochemical analysis

Blood minerals, plasma calcium (Ca), phosphorus (P), magnesium (Mg), and iron (Fe) were evaluated using commercial kits "Elitech", France, as well as the DIRUI CS-T180 Auto-chemistry Analyzer. Plasma sodium (Na), potassium (K), and chloride (Cl) levels were measured with ion-selective equipment (Easy Lyte ® Plus, MEDICA).

Reproductive characteristics

Currently, breeding productivity is determined using the indices of breeding. They represent an absolute or relative rate that indicates the level at which the reproductive process of an animal farm is conducted. With the data collected by surveying females throughout the whole reproductive cycle, from the mating to the post-partum period, it was possible to determine the principal breeding indices.

Fertility rate: during the same parity confirmed when goats do not come back to heat after mating and calculated as: *number of goats gravid / number of goats put to breed.*

Fecundity rate: during the same parity, the number of kids calved by the goats assigned for mating is calculated as: *number of kids born (dead and alive) / number of goats put to breed.*

Prolificacy rate: during same parity measured post-partum for goats and calculated as: *number of kids born (dead and alive) / number of goats that gave birth.*

Body weight of new kids: Immediately as the newborns were cleansed and dried, their birth weights were measured using an electronic digital balance.

Statistical analyses

All data were collected and coded for statistical analyses in Microsoft Office Excel. Statistical analyses were carried out using SPSS (version 22.0; IBM, USA), and the results were expressed as mean ± SD (Standard Deviation). The paired t-test was to assess the effect of parity on mineral levels during the different stages of reproduction and the Pearson's correlation test was used to investigate the relationship between the goat's ages, the goat's weight at mating, the birth weight of Arbia kids, and minerals concentration during late pregnancy period. Statistical significance was set at α=0.05.

Table 2. Impact of the parity of Arbia goats on blood mineral parameter concentration levels during various phases of reproduction.

Physiological status Minerals + Parity		Estrus period		Early pregnancy (1-2 months)		Mid pregnancy (3-4 months)		Late pregnancy (5 months)		Post-partum	
		*Mean±SD	*P*-value	Mean±SD	*P*-value	Mean±SD	*P*-value	Mean±SD	*P*-value	Mean±SD	*P*-value
Na (mmol/l)	Primi (N=7)	219.61 42.84	0.4	257.0 22.63	0.84	260.98 15.71	0.27	235.14 14.67	0.17	231.27 17.28	0.4
	Multi (N=7)	221.34 18.76		259.84 30.5		277.17 33.77		262.91 22.96		240.47 22.33	
K (mmol/l)	Primi (N=7)	6.24 0.98	0.4	6.86 0.63	0.39	7.71 0.86	0.44	6.53 0.99	0.2	6.24 0.42	0.54
	Multi (N=7)	6.18 0.52		7.17 0.68		8.11 1.02		7.20 0.87		6.41 0.58	
Cl (mmol/l)	Primi (N=7)	175.72 35.38	0.33	208.75 18.64	0.66	211.47 9.9	0.33	192.9 31.96	0.14	187.61 16.07	0.44
	Multi (N=7)	176.98 14.54		213.84 23.58		223.54 25.41		217.01 20.1		194.98 18.86	
P (mg/l)	Primi (N=7)	48.62 14.25	0.84	38.01 19.04	0.22	39.77 8.1	0.18	34.48 6.78	0.03	46.66 11.75	0.16
	Multi (N=7)	49.11 21.07		27.62 8.02		34.9 7.74		26.68 5.75		38.06 10.05	
Mg (mg/l)	Primi (N=7)	7.84 3.24	0.75	6.61 3.53	0.4	6.79 2.03	0.85	7.79 2.25	0.18	10.5 2.66	0.77
	Multi (N=7)	7.40 1.58		5.00 1.81		6.99 2.08		6.45 1.08		10.12 2.02	
Ca (mg/l)	Primi (N=7)	26.91 9.64	0.9	27.98 19.41	0.4	21.78 7.1	0.6	29.19 8.18	0.04	40.55 8.62	0.18
	Multi (N=7)	26.85 4.28		18.75 6.13		23.55 6.5		21.06 4.73		33.79 9.25	
Fe (µg/dl)	Primi (N=7)	40.11 24.65	0.9	45.21 53.55	0.7	31.10 13.11	0.2	44.11 17.18	0.01	45.21 15.3	0.01
	Multi (N=7)	34.01 6.97		17.38 8.54		25.68 17.75		22.63 9.84		25.06 10.72	

* Mean ± Standard deviation, *P*-value, Na – Sodium, K – Potassium, Cl – Chlorine, P – Phosphorus, Mg – Magnesium, Ca – Calcium, Fe – Iron. Key – Primi, primiparous, Multi – Multiparous.

Results

Results of biochemical mineral parameters in primiparous and multiparous Arbia goats in the different phases of reproduction (mating period, pregnancy, and post-partum period) are shown in Table 2.

In this study, mineral levels fluctuate in both groups: in primiparous and multiparous females, the highest concentration of the electrolytes: sodium (Na), potassium (K), and chloride (Cl) was observed in the middle of gestation (3-4 months), while a decreased concentration shows up during the mating period. There is no appreciable difference ($p>0.05$) in these requirements throughout the various reproductive phases. Phosphorus levels in the late pregnancy period for groups were significantly lower ($p<0.05$) at 34.48 mg/l and 26.68 mg/l, respectively. Results showed that both primiparous and multiparous animals had high concentrations of this parameter across the estrus period. However, a significant difference ($p<0.05$) was observed for calcium (Ca) concentration in the last month of pregnancy. Magnesium (Mg) did not record any significant change, and after gestation, their concentrations increased. In the late pregnancy and post-partum periods, multiparous goat's iron (Fe) levels were significantly lower than those of primiparous goat's (44.11 µg/dl, 22.63 µg/dl, and 45.21 µg/dl, 25.06 µg/dl, respectively).

Values of the coefficient of correlation between the age and weight of goats at mating, kids' birth weight, and the minerals plasma parameter during the late pregnancy stage have been presented in Table 3.

In Arbia goats, W_0 and A_0 ($r=0.768$), W_0 and plasma Na ($r=0.648$), W_0 and plasma K ($r=0.625$), and W_0 and plasma Cl ($r=0.653$) all showed a significant correlation ($p<0,01$). It was also observed that there was a significant correlation ($p<0.01$) between plasma Cl and Na ($r=0.996$) and K ($r=0.931$). However, there was a positive

Table 3. Pearson's correlation coefficient between the age and weight of goats at mating, kids' birth weight, and the minerals plasma parameter during the late pregnancy stage.

		The goat's age	The goat's weight at mating	Kids' birth weight	Na	K	Cl	P	Mg	Ca	Fe
The goat's age	r	1									
	p										
The goat's weight at mating	r	0.768**	1								
	p	0.001									
Kids birth weight	r	0.213	0.459	1							
	p	0.464	0.099								
Na	r	0.426	0.648*	0.403	1						
	p	0.128	0.012	0.153							
K	r	0.440	0.625*	0.323	0.926**	1					
	p	0.115	0.017	0.259	0.00						
Cl	r	0.430	0.653*	0.438	0.996**	0.931**	1				
	p	0.125	0.011	0.117	0.00	0.00					
P	r	-0.571*	-0.476	-0.293	-0.90	-0.231	-0.144	1			
	p	0.033	0.085	0.310	0.758	0.427	0.624				
Mg	r	-0.207	-0.055	0.030	0.070	-0.064	0.049	0.547*	1		
	p	0.479	0.853	0.919	0.813	0.829	0.868	0.043			
Ca	r	-0.457	-0.377	-0.086	-0.473	-0.504	-0.447	0.351	0.655*	1	
	p	0.101	0.184	0.769	0.088	0.066	0.109	0.219	0.011		
Fe	r	-0.562*	-0.436	-0.199	-0.557*	-0.593*	-0.561*	0.543*	0.605*	0.798**	1
	p	0.036	0.119	0.496	0.039	0.025	0.037	0.045	0.022	0.001	

r – Pearson's correlation coefficient, p – *P*-value, * Significant correlation at p<0,05, ** significant at p<0.01. Na – Sodium, K – Potassium, Cl – Chlorine, P – Phosphorus, Mg – Magnesium, Ca – Calcium, Fe – Iron.

correlation (r=0.926, p=0.00) between plasma K level and Na. Plasma P showed a negative relation (r=-0.571, p=0.03) with A_0, but a positive correlation (r=0.547, p=0,04) with Mg. Nonetheless, there was a positive correlation between Mg and Ca concentration (r=0.655, p=0.01). Plasma Fe correlated negatively with Cl (r=-0.561, p=0.03), K (r=-0.593, p=0.02), Na (r=-0.557, p=0.03), and A_0 (r=-0.562, p=0.03) but positively with P (r=0.543, p=0.04), Mg (r=0.605, p=0.02), and Ca (r=0.798, p=0.00). The different reproductive characteristics are presented in Table 4.

Results of the present research indicated that the weight of multiparous female goats at mating was higher than that of primiparous females (20.85±1.95, and 27.00±4.76, respectively). However, the birth weight of multiparous kids (n=7) was higher than that of primiparous kids (n=8) (3.12±0.54 and 2.84±0.78 respectively). As regards the reproduction parameters applied in the studied animals, primiparous females were more fertile (100%), more productive (72.72%), and more prolific (114.28%) compared to multiparous. Furthermore, data show that primiparous goats present a notable abortion rate (36.36%).

Discussion

In general, several factors other than insufficient supply or amount affect the concentration of trace elements and macrominerals. The following factors, for instance, can impact the bioavailability of minerals and result in a secondary deficiency: species, breed, sex, age, physiological status (e.g., stage of pregnancy and lactation), inflammation, antagonists, concentration in the forage (i.e., forage species, age of plant, soil type, climate, management practices), and season (Khan et al. 2007, Russell et al. 2007, Herdt et al. 2011, Schweinzer et al. 2017).

Table 4. Differences in reproductive variables in Arbia goats related to parity.

	Primiparous (n=11)		Multiparous (n=10)		Total (n=21)	
Number of goats whelping	7		7		14	
Infertile goats	0		2		2	
Aborted goats	4		1		5	
The goat's age at mating (Mean ± SD)	2±0.00		7.42±0.78		4.71±3.28	
The goat's weight at mating (Mean ± SD)	20.85±1.95		27.00±4.76		24.19±6.08	
Number of kids	8		7		15	
Sex of kids + number	M	F	M	F	M	F
	4	4	4	3	8	7
Kids' birth weight (Mean ± SD)	2.84±0.78		3.12±0.54		2.98±0.66	
Fertility rate	100%		80%		90.47%	
Fecundity rate	72.72%		70%		71.42%	
Prolificacy rate	114.28%		100%		107.14%	
Abortion rate	36.36%		12.5%		26.31%	

Parity's effects on blood mineral parameters during various stages of reproduction

Results of biochemical mineral parameters in primiparous and multiparous Arbia goats in the different phases of reproduction (mating period, pregnancy, and post-partum period) indicated that all investigated plasma blood parameter levels showed different variations. In this study, the highest concentrations of the electrolytes sodium (Na), potassium (K), and chloride (Cl) were observed in the middle of gestation (3-4 months). Contrary to Dakka and Abdel Ali (1992) findings, the plasma Na concentrations of gestating Arbia goats were higher before gravidity (Dakka and Abdel Ali 1992). However, the participation of Cl, K, and Na ions in fertilization, oocyte activation, follicle viability, and its activity in estrogen synthesis contributes to the substantial decrease in the concentration of these parameters during the mating period; during murine oocyte activation, the membrane potential changes, indicating the permeability of the membrane to K and Na (Hassan et al. 2018, Gałęska et al. 2022).

Phosphorus levels in the late pregnancy period were significantly lower ($p<0.05$), the results observed in this study were in agreement with those of Ahmed et al. (2000), the reduction in this element may be the consequence of hemodilution from maternal plasma expansion, increased transport of these element to the fetus by certain mediators, which are expressed in the placenta, thereby causing a fall in blood concentration of these elements during pregnancy (Asma et al. 2020, Derar et al. 2022).

There was a significant change ($p<0.05$) in the calcium (Ca) content during the last month of pregnancy. Comparable to our results, Ca levels in late gestation in Kilis does (Iriadam 2007) show substantial variations, while in Baladi does (Azab et al. 1999), there was a notable decrease in late pregnancy as compared to before pregnancy. Our findings are in line with those reported by Elias and Shainkin-Kestenbaum (1990), who noted hypocalcemia in ewes throughout the latter stages of pregnancy and related it to the growing calcium requirements of the developing fetus (Elias et al. 1990). Additionally, Liesegang et al. (2006) suggest that the loss of calcium during different stages of reproduction is probably the cause of calcemia deficiency in females (Liesegang et al. 2006).

In contrast, our results showed no significant shift in the magnesium concentration, and their concentrations increased following gestation. According to Allaoua and Mahdi (2018), there was a non-significant modification in late gestation, although the phases of lactation did not affect magnesium concentrations. It demonstrates that Arbia goats may be compensating for the reduced supply of magnesium by excreting less of it in their milk and urine (Allaoua et al. 2014).

A significant decrease in iron concentrations was observed during the late pregnancy and post-partum phases. Tanritanir et al. (2009) found that Fe increased significantly after parturition compared to pregnancy in goats, which is contrary to our results (Tanritanir et al. 2009). However, similar to the findings of Azab and Abdel-Maksoud (1999), Fe declined significantly during late pregnancy, on the day of parturition, and during the three weeks following partum compared to before pregnancy (Azab et al. 1999). However, Antunovic et al. (2004) reported that although there was a marked increase in serum Fe levels depending on fetal growth, particularly during the last trimester of pregnancy, while the levels decreased immediately before the lambing of Akkaraman ewes (Antunović et al. 2004). This decline is thought to occur due to the usage of Fe (Gürdoğan et al. 2006).

Relationship between the kids' birth weight, the age and weight of the goats on mating, and the minerals plasma parameters in the later stages of pregnancy

It is well known that throughout late gestation, parturition, and the post-partum period, significant metabolic changes occur (Azab et al. 1999). These modifications are necessary for providing the developing fetus's nutritional needs and controlling the female's lactation requirements. According to our results, the minerals plasma parameter during the late pregnancy stage and the age and weight of the goats at mating have a significant relationship **(Table 3)**. Electrolytes, which include sodium (Na^+), potassium (K^+), and chloride (Cl^-), are charged ions that are necessary for the survival of organisms. An electrolyte imbalance affects an animal's ability to reproduce, which in turn affects its capacity to breed more animals. Reproductive cell inhibition is one distinct consequence of electrolyte-hormone line irregularities. The animal's reproductive system becomes ineffective, and its health deteriorates as a result of anomalies in the feedback line. Its viability for breeding and general well-being is therefore decreased (Leemans et al. 2016). Hypomagnesemia can develop as a result of hyperkalemia, among other factors. Some studies have shown that ruminants fed diets high in potassium have a markedly decreased ability to absorb magnesium from their digestive tracts. For ruminants in particular, magnesium is crucial (Hernández et al. 2020). Hypocalcemia and hypomagnesemia frequently coexist because the fetal calcium demand is greater than that of lactation in sheep (Allen et al. 1986, Castillo et al. 1997), hypocalcemia and hypophosphatemia in sheep typically manifest in the last month of pregnancy rather than during lactation (Russell et al. 2007).

The effect of parity on kids' birth weight

The data of our research indicated that the parity affected the birth weight of Arbia kids, the multiparous kids (n=7) had a higher birth weight than the primiparous kids (n=8) (3.12±0.54 and 2.84±0.78, respectively). According to Laes-Fettback and Peters (1995), mothers' ages are important factors; primiparous kids are lighter at birth than multiparous kids (Laes-Fettback et al. 1995). The same results reported by Bharathidhasan et al. (2009) indicated that second parity birth weights (2.04 kg) tended to be higher than first parity birth weights (1.88 kg) (Thiruvenkadan et al. 2008). Additionally, the same authors noted that in the second parity, there was a higher weight growth (58.69 g) and weaning weight (7.25 kg) compared to the first parity (6.61 kg and 52.42 kg, respectively). Moreover, Mahal et al. (2013) noted that birth weight increased as parity increased (Mahal et al. 2013). The highest birth weight was significantly associated with the 4th and second parities (1.5 kg and 1.3 kg, respectively), while the lowest parity had the lowest birth weight (1.1 kg). The difference in birth weight between the first and second parities was not significantly different (El-Moghazy et al. 2018).

The effect of parity on reproduction parameters

Our results demonstrate that in Arbia goats, primiparous females are more fertile (100%), more fecund (72.72%), and more prolific (114.28%) compared to multiparous Zaraibi goats. On the other hand, they show superior reproductive characteristics in the 5th parity (El-Moghazy et al. 2018). In terms of prolificacy, a higher prolificacy was observed in the 3rd (185.71%) and 5th (185.71) parity than the 1st (157.14%) parity. Furthermore, Hossain et al. (2004) found that prolificacy has been significantly affected by parity 1, 2 and 3, with estimates of 108, 176 and 196%, respectively (Hossain et al. 2004). In addition, Akpa et al. (2011) noted that goat prolificacy tended to increase as parity advanced.

In conclusion, Arbia goats' parity affects mineral concentrations at different phases of reproduction and throughout the entire late gestation period. This research also revealed an intense relationship between minerals, proving that since a fetus's requirements increase in the last month of pregnancy, deficiencies must be avoided with a balanced diet and supplementation. As a result, parity affects the birth weight of Arbia kids; the birth weight increases as parity increases. However, this study shows that the Arbia goats' reproductive parameters decrease with parity, indicating that aged goats should not be mated to maintain their highest level of performance.

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