



Impact of Defaunation on Physical Examination, Bodyweight, Feed Intake and Rumen Protozoal, Biochemical and Histo-Anatomical Compositions in Native-breed Goats

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Abstract | Defaunation is the selective removal of protozoa from the rumen of ruminant animals. Defaunation's effects on rumen ecology and ruminant bodyweight gain are still up for debate. The objective of the study was to evaluate the effects of two defaunating agents, sodium lauryl sulfate (SLS) and dioctyl sodium sulphosuccinate (DOSS), on physical examination, feed intake, bodyweight, and the protozoal, biochemical, and histo-anatomical compositions of the rumen in native-bred goats. Fifteen healthy female goats were used; five of them were kept as control group, while the remaining ten goats were divided randomly into two groups each one contained five goats. The first group was given sodium lauryl sulfate (SLS) in an 8% solution and the second group was administered dioctyl sodium sulphosuccinate (DOSS) in a 98% solution. The results demonstrated that both defaunating agents had a detrimental effect on rumen motility, feed intake, bodyweight gain, as well as rumen total and differential protozoal counts, rumen ammonia nitrogen, and rumen enzymatic activities. Despite the fact that SLS and DOSS have practical applications in industries ranging from environmental cleanup to personal care, ongoing research is essential to optimize their use, understand their environmental impact, and explore alternatives and new applications in biomedical and advanced materials fields. SLS revealed more harmful effects than DOSS, causing the ruminal mucosa and ruminal papillae to shorten, degenerate, and burn, especially at ruminal pillars. Due to their dramatic drawbacks, it is not recommended to administer DOSS as a surfactant for treating bloat or to apply defaunation using SLS in fattening ruminants, to maintain sustainable production in goat's flocks.

Keywords | Goats, Rumen ciliates, Rumen papillae, Bodyweight, Defaunation, Dioctyl sodium sulphosuccinate, Sodium lauryl sulphate

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Ruminants have a characteristic ability to transform plant structural carbohydrates and non-protein nitrogenous substrates into animal protein of great biological value. They are abundant and contribute significantly in agriculture livestock economy (Bhatia *et al.*, 2004). Goats are widely distributed livestock species due to their ability to generate essential products such as milk, meat, and skin (Wang *et al.*, 2021). They are found all over Egypt, but are particularly concentrated in the delta and valley of the Nile, and are less common in the northwest coastal region and at oasis (Galal *et al.*, 2005). In the context of climate change, goats stand out from other ruminants due to their superior capacity to sort feed and their high resistance to environmental anxieties like heat and water stress (Fehr *et al.*, 2004; Reverdin *et al.*, 2020).

Goats' stomach is a multi-chamber organ that is composed of four separate chambers: the reticulum, omasum, abomasum, and rumen. It has the capacity to break down fibrous foods into very small nutritious compounds. The rumen is the most significant compartment which located in the left side of the abdominal cavity. Evans and Sack (1973), and its shape resembles a flattened bag with an incomplete U shape as well as it bordered with numerous papillae, which are tiny tissue projections, and internally separated into compartments by pillars (Bello *et al.*, 2020). Selective Removal of protozoa from the rumen is known as defaunation. Through the use of defaunated animals, previous studies have assessed the modifications in rumen kinetics that protozoa cause (Santra and Jakhmola, 1998). It is challenging to do research on the defaunation of the rumen, in part because defaunated animals are hard to get and keep alive without complete absence of protozoa and because protozoa are challenging to grow in vitro. Additionally, it is said that the differences in the physical architecture of the ovine and bovine rumens are the reason why defaunation of cattle is more difficult than it is for sheep (Eugène *et al.*, 2004).

Defaunation's effects on animal productivity and health are still debatable. Defaunation is found to have a favorable impact on feed intake (Chandramoni *et al.*, 2002) and growth rates (Bird and Leng, 1978). On the contrary, numerous previously published literatures have noted that defaunation has no discernible impact on feed intake, animal health, ruminal fermentation pattern (Bird *et al.*, 1994; Eryavuz *et al.*, 2003; Eadie and Oxford, 1957; Ankrah *et al.*, 1990) and milk composition (Saber *et al.*, 2023). The generation of microbial proteins and methane is tightly connected with the presence or absence of rumen protozoa in terms of ruminal metabolism. Defaunation increases the bacterial population density, the effectiveness of bacterial protein synthesis, the rate of nitrogen flow to the du-

odenum, as well as the reduction in methane production (Nguyen *et al.*, 2020). These effects are positively reflecting on livestock productivity, particularly when the feed is low in protein in relation to the energy content or allows for the consumption of poor quality roughage diets (Newbold *et al.*, 2015), which is the main feed source in most agricultural systems.

Defaunation has thus been one of the subjects of ongoing research by veterinary practitioners in different parts around the globe, particularly the developing countries (Mekasha and Gebeyehu, 2013), especially from productive perspectives (Saber *et al.*, 2023) such as bodyweight gain and feed utilization. The purpose of our study is to determine how employing SLS and DOSS, two distinct defaunating agents, for 21 days might affect bodyweight, feed intake, and rumen biochemical, histo-anatomical compositions in native-breed goats.

MATERIALS AND METHODS

ANIMALS CARE

Fifteen apparently healthy female Baladi native-breed goats were kept individually in separated pens (2X2 meters) belonged to Department of Medicine and Infectious Diseases, Faculty of Veterinary Medicine, Cairo University. Availability of separate pens in the department was the determinant factor of sample size to estimate the daily feed intake for each separate animal. Their mean age was 2.5 ± 0.36 years old and mean bodyweight was 32.45 ± 2.39 kg. All of them were exposed to a comprehensive physical clinical examination to ensure that they are apparently healthy and free from any signs of illness. This study was carried out according to the regulations of the statement of "Ethics of Animal Experiments Committee", Faculty of Veterinary Medicine, Cairo University (Date: 10/11/2023), No: VetCU10112023085.

EXPERIMENTAL DESIGN

Five of goats were used as a control group for determination the normal anatomical and histological composition of rumen papillae. Then, the other ten goats were classified randomly according to type of defaunating agent into two groups; sodium lauryl sulfate (SLS) and dioctyl sodium sulphosuccinate (DOSS), each one contained 5 goats. SLS group was exposed to defaunation using sodium lauryl sulfate as 8% solution at dose rate of 80 mg/kg according to (Santra and Karim, 2000). DOSS group was exposed to defaunation using dioctyl sodium sulphosuccinate 98% at dose rate of 0.7 mg/kg according to (Orpin, 1977). The oral administration of both defaunating agents was carried out daily for the first three days of the experiment then once weekly for three consecutive weeks.

PHYSICAL EXAMINATION, FEED INTAKE, BODYWEIGHT AND RUMEN FLUID PARAMETERS: Physical clinical examination including pulse rate, respiratory rate, temperature, rumen motility and body condition scoring (BCS) were estimated weekly according to (Pugh and Baird, 2012). As well as feed intake was estimated daily and bodyweight was measured weekly. A physical clinical examination is a valuable tool for evaluating the defaunating agents (SLS and DOSS) which it provides direct observations of physiological effects, complements laboratory findings, aids in monitoring changes over time. By integrating physical examination with other evaluation methods, you can gain a comprehensive understanding of how these agents' impact health and safety.

The rumen fluid samples were taken every week for three weeks starting at 8 a.m., before morning meal at 0 day; before defaunation, and then at 7, 14, and 21 days after defaunation. About 50 ml of rumen fluid samples were collected in a dry clean cup using a rubber stomach tube and suction pump. Rumen pH were examined immediately according to (Alonso 1979; Dirksen and Smith 1987), then samples were sieved through 4 folds of sterile gauze. 2 ml fixed with strong acids to determine total volatile fatty acids (VFAs) concentration by steam distillation method described by Eadie *et al.* (1967), 2 ml fixed and stained with methyl green formal saline for counting of Total protozoa count (TPC) and protozoa percentages according to ITO *et al.* (1994), 2 ml for determination of Rumen ammonia nitrogen concentration ($\text{NH}_3\text{-N}$) by using specific kit produced by Spectrum Company, Egypt, according to the method of (Chaney and Marbach, 1962). Then 10 ml of strained rumen fluid were centrifuged for 15 minutes at 3000 rpm and the supernatants were collected to determine the biochemical constituents; calcium (Ca), magnesium (Mg), inorganic phosphorus (P), rumen enzymes; ALT, AST and GGT were estimated using specific kits produced by SPECTRUM Company, Egypt, according to the method described by Young and Friedman (2001).

GROSS RUMEN SAMPLES: The five rumen samples of control goats, and the ten samples of defaunated goats were collected manually after Islamic slaughter at 21 day post defaunation. The abdomen was cut open immediately, the complex-stomach was exteriorized, and the weight of the rumen was recorded by digital weighing balance. With the use of a hand lens and eyes, the shape, size, and color of the rumen were examined both inside and externally. Before being examined for papillae morphology, the rumen from the atrium ruminis cleaned with PBS and the rumen tissues were removed then preserved in 4% paraformaldehyde solution.

Measurements were taken by measuring tapes for the rumen papillae length ($\text{RPL} = \text{from base to apex}$), rumen pa-

pillae width ($\text{RPW} = \text{in the middle region of the papillae}$), and rumen papillae area ($\text{RPA} = \text{RPL} \times \text{RPW}$) in order to perform morphometric analysis. Using a micrometer screw gauge, the thickness of the rumen was measured from its surface to the segment's internal wall. Using the water displacement approach, the volume of the rumen was calculated as its total volume (Achimadic principle). The Olympus SP-600UZ 12 mega pixel digital camera was used to take pictures of the specimens.

HISTOPATHOLOGICAL SAMPLES: Histological preparations follow the procedure described by (Bancroft and Stevens 2016). In summary, rumen tissues were cut into slices that were 3–4 mm thick, preserved for 72 hours in 10% neutral buffered formalin (10% NBF), dehydrated in ethanol dilutions, cleaned in xylene, and finally embedded in paraffin. Using a microtome, the rumen paraffin blocks were sectioned at a thickness of 4–6 μm , and then stained with Hematoxylin and Eosin to evaluate the overall rumen tissue structure among the groups under microscopic examination to assess changes in microbial populations and tissue structure. This approach helps researchers understand the effects of defaunation on the rumen ecosystem and its potential implications for ruminant nutrition and health. A Light Leica Microscope (CH9435, Hee56rbrugg) (Leica Microsystems, Switzerland) was applied to take pictures at various magnification power settings. Analyzing and interpreting histopathological findings from rumen tissue in goats exposed to SLS or DOSS involves a thorough examination of tissue sections for structural and cellular changes. By comparing treated and control samples, quantifying changes, and relating findings to clinical and mechanistic contexts, researchers can gain insights into the impact of these defaunating agents on rumen health and function.

HISTOCHEMICAL EXAMINATION: Rumen slices were stained with Sirius Red stain (Sigma-Aldrich "Direct Red 80", St Louis, MO, USA) to accurately see collagen fibers and estimate collagen sedimentation. Collagen fibers had a red color, while non-collagen proteins had a pale yellow color, according to Gopinathan *et al.* (2020). The Light Leica Microscope (CH9435, Hee56rbrugg) from Leica Microsystems, Switzerland was utilized to capture images at different magnification power levels. The quantification of collagen fibers was assessed along the rumen area using an image analysis system, known as "L.A.S. software v.4", Cambridge, UK (20 $\times$ objective lens).

STATISTICAL ANALYSIS

A two-way (2×3) repeated-measures analysis of covariance test (RANCOVA) was performed to determine the main effects of defaunating agents (SLS and DOSS) and defaunation time interval (7, 14, and 21 days following defaunation) on each physical and rumen fluid parameter under

study while controlling for their baseline values. Every parameter's value prior to defaunation was examined as a covariate to control for any initial differences among the goats and improves the accuracy of comparing changes after treatment and the interaction term between the two main effects was also examined. Two-way (2×2) repeated-measures analysis of variance test (RANOVA) was used specifically to test for the main effect of defaunation (before versus after) and its interaction of defaunating agent (SLS versus DOSS).

uate the homogeneity of variance; this ensures that the variance within groups was consistent. Post-hoc analysis used if significant differences were found in ANOVA or ANCOVA tests, Tukey's honestly significant difference (HSD) test was used to determine which specific groups differed from each other. Non-parametric tests were used for data that were not normally distributed. Data were presented as the mean ± standard deviation (SD). Statistical significance was set at $P < .05$. All analyses were performed with SAS® version 9.4 (SAS, 2013).

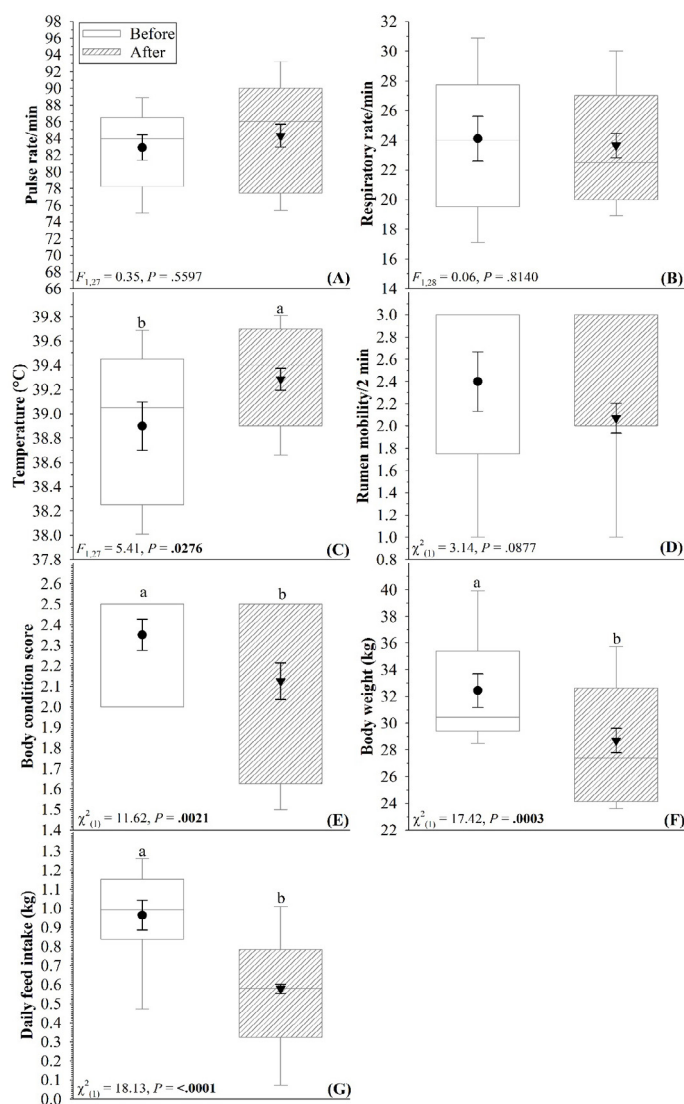


Figure 1: Comparisons between values of physical examination parameters measured in goats before and after defaunation. Within each box plot, vertical line indicates median, black symbol indicates mean, and error bars represent standard error of mean. Within the same parameter, data with different lowercase letters differ significantly between before and after defaunation at $p < .05$ if bold.

The Shapiro–Wilk test was checked for normality analysis; if data was normally distributed, parametric tests (like ANOVA) were used. While, Levene's test was used to eval-

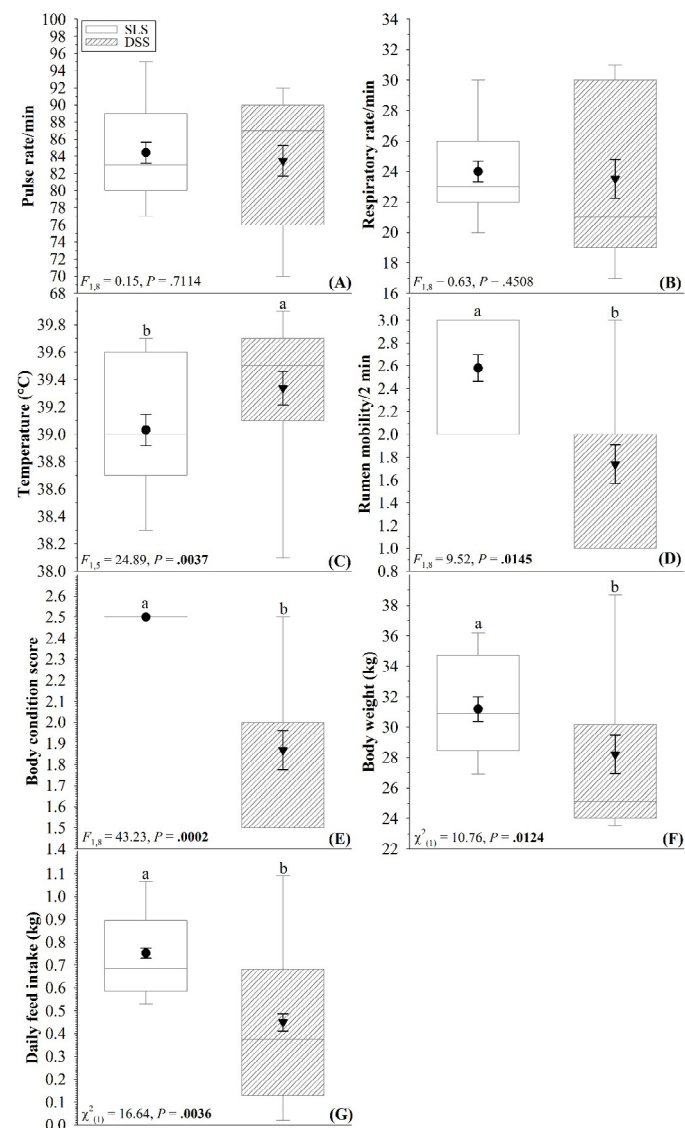


Figure 2: Comparisons between effects of two defaunating agents (sodium lauryl sulfate [SLS] and dioctyl sodium sulphosuccinate [DSS]) on values of different physical examination parameters measured in goats. Within each box plot, vertical line indicates median, black symbol indicates mean, and error bars represent standard error of mean. Within the same parameter, data with different lowercase letters differ significantly between defaunating agents at $p < .05$ if bold.

In essence, these statistical methods were employed to rigorously analyze how defaunating agents and time intervals

affect various parameters in the rumen of goats, ensuring robust conclusions from the experimental data.

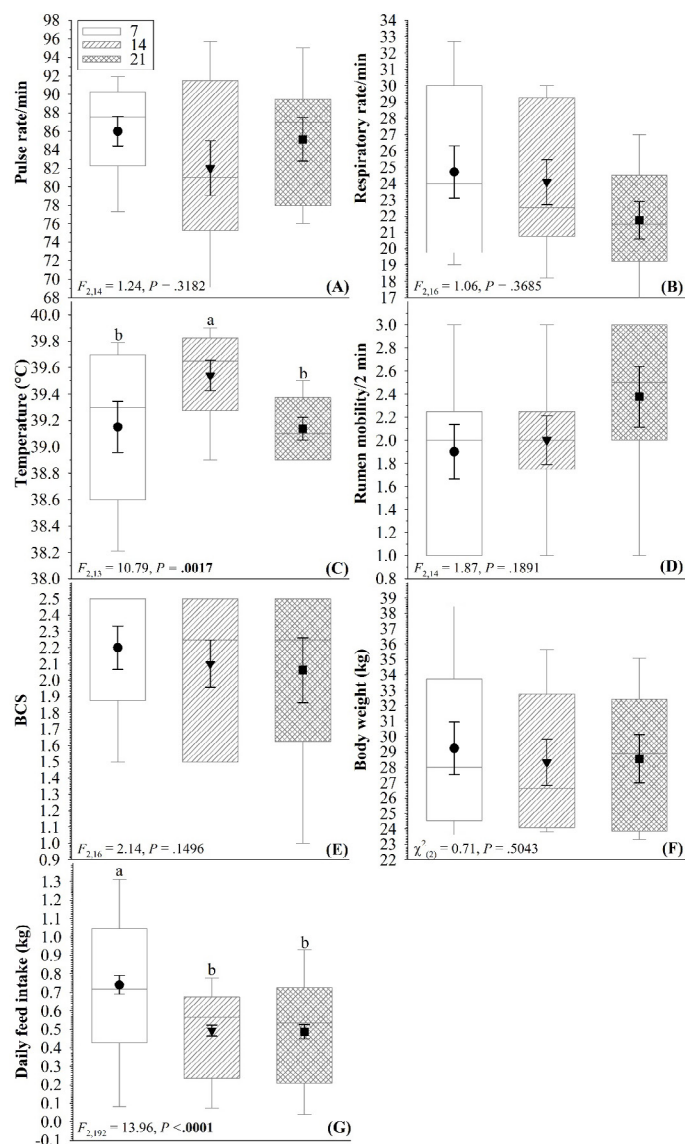


Figure 3: Effect of days after defaunation (7, 14, and 21 days) on different physical examination parameters measured in goats. Within each box plot, vertical line indicates median, black symbol indicates mean, and error bars represent standard error of mean. Within the same parameter, data with different lowercase letters differ significantly among days after defaunation at $p < .05$ if bold.

STATISTICAL ANALYSIS OF HISTOCHEMICAL FINDINGS

Data were examined for normal distributed (parametric data) via Kolmogorov-Smirnov test of normality. One Way ANOVA used to analyze the differences between groups for each parameter studied. When significant differences were found in the ANOVA, post-hoc tests (such as Tukey's HSD test) were conducted to determine which specific groups differed from each other. P -values < 0.001 were considered as statistically significant. Statistical analysis was conducted with SPSS (Statistical Package for Scientific Studies, SPSS, Inc., Chicago, IL, USA) version 21.0

for Windows. In essence, these statistical methods were applied to explore relationships between different groups in the data, using standard techniques and software commonly used in scientific research.

RESULTS AND DISCUSSIONS

PHYSICAL EXAMINATION, BODYWEIGHT GAIN AND DAILY FEED INTAKE

The results of physical clinical examination were tabulated in (Table 1 and 2) and revealed that there were no significant effect in all parameters before and after administration of SLS and DOSS (defaunating agents) exclude temperature (Figure 1). Regarding SLS and DOSS groups, there was significant increase in temperature (Figure 2) and decrease in BCS, feed intake and bodyweight in days 14 and 21 in comparison with day 7 of administration (Figure 3).

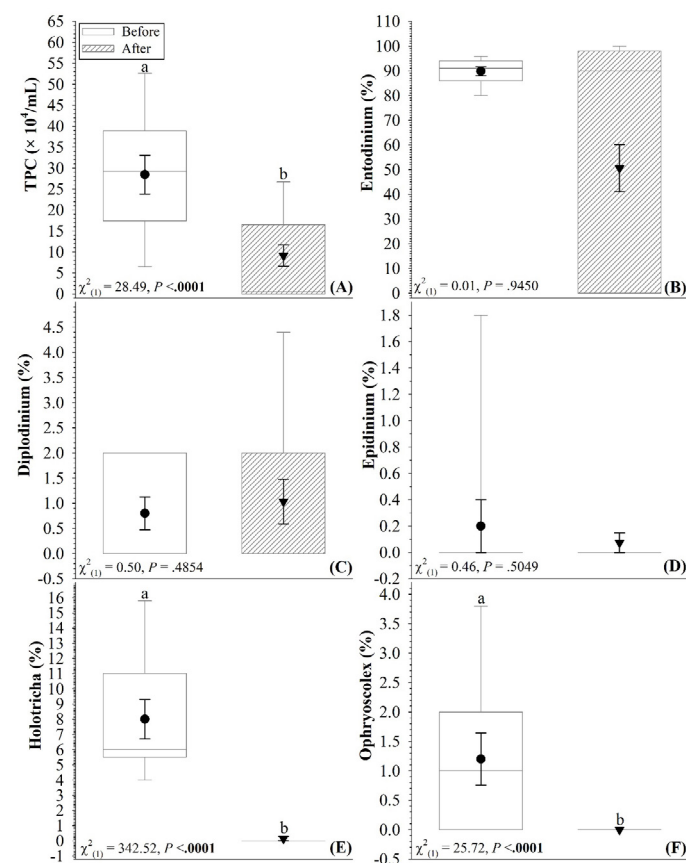


Figure 4: Comparisons between values of different rumen protozoa examined in goats before and after defaunation. Within each box plot, vertical line indicates median, black symbol indicates mean, and error bars represent standard error of mean. Within the same parameter, data with different lowercase letters differ significantly between before and after defaunation at $p < .05$ if bold.

RUMEN PROTOZOA AND RUMEN BIOCHEMICAL CONSTITUENTS

Results of rumen protozoal populations under the effect of defaunating agents and defaunation period were sum-

marized in (Tables 1 and 3) and (Figure 4, 5 and 6). Total protozoal count (TPC), Entodinium % and Diplodinium were significantly influenced by the defaunating agent, while Diplodinium % were significantly affected by days post defaunation and days-agent interaction (Table 1). Referring to (Figure 4), defaunation caused significant decrement in TPC, *Holotrich* % and *Ophryoscolex* %. Regardless the effect of defaunation period, TPC, *Entodinium* %, *Holotricha* % and *Diplodinium* % decreased significantly due to DOSS (Figure 5 and Table 3). Regarding the effect of days after defaunation, *Diplodinium* % showed significant decrement at 14 days post defaunation (Figure 6).

Results of rumen biochemical constituents under the effect of defaunating agents and defaunation period were summarized in (Table 1 and 4) and (Figure 7, 8 and 9). Rumen pH and rumen ALT were significantly affected by the defaunating agent, while rumen P was significantly affected by days after defaunation, but rumen Mg was significantly influenced by days-agent interaction, however, rumen TVFAs and rumen Mg were significantly affected by both; the defaunation period and the defaunating agent (Table 1).

Considering Figure 7, defaunation generally caused significant decrement in rumen ammonia nitrogen concentration, rumen Mg concentration, rumen GGT activity and rumen ALT activity. Regardless the effect of days post defaunation, rumen ammonia nitrogen concentration decreased significantly due to SLS, however, DOSS caused non-significant difference (Table 4). Rumen GGT activity decreased significantly due to SLS and DOSS, while ALT activity decreased significantly due to DOSS, however, SLS caused non-significant difference (Table 4). Rumen pH decreased significantly due to DOSS, while rumen Mg and rumen TVFAs revealed significant decrement due to SLS (Figure 8).

Regarding the effect of days post defaunation; 7, 14 and 21, rumen TVFAs increased significantly at 21 days post defaunation. Rumen P showed sequential significant increment in 7, 14 and 21 days post defaunation, respectively. Rumen Mg showed significant increment in 14 and 21 days after defaunation (Figure 9).

Table 1: Statistical analysis results (test statistics, degrees of freedom, and P-value) for main effects of days after defaunation (days) and defaunating agent (agent); and their interaction. Effect of values of each parameter before defaunation was tested as a covariate. Significant results at *P* < .05 if bold.

Parameters		Covariate		Days		Agent		Days × Agent	
		F _{1,7}	p-value	F _{2,16}	p-value	F _{1,6}	p-value	F _{2,16}	p-value
Physical	Pulse rate/min	0.01	.9065	1.24	.3182	0.13	.7245	3.72	.1471
	Respiratory rate/min	8.91	.0217	0.79	.4717	0.16	.7001	1.66	.2212
	Temperature (°C)	10.98	.0200	10.79	.0017	24.89	.0037	14.3	.0005
	Rumen mobility/2 min	0.88	.3791	1.87	.1891	9.52	.0145	0.20	.8216
	BCS	3.01	.1260	2.19	.1487	19.19	.0030	2.19	.1487
	Body weight (kg)*	52.20	0.0002	0.71	0.5043	10.76	.0124	0.51	.6095
	Daily feed intake (kg)*	1.52	.2540	16.48	<.0001	16.64	.0036	0.27	.7644
Rumen protozoa	TPC (×10 ⁴ /mL)*	0.27	.6149	0.62	.5507	162.11	<.0001	0.69	.5188
	Entodinium (%)*	1.10	.3364	1.51	.2585	22.38	.0038	0.64	.5434
	Diplodinium (%)*	2.93	.1361	8.55	.0040	14.93	.0055	8.55	.0040
	Epidinium (%)*	0.42	.5422	0.82	.4617	1.30	.2886	0.82	.4617
	Holotricha (%)*	6.54	.0347	1.18	.3343	1.81	.2146	1.25	.3132
	ophryoscolex (%)*	<0.01	>.9999	<0.01	>.9999	<0.01	>.9999	<0.01	>.9999
Rumen biochemistry	pH	0.01	.9739	2.31	.1325	7.80	.0257	0.20	.8189
	Ammonia-N	0.03	.866	0.68	.5213	0.51	.5055	0.93	.4182
	Total VFAs	0.05	.8292	11.58	.0009	9.94	.0151	0.55	.5898
	Ca	1.52	.2504	3.07	.0831	0.02	.8790	3.04	.0846
	P	0.11	.7512	473.82	<.0001	1.48	.2639	0.87	.4407
	Mg	1.68	.2403	11.68	.0010	42.6	.0005	8.90	.0030
	GGT	1.40	.2802	3.57	.0505	2.20	.1776	0.80	.4689
	ALT	0.80	.4091	3.33	.0599	8.83	.0194	2.74	.0975
	AST	0.02	.8870	0.46	.6414	0.06	.8170	2.81	.0918

Table 2: Mean ± standard deviation (*SD*) and 95% confidence intervals (between parentheses) of physical examination parameters measured in female goats before and after defaunation by sodium lauryl sulfate (SLS) or dioctyl sodium sulphosuccinate (DSS).

Variables	SLS			DSS		
	Before defaunation (n = 5)	After Defaunation (n = 14)	Days after Defaunation 7 (n = 5) 14 (n = 5) 21 (n = 4)	Before defaunation (n = 5)	After Defaunation (n = 14)	Days after Defaunation 7 (n = 5) 14 (n = 5) 21 (n = 4)
Pulse rate/min	83.8 ± 3.63 (79.29–88.31)	84.64 ± 6.08 (81.13–88.16)	82.40 ± 4.45 (76.87–87.93)	84.00 ± 7.42 (74.79–93.21)	88.25 ± 5.85 (84.94–97.56)	82.00 ± 6.04 (74.50–89.50)
Respiratory rate/min	23.60 ± 2.61 (20.36–26.84)	24.14 ± 3.21 (22.29–25.99)	27.00 ± 3.08 (23.17–30.83)	22.60 ± 2.19 (19.88–25.32)	22.50 ± 2.08 (19.19–25.81)	24.60 ± 6.66 (16.34–32.86)
Temperature (°C)	39.02 ^{AB} ± 0.63 (38.24–39.80)	39.04 ^{AB} ± 0.48 (38.76–39.31)	38.62 ^c ± 0.36 (38.18–39.06)	39.40 ^{ab} ± 0.46 (38.83–39.97)	39.10 ^b ± 0.18 (38.81–39.39)	38.78 ^B ± 0.68 (37.94–39.62)
Rumen mobility/2 min	2.80 ^A ± 0.45 (2.24–3.36)	2.50 ^A ± 0.52 (2.20–2.80)	2.40 ^{ab} ± 0.55 (1.72–3.08)	2.40 ^{ab} ± 0.55 (1.72–3.08)	2.75 ^a ± 0.50 (1.95–3.55)	2.00 ^{AB} ± 1.00 (0.76–3.24)
BCS	2.50 ^A ± 0.00 –	2.50 ^A ± 0.00 –	2.50 ^a ± 0.00 –	2.50 ^a ± 0.00 –	2.50 ^a ± 0.00 –	2.20 ^B ± 0.27 (1.86–2.54)
Body weight (kg)*	34.70 ^{AB} ± 4.32 (28.89–37.29)	30.90 ^{AB} ± 5.00 (28.52–32.49)	31.24 ± 3.84 (26.83–35.69)	30.90 ± 5.00 (24.12–35.56)	30.40 ± 3.00 (27.09–33.71)	30.10 ^A ± 0.60 (25.90–37.74)
Daily feed intake (kg)*	1.03 ^A ± 0.22 (0.57–1.36)	0.68 ^A ± 0.30 (0.70–0.78)	0.86 ^a ± 0.38 (0.78–0.96)	0.63 ^b ± 0.13 (0.61–0.68)	0.63 ^{ab} ± 0.33 (0.63–0.77)	0.96 ^A ± 0.22 (0.74–1.19)

Table 3: Median $\pm$ interquartile range and 95% confidence intervals (between parentheses) of different rument protozoa examined in female goats before and after defaunation by sodium lauryl sulfate (SLS) or dioctyl sodium sulphosuccinate (DSS).

Variables	SLS				DSS					
	Before defau- nation (n = 5)	After Defau- nation (n = 14)	Days after Defaunation		Before defau- nation (n = 5)	After Defau- nation (n = 14)	Days after Defaunation			
TPC (×10 ⁴ /mL)	33.00 ^A ± 4.50 (21.68–44.72)	16.50 ^A ± 8.50 (10.20–26.72)	7 (n = 5) 16.00 ^{ab} ± 11.50 (-5.93–39.93)	14 (n = 5) 18.75 ^a ± 10.25 (4.28–28.47)	21 (n = 4) 17.00 ^a ± 17.25 (-0.43–45.18)	18.00 ^A ± 10.50 (1.11–46.29)	0.00 ^B ± 0.00 (-0.42–1.27)	7 (n = 5) 0.00 ^{bc} ± 0.00 (-0.18–0.38)	14 (n = 5) 0.00 ^{bc} ± 0.00 (-1.95–4.15)	21 (n = 4) 0.00 ^c ± 0.00 –
Entodinium (%)	88.00 ^{AB} ± 12.00 (78.64–94.96)	98.00 ^A ± 6.00 (73.31–106.08)	98.00 ^{ab} ± 4.00 (23.79–132.21)	100.00 ^a ± 1.00 (97.91–101.09)	95.00 ^{ab} ± 5.00 (89.06–99.94)	94.00 ^{AB} ± 4.00 (89.47–96.13)	0.00 ^B ± 0.00 (-6.68–35.25)	0.00 ^b ± 0.00 (-35.53–75.53)	0.00 ^b ± 0.00 (-35.53–75.53)	0.00 ^b ± 0.00 –
Diplodinium (%)	2.00 ^{AB} ± 2.00 (-0.71–1.51)	0.00 ^B ± 0.00 (0.34–3.96)	0.00 ^b ± 2.00 (-0.56–2.16)	0.00 ^b ± 1.00 (-1.09–2.09)	5.00 ^a ± 5.00 (0.06–10.94)	2.00 ^A ± 2.00 (-0.16–2.56)	0.00 ^B ± 0.00 (-0.16–2.56)	0.00 ^b ± 0.00 –	0.00 ^b ± 0.00 –	0.00 ^b ± 0.00 –
Epidinium (%)	0.00 ± 0.00 (-0.71–1.51)	0.00 ± 0.00 (-0.18–0.49)	0.00 ± 0.00 (-0.71–1.51)	0.00 ± 0.00 (-0.71–1.51)	0.00 ± 0.00 –	0.00 ± 0.00 –	0.00 ± 0.00 –	0.00 ± 0.00 –	0.00 ± 0.00 –	0.00 ± 0.00 –
Holotricha (%)	10.00 ^A ± 6.00 (5.65–15.95)	0.00 ^C ± 0.00 (-0.36–0.98)	0.00 ± 0.00 (-1.42–3.02)	0.00 ± 0.00 –	0.00 ± 0.00 –	6.00 ^B ± 2.00 (3.84–6.56)	0.00 ^C ± 0.00 (-0.36–0.98)	0.00 ± 0.00 –	0.00 ± 0.00 –	0.00 ± 0.00 –
Ophryoscolex (%)	2.00 ^A ± 2.00 (-0.48–3.68)	0.00 ^B ± 0.00 –	0.00 ± 0.00 –	0.00 ± 0.00 –	0.00 ± 0.00 –	0.00 ^A ± 2.00 (-0.56–2.16)	0.00 ^B ± 0.00 –	0.00 ± 0.00 –	0.00 ± 0.00 –	0.00 ± 0.00 –

* Data are presented as median $\pm$ interquartile range instead of mean $\pm$ SD because normality assumption was violated ($p < .05$). Different uppercase letters, within the same row, indicate significant differences at $p < .05$ among four groups (SLS before, SLS after, DSS before, and DSS after). Different lowercase letters, within the same row, indicate significant differences at $p < .05$ among six groups (SLS at 7 d, SLS at 14 d, SLS at 21 d, DSS at 7 d, DSS at 14 d, and DSS at 21 d).

Table 4: Mean $\pm$ standard deviation (*SD*) and 95% confidence intervals (between parentheses) of rumen biochemistry parameters determined in female goats before and after defaunation by sodium lauryl sulfate (SLS) or dioctyl sodium sulphosuccinate (DSS).

Variables	SLS				DSS					
	Before defaunation (n=5)	After defaunation (n=14)	Days after Defaunation			Before defaunation (n=5)	After defaunation (n=14)	Days after Defaunation		
			7 (n=5)	14 (n=4)	21 (n=4)			7 (n=5)	14 (n=5)	21 (n=4)
pH	6.88 ± 0.22 (6.61–7.15)	7.21 ± 0.25 (7.05–7.36)	7.24 ± 0.09 (7.13–7.35)	7.43 ± 0.22 (7.07–7.78)	6.95 ± 0.21 (6.62–7.28)	6.98 ± 0.22 (6.71–7.25)	7.01 ± 0.39 (6.78–7.23)	7.04 ± 0.36 (6.59–7.49)	7.1 ± 0.43 (6.57–7.63)	6.85 ± 0.41 (6.19–7.51)
Ammonia-N (mmol/L)	13.79A ± 4.47 (8.24–19.35)	7.33B ± 2.06 (6.08–8.57)	8.99 ± 1.78 (6.78–11.21)	5.19 ± 1.37 (3.01–7.38)	7.37 ± 0.43 (6.68–8.06)	11.90AB ± 3.70 (7.31–16.50)	7.44B ± 4.50 (4.84–10.04)	8.16 ± 3.95 (3.25–13.07)	8.60 ± 5.98 (1.18–16.02)	5.10 ± 3.01 (0.31–9.88)
Total VFAs (mmol/L)	51.13 ± 10.65 (34.18–68.07)	43.42 ± 16.29 (33.58–53.27)	37.20b ± 4.86 (31.16–43.24)	31.50b ± 1.74 (28.72–34.28)	40.15 ± 3.96 (37.67–88.58)	54.48 ± 14.47 (46.12–62.84)	50.10ab ± 14.13 (46.12–62.84)	47.90ab ± 12.89 (32.55–67.65)	68.19a ± 8.09 (31.90–63.90)	68.19a ± 8.09 (55.31–81.06)
Ca (mmol/L)	0.43 ± 0.15 (0.25–0.61)	0.75 ± 1.07 (0.10–1.39)	1.36 ± 1.58 (–0.61–3.32)	0.16 ± 0.12 (–0.04–0.35)	0.57 ± 0.33 (0.04–1.10)	0.39 ± 0.33 (–0.02–0.80)	0.84 ± 1.06 (0.17–1.51)	0.57 ± 0.68 (–0.28–1.41)	0.34 ± 0.25 (–0.28–0.97)	1.57 ± 1.54 (–0.88–4.01)
P (mmol/L)	2.45 ± 0.09 2.33–2.56	2.67 ± 1.44 1.80–3.55	1.06c ± 0.00	3.06b ± 0.43	4.31a ± 0.18	2.51 ± 0.08	2.58 ± 1.41	0.97c ± 0.05	2.80b ± 0.19	4.33a ± 0.30 3.84–4.81
Mg (mmol/L)	3.24A ± 1.02 (1.97–4.50)	1.21B ± 0.47 (0.92–1.49)	1.08b ± 0.55 (0.40–1.77)	1.09b ± 0.52 (0.25–1.92)	1.48b ± 0.26 (1.07–1.89)	2.82A ± 1.27 (1.25–4.39)	2.31A ± 1.25 (1.59–3.04)	0.90b ± 0.55 (0.21–1.59)	3.23a ± 0.89 (2.13–4.34)	2.93a ± 0.33 (2.41–3.46)
GGT (Ukat/L)	0.38C ± 0.17 (0.45–1.11)	0.43 ± 0.1 (0.28–0.48)	0.39 ± 0.27 (0.31–0.55)	0.3 ± 0.1 (–0.04–0.83)	1.02A ± 0.51 (0.13–0.46)	0.47BC ± 0.22 (0.35–0.60)	0.53 ± 0.28 (0.18–0.88)	0.58 ± 0.08 (0.48–0.68)	0.27 ± 0.06 (0.17–0.36)	
ALT (Ukat/L)	3.82AB ± 2.66 (1.82–9.13)	1.66ab ± 0.89 (2.21–5.42)	3.93ab ± 2.08 (0.55–2.77)	6.40a ± 2.48 (0.61–7.24)	5.99A ± 3.08 (2.45–10.35)	1.92B ± 2.47 (0.49–3.35)	0.89b ± 0.50 (0.27–1.50)	3.54ab ± 3.80 (–1.18–8.26)	1.19b ± 0.27 (0.75–1.63)	
AST (Ukat/L)	5.16 ± 3.62 (0.67–9.65)	3.34 ± 2.75 (1.67–5.00)	2.28 ± 1.78 (0.07–4.49)	1.92 ± 0.33 (1.40–2.44)	6.08 ± 3.38 (0.70–11.45)	5.97 ± 2.97 (2.28–9.67)	3.31 ± 4.18 (0.89–5.72)	2.56 ± 2.69 (–0.78–5.91)	5.48 ± 6.27 (–2.31–13.26)	1.52 ± 0.63 (0.51–2.53)

* Data are presented as median $\pm$ interquartile range instead of mean $\pm$ *SD* because normality assumption was violated ($p < .05$). Different uppercase letters, within the same row, indicate significant differences at $p < .05$ among four groups (SLS before, SLS after, DSS before, and DSS after). Different lowercases letters, within the same row, indicate significant differences at $p < .05$ among six groups (SLS at 7 d, SLS at 14 d, SLS at 21 d, DSS at 7 d, DSS at 14 d, and DSS at 21 d).

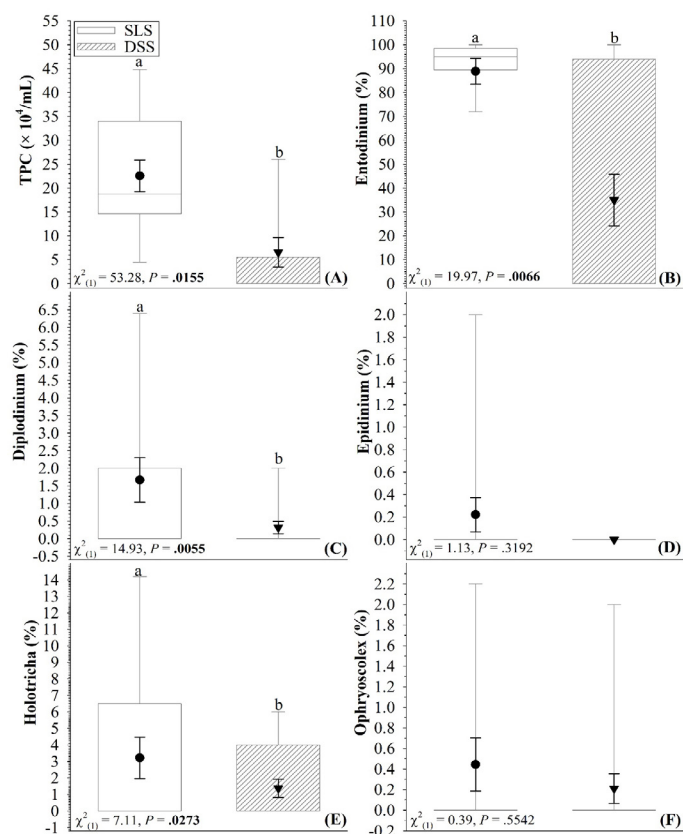


Figure 5: Comparisons between effects of two defaunating agents (sodium lauryl sulfate [SLS] and dioctyl sodium sulphosuccinate [DSS]) on values of different rumen protozoa examined in goats. Within each box plot, vertical line indicates median, black symbol indicates mean, and error bars represent standard error of mean. Within the same parameter, data with different lowercase letters differ significantly between defaunating agents at $p < .05$ if bold.

ANATOMICAL FINDINGS

In healthy control goats, the inside surface of the rumen, the largest part of their stomach, was lined with long, finger-like projections known as ruminal papillae (Figure 10, 11b). A healthy adult goat's rumen wall possessed a thickness of anywhere between 0.5 and 1 cm on average (Figure 10c). The rumen papillae of the dorsal sac were usually long, slender, pointed projections from the inner lining of the sac into the rumen chamber. The rumen papillae in the ventral sac, on the other hand, were short, broad, and extensively distributed across the inner lining beside the cranial portion of the rumen. The papillary pattern was particularly obvious in the blind sacs. The papilla appeared in a variety of morphologies; the biggest are foliate, many are filiform or slender, and others had a conical or club-shaped surface. The rumen also contained the ruminal pillars, which help to maintain the structural integrity of the rumen wall and provide support for it (Figure 10, 11a). Ruminal pillars were attached to the inside of the rumen wall and placed throughout the rumen.

When goats were exposed to SLS, the rumen environment was disturbed with an impact on the ruminal papillae's structure and health (Figure 12). It caused an irritation and harmfulness to the mucosa of the rumen, resulting in inflammation, a short integrity villa of the ruminal mucosa, and swelling of the ruminal papillae, generating an uneven or distorted shape. Inflammation and tissue damage brought on by SLS also has led to potentially compromise the integrity of the ruminal pillars, resulting in structural irregularities and malfunction.

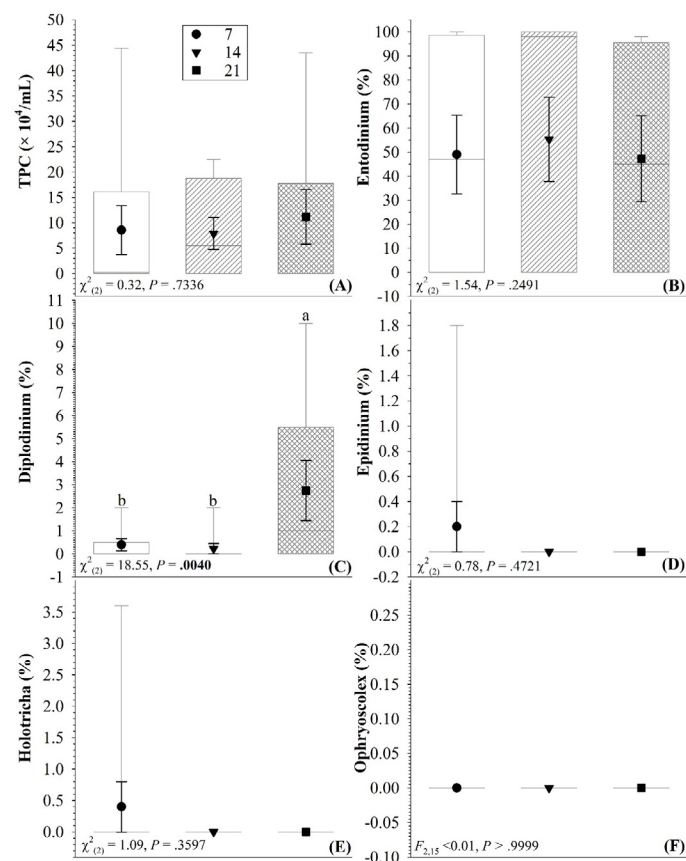


Figure 6: Effect of days after defaunation (7, 14, and 21 days) on different rumen protozoa examined in goats. Within each box plot, vertical line indicates median, black symbol indicates mean, and error bars represent standard error of mean. Within the same parameter, data with different lowercase letters differ significantly among days after defaunation at $p < .05$ if bold.

DOSS exposure revealed a little impact on goats' ruminal structure. The ruminal pillars became weak and their functions were disrupted due to inflammation, swelling, erosion, and possibly ulceration. Exposure to DOSS caused morphological alterations in ruminal papillae (Figure 13), but the effects on ruminal papillae integrity, length, and degeneration were less pronounced if compared to those due to SLS.

HISTOPATHOLOGICAL FINDINGS

Results of hematoxylin and eosin stain showed that the control group's rumen had a regular length and histological

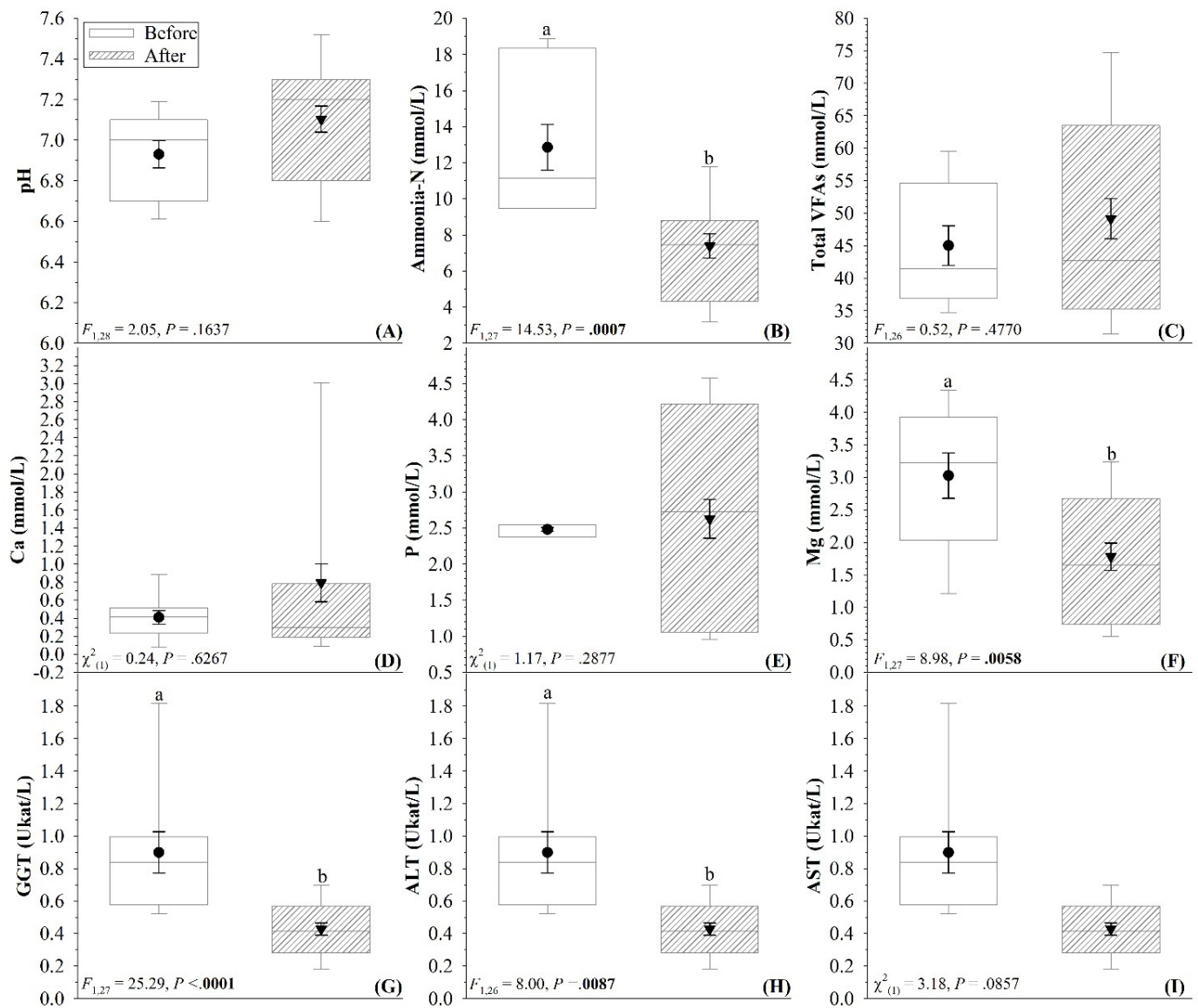


Figure 7: Comparisons between values of rumen biochemistry parameters determined in goats before and after defaunation. Within each box plot, vertical line indicates median, black symbol indicates mean, and error bars represent standard error of mean. Within the same parameter, data with different lowercase letters differ significantly between before and after defaunation at $p < .05$ if bold.

structure. It was put together as the propria submucosal layer's dense, uneven, fibroelastic connective tissue and stratified squamous keratinized epithelium tunica mucosa (Figure 14a, 14b and 14c). The DOSS group's rumen tissue sections showed moderate alterations, including a noticeable increase in the amount of fibrous tissue, infiltrations of inflammatory cells along the tunica mucosa layer, hyperplasia of the lining epithelium, and interstitial edema that caused the epithelium to disperse between the fibroelastic connective tissue (Figure 14d, 14e and 14f).

The results of the SLS group's rumen tissue sections showed significant alterations, as shown by the glaring shortening of the ruminal papillae height, the lining epithelium's hyperkeratosis and hyperplasia, the intense aggregations of inflammatory cells lengthwise propria submucosa, and the

increase in the amount of collagen fibers content and fibroelastic connective tissue (interstitial edema) (Figure 14g, 14h and 14i).

When the collagen deposition was stained with Sirius red, differences were detected between the groups under investigation. In the Control group, there were a few normal amounts of collagen fibers under the ruminal epithelium (Figure 15a and 15b). Records from the DOSS group had developed epithelial hyperplasia and a moderately considerable buildup of collagen fibers (Figure 15c and 15d). On the other hand, substantial epithelial hyperplasia from the DOSS and control groups, as well as excessive collagen fiber deposition with a significant difference, were visible in the ruminal sections of the SLS group (Figure 15e and 15f).

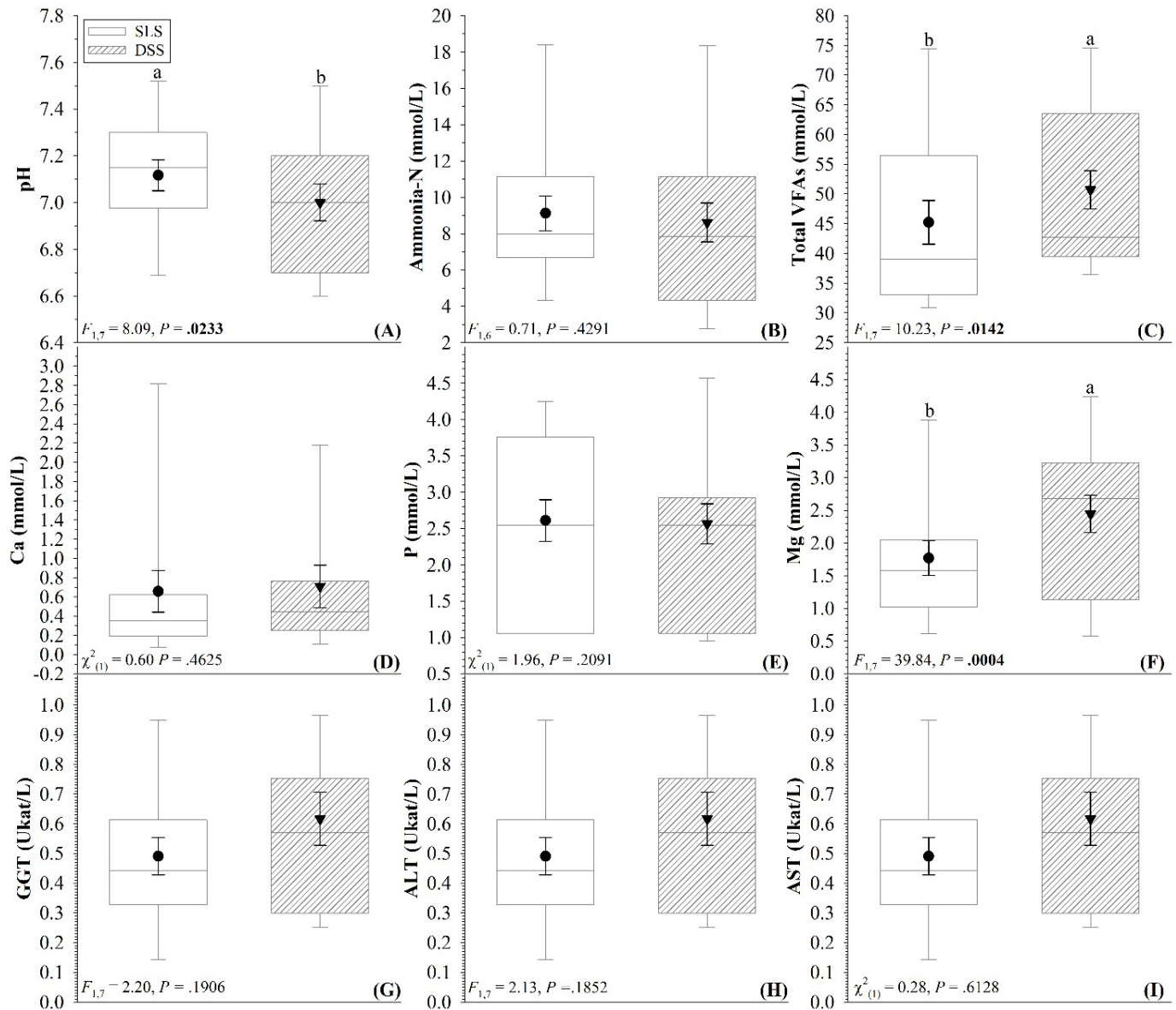


Figure 8: Comparisons between effects of two defaunating agents (sodium lauryl sulfate [SLS] and dioctyl sodium sulphosuccinate [DSS]) on values of rumen biochemistry parameters determined in goats. Within each box plot, vertical line indicates median, black symbol indicates mean, and error bars represent standard error of mean. Within the same parameter, data with different lowercase letters differ significantly between defaunating agents at $p < .05$ if bold.

The scoring findings showed that the DOSS (18.052 ± 1.702) and SLS (10.863 ± 1.367) groups' papillae lengths decreased significantly ($p < 0.001$) in comparison to the control group (4.23 ± 0.553). In the meantime, the SLS group's epithelial layer thickness (8.003 ± 1.486) was significantly thicker ($p < 0.001$) than that of the DOSS group (4.583 ± 1.167) and the control group (1.865 ± 0.169). In terms of collagen fiber area percentage, the results showed that the SLS group had excessive collagen fibers (26.744 ± 2.057) and the DOSS group had intermediate collagen aggregations (15.213 ± 3.157), which differed significantly ($p < 0.001$) from the control group (0.795 ± 0.148). (Figure 16, Table 5).

The previously recorded studies discussing the effect of defaunation particularly on bodyweight gain are contro-

versial. Due to this inconclusive results being reported by different scientists, enormous researches on defaunation has been done and is still being done up till now especially from productive perspectives (Saber *et al.*, 2023).

Parameters of clinical examination were presented in (Tables 1 and 2) and revealed non-significant ($P > 0.05$) variations. The values of day 0; (before defaunation) agreed with those previously reported by Pugh and Baird (2012) and Constable *et al.* (2016). There was no available data discussing the influence of administration of SLS and DOSS as defaunating agents on physical clinical examinations parameters. While the absence of significant clinical variations and data on the effects of SLS and DOSS on clinical parameters limits the ability to assess their full impact, integrating additional data sources such as histopathology,

Table 5: The histopathological scoring differences between the studied groups of goats; control, DOSS and SLS groups.

Parameters	Control GP (n = 5)	DOSS GP (n=5)	SLS GP (n=5)	F value	P- Value
Papillae Length	18.052 ± 1.702	10.863 ± 1.367 ^ +	4.23 ± 0.553 ^ *	169.514	0.000
Epithelium Thickness	1.865 ± 0.169	4.583 ± 1.167 ^ +	8.003 ± 1.486 ^ *	47.349	0.000
Collagen Quantity	0.795 ± 0.148	15.213 ± 3.157 ^ +	26.744 ± 2.057 ^ *	214.038	0.000

Values were expressed as Mean ± SD. ^ refers to significant difference from Control GP, * refers to significant difference from DOSS GP, + refers to significant difference from SLS GP. Significant difference was presented at $p < 0.001$.

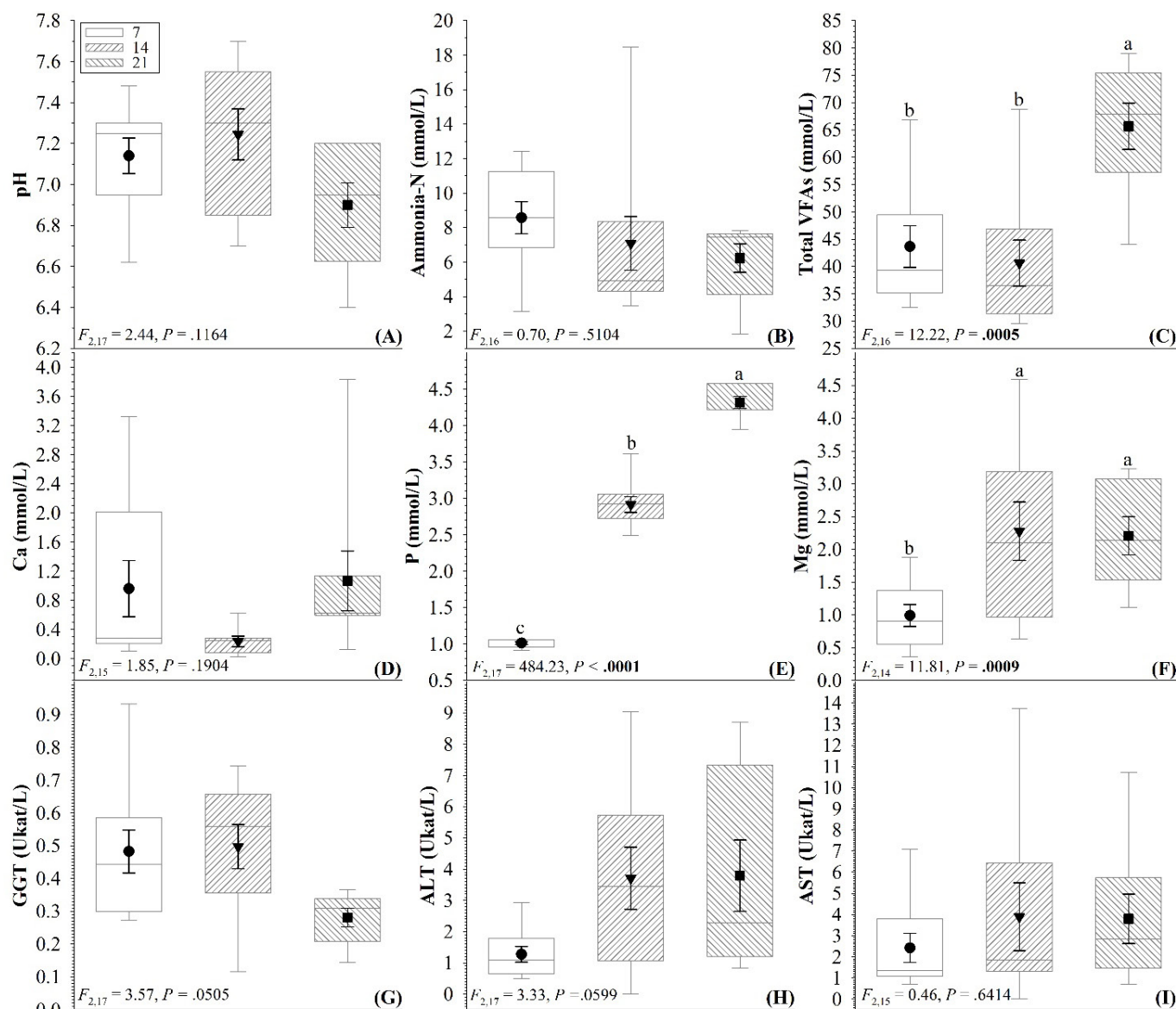


Figure 9: Effect of days after defaunation (7, 14, and 21 days) on rumen biochemistry parameters determined in goats. Within each box plot, vertical line indicates median, black symbol indicates mean, and error bars represent standard error of mean. Within the same parameter, data with different lowercase letters differ significantly among days after defaunation at $p < .05$ if bold.

proposing further research, and discussing broader implications can provide a more complete understanding. This approach helps in addressing the limitations and making informed decisions regarding the use of defaunating agents.

Our obtained results of daily feed intake in SLS group showed significant ($P < 0.05$) decrease at day 14 of administration, while in DOSS group revealed significant ($P < 0.05$)

decrease at day 21, and these results were in agreement with Archimede *et al.* (2010) who reported decreased dry matter intake in defaunated rams, and in the same context, Fahmy *et al.* (1998) reported short-term depression in feed intake following chemical defaunation. However, on the contrary, Eugene *et al.* (2004) stated that defaunation significantly increased average daily gain but did not affect dry matter intake, so that these authors concluded that defauna-

tion can improve feed conversion efficiency in ruminants. Chaturvedi *et al.* (2007) studied defaunation in sheep by sodium lauryl sulfate and mentioned that the daily dry matter intake was similar in both defaunated and faunated sheep, and the same findings were previously recorded by Bird *et al.* (1994). Effect of diet variation on rumen biochemical parameters is previously recorded away from defaunation. The point is our reported values of day 0; before defaunation (normally faunated animals) already differ according to adapted diet. To give a clearer explanation of how different diets compositions (proteins, fibers, carbohydrates) and environmental factors such as housing and management techniques, and climate conditions affect the outcomes of defaunation. By integrating these factors into the study design and interpretation, researchers can better understand the full impact of defaunating agents like SLS and DOSS and develop effective management strategies for their use.

tion. These findings were in agreement with Ankrah *et al.* (1990); Fahmy *et al.* (1998); Eugène *et al.* (2004); Santra and karim (2000); Nevel *et al.* (1985); Eryavuz *et al.* (2003), who reported more weight gain in faunated animals than defaunated ones. From earlier reports, Abou Akkada *et al.* (1968) indicate that faunated lambs have higher rate of gain than defaunated ones, however, on the opposite, Santra and karim (2000) reported that bodyweight gain and feed conversion efficiency were higher in defaunated lambs even with similar dry matter intake. In the same context, Nevel *et al.* (1985) reported better daily weight gain and food conversion efficiency in the defaunated group. While, Bird *et al.* (1994) reported that the effect of defaunation on daily liveweight gain was not significantly different.

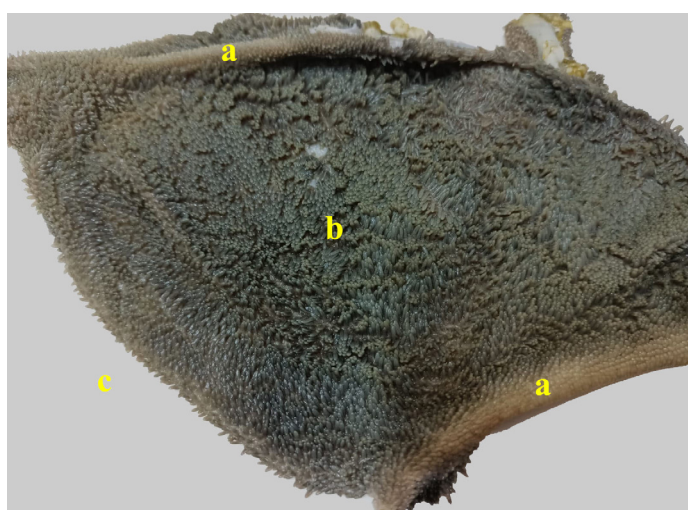


Figure 10: Photograph showing the normal thickness of ruminal papillae in goat.



Figure 12: Photograph showing the effect of SLS (sodium Lauryl sulfate) on ruminal papillae and ruminal pillar.



Figure 11: Photograph showing the normal length of ruminal papillae in goat.



Figure 13: Photograph showing the effect of photograph showing the effect of DOSS (Diocetyl sodium sulphosuccinate) on ruminal papillae and ruminal pillar.

Results of the effect of DOSS on BCS and weight gain revealed significant ($P < 0.05$) decrease after administra-

Defaunation disrupts the symbiotic relationship between animal and rumen microbiome by reducing the diversity and abundance of certain microbial species, decreases the efficiency of fiber fermentation, leading to less energy extraction from the diet and decrease in the absorption

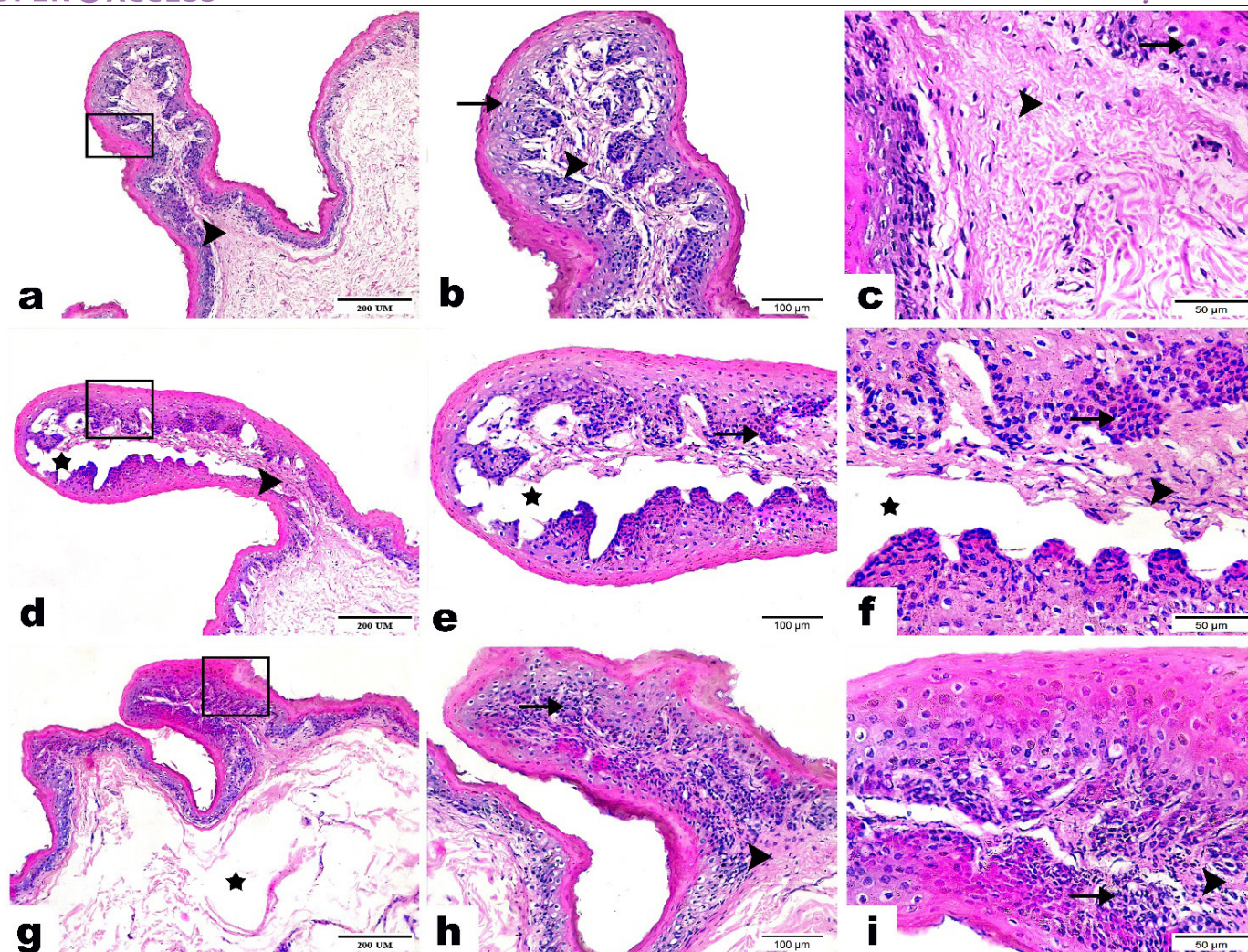


Figure 14: Photomicrographs displayed the histopathological variations of rumen tissue sections between examined groups as follows: (a, b, c) Control Group demonstrated the standard histological structure of tunica mucosa (rectangle) in its stratified squamous keratinized epithelium (arrow) and propria sub mucosal layer (arrowhead). (d, e, f) DOSS Group: revealed hyperplasia of the lining epithelium (rectangle), inflammatory cells (arrow), increase in fibrous amount (arrowhead), as well as interstitial edema (star). (g, h, i) SLS Group: highlighted hyperkeratosis along with hyperplasia in the lining epithelium (rectangle), inflammatory cells (arrow) and increase in the fiber amount (arrowhead). (H&E, Magnification power: x100, x200, x400, respectively).

of vitamins and minerals and influence the host's appetite and feed intake. Reduced energy extraction from the diet and altered appetite regulation can contribute to changes in bodyweight over time.

Our obtained results revealed complete absence of rumen protozoa due to DOSS at time point of 21 day post defaunation, however, SLS caused partial defaunation at all time points (Table 3). Obtained values of TPC before defaunation were in agreement with Talari *et al.* (2004), while Abe-cia *et al.* (2012) reported lower value, however, Ștefănuț *et al.* (2015) reported higher value.

In our study, defaunation caused significant decrement in rumen ammonia nitrogen concentration (Figure 5) and this finding disagreed with (Santra and Karim, 2000) but agreed with (Kayouli *et al.*, 1986; Ankrah *et al.*, 1990; Hsu

et al., 1991; Abel *et al.*, 2006; Damry, 2009), and this could be explained on basis of reduction of nitrogen metabolism in rumen due to elimination of protozoa beside increase ruminal escape of dietary protein and availability of protein to be absorbed from the intestine (Williams and Coleman, 1988; Hsu *et al.*, 1991) increasing the rate of nitrogen flow to the duodenum (Nguyen *et al.*, 2020) in addition to decrease rumen nitrogen retention in defaunated animals (Ankrah *et al.*, 1990).

Rumen pH also decreased significantly due to defaunation (Table 1), which is consistent with Millen *et al.* (2016)'s finding that explained that the significant decrease in rumen NH₃-N, which represents the weaker side of the alkaline side of rumen pH buffering capability, considerably decreased following defaunation. Reported value of rumen pH before defaunation disagreed with (Mor *et al.*, 2019)

who reported lower value, while (García *et al.*, 1994) documented higher value.

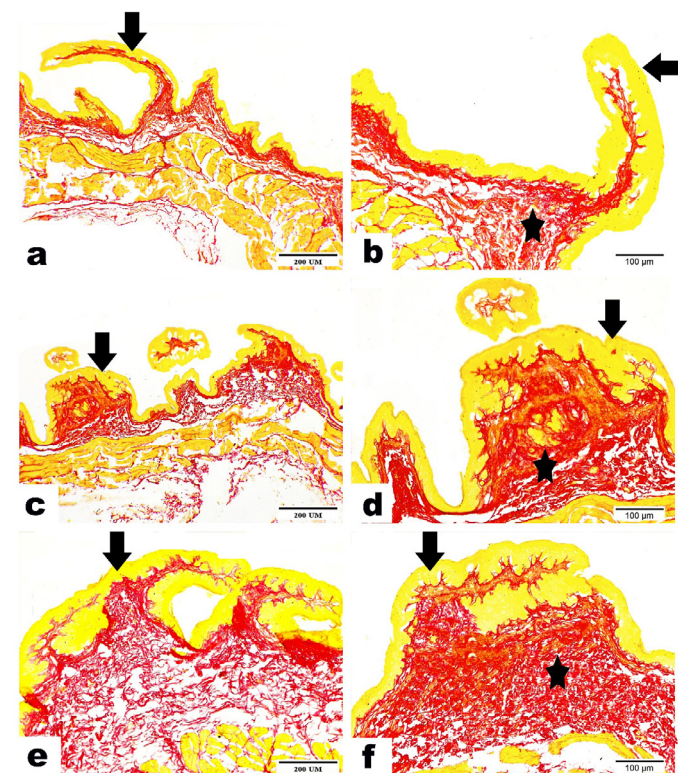


Figure 15: Photomicrographs exposing the impact of DOSS and SLS on collagen deposition in rumen tissues as follows: (a, b, c) Control Group displaying normal epithelium (arrow) and a few amounts of collagen fibers (star). (d, e, f) DOSS Group: demonstrated hyperplasia of epithelium (arrow) as well as moderate deposition of collagen fibers (star). (g, h, i) SLS Group: highlighted epithelium with intense hyperkeratosis and hyperplasia (arrow), as well as extreme proliferative collagen fibers (star). Collagen fibers were labelled in red, while non-collagen proteins were marked in orange. (Sirius Red, Magnification power: x100, x200).

Our results revealed significant increment in rumen TV-FAs at 21 days post defaunation, regardless the type of defaunating agent (Figure 9), and this could be referred to absence of rumen protozoa which stabilize the number of rumen *Streptococci* to reduce the produced harmful lactic acid Ushida (2018), and the ability of Entodiniomorphid protozoa (the major population of rumen ciliates) to protect easily fermentable carbohydrates from sugar/starch-utilizing bacteria Kamra (2005) by engulfing starch granules and ferment it slowly, which in a way contributes to slowing down the rate of starch fermentation in the rumen (Millen *et al.*, 2016).

Our work revealed that defaunation caused significant decrement in rumen GGT and ALT activities. GGT activity is linked to the detoxification of xenobiotics and the metabolism of amino acids while ALT plays a crucial role

in amino acid metabolism and gluconeogenesis in the liver and potentially in the rumen. Regarding the type of defaunating agent, rumen GGT activity decreased significantly due to SLS and DOSS, while ALT activity decreased significantly due to DOSS, however, SLS caused non-significant difference (Table 4). This decline in rumen microbial enzymatic activities could be explained on basis of the slight antimicrobial effect of SLS (Babich and Babich, 1997) decreasing rumen bacterial biomass and its microbial enzyme activities. To our limited knowledge, there are no previous literatures discussing the effect of defaunation on rumen microbial enzymatic activity and rumen macro-minerals concentration; Ca, P and Mg.

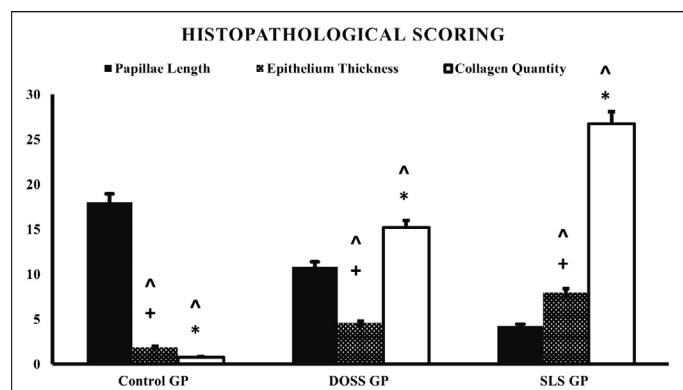


Figure 16: Bar graph reflecting % area of collagen fibers; n = 6. Values were expressed as means $\pm$ SD. Significant difference was presented at $p < 0.001$; using One-way ANOVA followed by Tukey's Honestly Significant Difference (HSD) post-hoc.

The rumen contains the ruminal pillars, which help to maintain the structural integrity of the rumen wall and provide support for it in addition to ruminal papillae that are crucial for the absorption of nutrients, microbial adhesion, and the conversion of complex carbohydrates into simpler molecules that the goat may use for growth and energy. Regarding the results of gross anatomy of rumen in healthy goats, rumen papillae of the dorsal sac were long, slender, pointed projections from the inner lining of the sac into the rumen chamber, while the papillae in the ventral sac, on the other hand, were short, broad, and extensively distributed across the inner lining beside the cranial portion of the rumen and these findings agreed with García *et al.*, (2012), who stated that the rumens of goats and deer were similar. Conversely, Anuradha (2012); Sultana *et al.* (2021) reported that the rumen mucosa of sheep exhibited conical-shaped short papillae and tongue-shaped long papillae. Our results showed that ruminal pillars were attached to the inside of the rumen wall and placed throughout the rumen (Figure 10, 11a) in complete agreement with Gupta *et al.* (2015). According to Sisson (2016), there is no papillation on the margins of the major pillars and a significant section of the middle wall of the dorsal sac. The papilla come in a variety of morphologies; the biggest are

foliate, many are filiform or slender, and others have a conical or club-shaped surface. However, Clauss *et al.*, (2009) demonstrated that the rumen's papillation is uneven, with a large number of conspicuous papillae in the atrium ruminis and few, tiny papillae on the dorsal and ventral surfaces. Cattle's rumen regions vary in the degree of papillation; the dorsal rumen wall, in particular, is entirely devoid of papillae Garrod (1877); Langer (1973). On the other hand, Martin and Schauder (1938) observed that several species of deer have uniformly papillated rumen.

Defaunating agents had led to disrupt rumen microbiome by removing of protozoa, leading to an alteration of the microbial ecosystem and potentially affecting the integrity and health of the ruminal papillae and pillar, as well as altering the function of the rumen on nutrient absorption efficiency and rumen health, which impacts ruminant digestion and performance.

Ruminal pillar integrity has been damaged by SLS-induced inflammation and tissue injury, leading to abnormalities in structure and functioning. Ruminal papillae integrity, length, and degeneration were less affected by DOSS exposure than by SLS, while there was still some influence on the ruminal structure of the goats. To our limited knowledge, there are no available data discussing the effects of SLS and DOSS on the rumen pillars and papillae in goats, either grossly or microscopically.

CONCLUSIONS AND RECOMMENDATIONS

Oral administration of DOSS or SLS has a detrimental effect on rumen motility, feed intake, and bodyweight gain, as well as rumen total and differential protozoal counts, rumen ammonia nitrogen concentration, and rumen enzymes. Grossly, the length, density, and integrity of the ruminal mucosa and ruminal papillae were seriously damaged, particularly at ruminal pillars. SLS had more negative effects than DOSS causing shortening, degeneration and burning of the ruminal mucosa and ruminal papillae especially at ruminal pillars. Histologically, DOSS supplemented goats had moderate alterations while SLS group emphasized severe alterations that were shown by epithelial hyperplasia, infiltrations of inflammatory cells, increase in collagen fibers content, as well as interstitial edema. Due to its serious drawbacks on rumen ecology, it is not recommended to administer DOSS- even in short-term dosages as a surfactant for treating bloat or impaction, to maintain sustainable production in goats flocks.

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NOVELTY STATEMENT

This study is the first to evaluate the effect of two defaunating agents; SLS and DOSS on physical examination, feed Intake, bodyweight, and the protozoal, biochemical and histo-antatomical compositions of the rumen in native breed Egyptian goats.

AUTHOR'S CONTRIBUTIONS

Mahmoud Saber and Sabry Mousa contributed to the research idea and experimental design. Rumen fluid samples were collected and analyzed by Mahmoud Saber. Gross rumen samples were collected and grossly examined by Ramadan Sary and Meray Ramsis. Histopathological rumen samples were collected and analyzed by Eman Rashad. Statistical analyses were performed by Hisham Abdelrahman and Eman Rashad. The first draft of the manuscript was written by Mahmoud Saber and Meray Ramsis. All authors commented on previous versions of the manuscript. The manuscript was revised by Sabry Ahmed Mousa and Mahmoud Saber. All authors read and approved the final version of the manuscript.

DATA AVAILABILITY

The full datasets generated during the study are not available for public due to institutional instructions, but are available from the corresponding author on rational request.

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ETHICAL APPROVAL

This study was carried out according to the regulations of the statement of "Ethics of Animal Experiments Committee", Faculty of Veterinary Medicine, Cairo University (Date: 13/10/2024), No: VetCU13102024948.

CONSENT FOR PUBLICATION

A documented agreement approving the publication of this manuscript was signed all authors.

CONFLICT OF INTEREST

The authors announce that there are no competing interests.

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