Theme: Safe, Sustainable and Innovative Dairy and Food Systems for One Health

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Assessment of The Digestive Efficacy of a Nutritional Supplement in Bovines

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ABSTRACT

Background: Digestive disorders in cattle impair rumen function, feed utilization and productivity. Nutritional strategies such as probiotics, enzymes and herbal extracts may enhance ruminal health. This study evaluated the efficacy of a rumenotonic bolus containing probiotics, enzymes and herbal extracts in managing ruminal disorders in bovines.

Methods: A clinical trial was conducted on 18 lactating cows with ruminal disorders at the Department of Veterinary Medicine, Parbhani (February-June 2025). Animals were divided into three groups: Group I (healthy control), Group II (anorexia treated with standard therapy) and Group III (anorexia treated with rumenotonic bolus, 2 boli BID for 5 days). Clinical, ruminal, hematological, fecal and milk parameters were assessed on days 0, 5 and 7.

Result: Ruminal motility, pH and fermentation parameters improved significantly in treated groups, with the greatest response in Group III. Hematological indices normalized and fecal consistency improved, with faster resolution of diarrhoea in Group III. Milk yield, fat and solids-not-fat increased significantly, while protein remained stable. Group III showed the most rapid recovery (Days 3-5), compared to slower improvement in Group II (Days 5-7). Overall, the rumenotonic supplement enhanced ruminal function and clinical recovery more effectively than standard treatment.

Key words: Cow, Enzyme, Milk analysis, Probiotic, Ruminal disorder, Ruminal fluid examination.

INTRODUCTION

India possesses one of the largest bovine populations globally, with 192.49 million cattle and 109.85 million buffaloes (Government of India, 2019). Maharashtra ranks fifth in cattle and seventh in buffalo population nationally. Cattle and buffaloes constitute 35.94% and 20.45% of India's livestock population, respectively, highlighting their vital role in the rural economy and dairy sector. However, productivity is often compromised by health disorders, particularly digestive ailments, among which ruminal disorders are most prevalent.

In ruminants, conditions such as anorexia, tympany and indigestion are characterized by reduced feed intake, altered ruminal pH, decreased motility and reduced protozoal counts. Simple indigestion commonly arises from sudden dietary changes, poor-quality fodder, imbalanced roughage-to-concentrate ratios, or inadequate water intake (Biswal *et al.*, 2016). These disturbances may lead to ruminal acidosis or alkalosis, depending on fermentation patterns (Constable *et al.*, 2017). Additionally, indigestible feed accumulation and poor feeding practices further aggravate ruminal dysfunction.

The rumen, the largest and most vital digestive organ of ruminants, functions as a fermentation chamber housing a complex microbial ecosystem that maintains physiological homeostasis. The rumen is responsible for fermenting fibrous feeds into volatile fatty acids, the primary energy source for ruminants (Moran, 2005; Smith and Jones, 2009). Disruption of this microbial balance adversely affects nutrient utilization and predisposes animals to metabolic and digestive disorders such as acidosis, diarrhea, ketosis, mastitis and laminitis (Asrat *et al.*, 2015; Pan, 2016; Zhao *et al.*, 2023). Maintaining ruminal health is therefore essential for optimal productivity (Beauchemin, 2002).

The rationale for this study is based on the need for effective nutritional interventions that can restore ruminal microbial balance, improve digestion and enhance recovery from digestive disorders. Probiotics and exogenous enzymes have gained importance as nutritional interventions to restore ruminal function. These supplements

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enhance microbial balance, improve digestion and increase feed efficiency (Anadon *et al.*, 2006; Uyeno *et al.*, 2015). Enzymes, amino acids and herbal additives further support nutrient utilization and recovery during anorexia (Arowolo *et al.*, 2018; Mazinani *et al.*, 2022; Chaudhary *et al.*, 2021; Ramdani *et al.*, 2025).

Considering the high incidence and economic impact of ruminal disorders, the present study was undertaken with an objective to evaluate the efficacy of a multi-component nutritional supplement (bolus) containing probiotics, enzymes, amino acids and herbal extracts in improving ruminal function and managing ruminal disorders in bovines.

MATERIALS AND METHODS

Study area

The present clinical trial was conducted on 18 lactating cows presented to the Department of Veterinary Medicine, Veterinary Clinical Complex (VCC), Instructional Livestock Farm Complex (ILFC), College of Veterinary and Animal Sciences, Maharashtra Animal and Fishery Sciences University (MAFSU), Parbhani and nearby veterinary dispensaries in Parbhani district during February to June 2025. The study evaluated the effect of a nutritional supplement on ruminal disorders in lactating cows, with emphasis on rumen function, milk yield and milk composition.

Test product

The investigational product is a Rumenotonic with digestive enzymes, amino acids, probiotic and herbal extract supplement containing Amylase, Cellulase, Xylanase - Lysine-DL, Methionine, Histidine, Leucine, Valine, Threonine, *Lactobacillus acidophilus, Bacillus coagulans, Saccharomyces boulardii, Aspergillus oryzae*, ginger powder and soyabean meal, supplied by Advenza Global Limited in the form of a bolus.

Study design

Lactating cows diagnosed with ruminal disorders, including simple indigestion, acidic indigestion, alkaline indigestion and anorexia of unknown origin, irrespective of age and breed, were selected based on detailed history and thorough clinical examination. Observations were recorded on day 0 (before treatment), day 5 and day 7 (after treatment).

Eighteen cattle were divided into three groups (n = 6 each): Group I comprised healthy animals maintained under identical feeding and management conditions (control); Group II included clinical cases of anorexia of unknown origin treated with a standard protocol and Group III consisted of similar anorexic cases treated with a nutritional supplement administered as two boli twice daily for five days.

Sample size

The sample size was determined based on feasibility, ethical considerations and availability of animals with similar clinical conditions. A total of 18 animals were included and divided into three groups (Group I, II and III; n = 6 each). This size was considered sufficient to detect biologically meaningful differences while minimizing animal use, consistent with previous studies (Charan and Kantharia, 2013).

Clinical and physiological parameters

A detailed anamnesis and clinical examination were conducted for all animals. Heart rate was recorded by auscultation over the left thoracic region (3rd-5th intercostal space) and expressed as beats per minute. Respiratory rate was measured by observing nostril movement and thoracic auscultation, expressed as breaths per minute. Rectal temperature was recorded using a digital thermometer (°F). Rumen motility was assessed by palpation and auscultation of the left paralumbar fossa and expressed as contractions per two minutes. Bloat and anorexia were graded using standardized 0-3 scoring scales.

Rumen fluid collection and examination

Rumen fluid was collected aseptically from the left paralumbar fossa using an 18G, 6-inch spinal needle and extraction pump (Fig 1 and Fig 2). Physical characteristics (colour, odour, consistency) were visually



Fig 1: Collection of ruminal fluid by stomach tube.



Fig 2: Collection of ruminal fluid from left paralumbar fossa.

assessed (Fig 3 and Fig 4). pH was measured using indicator paper (HiMedia Laboratories) and categorized as mild (5.5-6.5), moderate (4.5-5.5) and severe (4.0-4.5) acidity (Fig 5 and Fig 6). Total protozoal count was estimated using the method of Moir (1951) and expressed as $\times 10^5$ /ml.

Blood samples were collected on day 0, 5 and 7 into EDTA (3.5%) vacutainers and analyzed using an automatic hematology analyzer (Spincell 5). Fecal examination assessed colour, odour, consistency and diarrhea. Milk yield and composition (pH, fat, protein, Solid -Non-Fat) were recorded and analyzed using a LactoScan analyzer (Fig 7 and Fig 8).

Statistical analysis

Data obtained were subjected to statistical analysis following the methods described by Snedecor and Cochran (1994). Analysis was performed using Completely Randomized Design (CRD) with SPSS version 16. Results were expressed as mean ± standard error (SE).

RESULTS AND DISCUSSION

The present study evaluated efficacy of a multi-component nutritional supplement on ruminal disorders in lactating cows by assessing clinical, physiological, ruminal, haematological, fecal and milk production parameters.

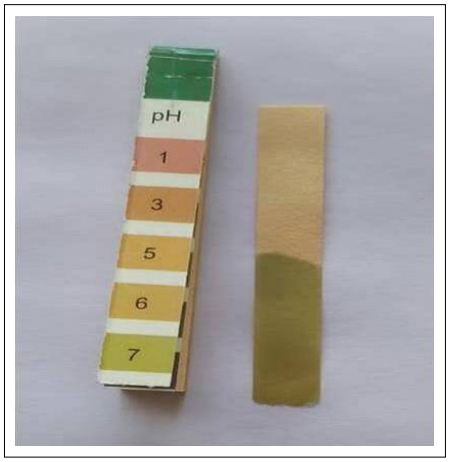


Fig 5: Normal rumen fluid pH hematological, fecal and milk analysis.

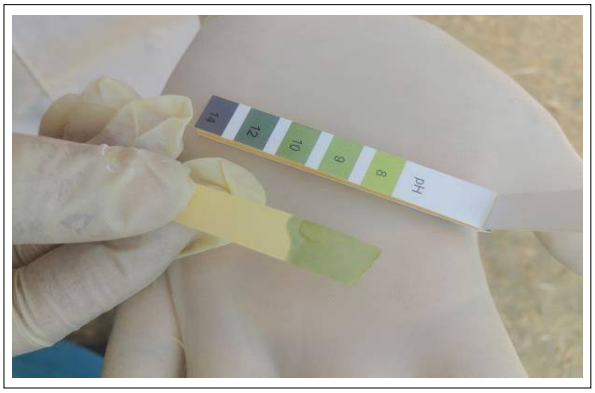


Fig 6: Alkaline pH of rumen fluid.



Fig 3: Brownish green rumen fluid.



Fig 4: Yellowish green rumen fluid.



Fig 7: Automatic milk analyzer.

Observations recorded at different time intervals (day 0, 5 and 7) provided insights into the progression and recovery pattern in treated animals compared to controls. The findings are discussed in relation to improvements in rumen function, microbial activity and overall health status.

Physiological and clinical examination

The physiological and clinical parameters in cows affected with simple indigestion showed anorexia, mild depression, reduced feces which were initially dry and and later became softer, voluminous and malodorous consistent with Kasaralikar *et al.* (2014); Syed *et al.* (2017) and Constable (2017). The heart rate, respiration rate and rectal temperature remained within normal limits and comparable to controls as presented in Table 1. Post-treatment, no significant changes ($p<0.05$) occurred except a slight heart rate increase in Group III ($p = 0.048$), remaining within normal range, similar to previous reports (Kasaralikar *et al.*, 2014; Syed *et al.*, 2017; Constable *et al.*, 2017).

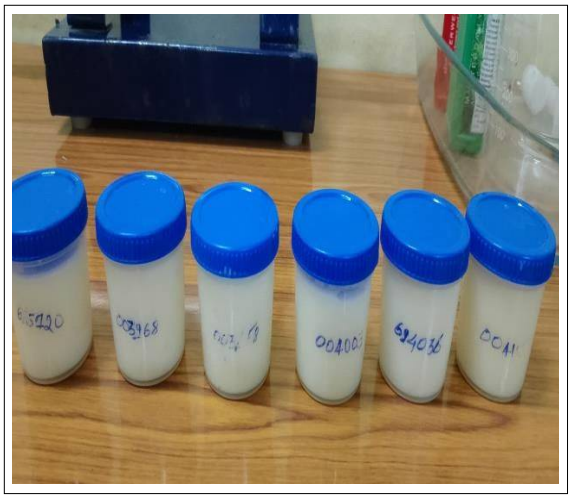


Fig 8: Estimation of milk samples.

Ruminal motility (Table 1) showed non-significant variation in Group I, while indigestion-affected cows in Groups II and III exhibited reduced baseline motility on Day 0, consistent with earlier reports (Walia *et al.*, 2011; Kasaralikar *et al.*, 2014). Group II showed significant improvement during treatment, whereas Group III demonstrated a highly significant progressive increase from 1.33±0.21 to 2.83±0.17 ($p = 0.000$), with Day 5 and Day 7 values significantly higher than baseline. This restoration approached normal ruminal motility (~3 contractions/2 minutes) as reported by Chakrabarti (2014) and Constable *et al.* (2017). Among all groups, Group III showed the greatest improvement.

In Group I, the left paralumbar fossa was normal, whereas mild distension was observed in a few cows ($n = 5$) in Groups II and III and the remaining ($n = 13$) showed a firm, doughy rumen. These findings agree with Constable *et al.* (2017). Post-treatment, all cows in Groups II and III showed normal paralumbar fossa, indicating resolution of distension, consistent with Walia *et al.* (2011) and Hussain and Uppal (2012).

Appetite remained normal in Group I, while reduced appetite was observed in all affected cows before treatment, as also reported by Constable *et al.* (2017). Post-treatment, normal appetite was restored in all cows of Groups II and III, indicating effective clinical recovery.

Rumen fluid examination

Physical examination

Healthy cows (Group I) exhibited greenish to yellowish-brown rumen fluid with aromatic odour and viscous-to-thick consistency (Handekar *et al.*, 2010; Kasaralikar *et al.*, 2014). In simple indigestion, it changed to yellowish-green to light brown with occasional ammoniacal odour and watery to semi-solid consistency (Handekar *et al.*, 2010). Post-treatment in Groups II and III, parameters normalized, indicating restoration of rumen function

Table 1: The Physiological parameters of animals before and after treatment.

Parameters	Groups	Before treatment (0 Day)	After treatment (5th Day)	After treatment (7th Day)	Significance
Heart rate (Beats/min)	I	71.16±1.07	71.00±0.36	71.16±0.60	0.980
	II	72.00±1.06	71.83±0.60	71.50±0.76	0.911
	III	70.16±0.70 b	72.00±0.57a	72.00±0.25a	0.048
Respiratory rate (Breaths/min)	I	18.83±0.70	18.50±0.71	17.83±0.79	0.631
	II	19.33±0.71	18.00±0.36	17.50±0.76	0.146
	III	18.16±0.90	19.83±0.60	18.50±0.4522	0.216
Rectal temperature (°F)	I	100.68±0.32	101.57±0.19	101.13±0.35	0.149
	II	101.27±0.39	101.17±0.24	101.25±0.29	0.972
	III	101.75±0.32	101.33±0.33	101.05±0.34	0.353
Ruminal motility (motility /2 min)	I	$2.16±0.17^{a}$	$2.33±0.21^{b}$	$2.50±0.22^{c}$	0.521
	II	$1.50±0.22^{a}$	$2.00±0.00^{b}$	$2.33±0.2^{c}$	0.015
	III	$1.33±0.21^{a}$	$2.33±0.2^{b}$	$2.83±0.17^{c}$	0.000

Overall means bearing different superscripts in a row (a, b, c, d) differ significantly ($P<0.05$).

Overall means bearing different superscripts in a column (A, B, C, D) differ significantly ($P<0.05$).

(Waghmare *et al.*, 2009). Observations are presented in Table 2.

Physicochemical and microbiological findings

The mean rumen liquor pH remained within the normal range in control cows (Chakrabarti, 2014; Constable *et al.*, 2017), while significantly higher values ($p<0.01$) were observed in Groups II and III before treatment, indicating ruminal alkalinization (Biswal *et al.*, 2016). Post-treatment, pH declined significantly in Groups II and III, reaching near-normal levels by Day 5 and Day 7.

Protozoal counts in Group I showed a mild, non-significant increase, while Groups II and III had significantly lower counts pre-treatment with marked post-therapy improvement, especially in Group III ($p<0.05$), consistent with Mohan *et al.* (2015). This recovery is closely linked to rumen pH, as protozoa are highly pH-sensitive (Granja-Salcedo *et al.*, 2016) and ruminal acidosis reduces microbial balance through excess volatile fatty acids (TVFA) and lactic acid formation (Biswal *et al.*, 2016). Protozoa play a key role in fermenting carbohydrates into acetic and butyric acids (Chakrabarti, 2014), so their restoration indicates improved fermentation efficiency (Petrovski, 2016).

TVFA levels remained normal in Group I (6-12 mEq/dl; Chakrabarti, 2006), while Groups II and III showed significant changes ($p<0.01$), with Group III exhibiting increased levels (Bhatt *et al.*, 2009). Ammonia nitrogen remained stable in Group I but improved significantly in Group III, indicating enhanced microbial protein synthesis (Shen *et al.*, 2023). Mean values are presented in Table 3.

Table 2: The physical rumen fluid examination parameters before and after treatment.

Parameter	Group	Before treatment (0 Day)	After treatment (5th Day)	After treatment (7th Day)
Color	I	Greenish brown	Greenish and yellowish brown	Greenish and yellowish brown
	II	Yellowish green light brown	Greenish brown	Greenish and yellowish brown
	III	Yellowish green light brown	Greenish and yellowish brown	Greenish and yellowish brown
Odor	I	Aromatic	Aromatic	Aromatic
	II	Aromatic or slightly Ammoniacal	Aromatic or slightly Ammoniacal	Aromatic
	III	Aromatic or slightly Ammoniacal	Aromatic	Aromatic
Consistency	I	Thick and viscous	Thick and viscous	Thick and viscous
	II	Slightly watery and semisolid	Slightly watery and semisolid	Viscous
	III	Slightly watery and semisolid	Thick and Viscous	Viscous

Table 3: The rumen fluid examination parameters before and after treatment.

Parameters	Groups	Before treatment (0 Day)	After treatment (5th Day)	After treatment (7th Day)	Significance between group
Ruminal fluid pH	I	6.66 ± 0.24^{B}	6.85 ± 0.05^{A}	6.96 ± 0.02	0.371
	II	7.58 ± 0.15^{aA}	6.71 ± 0.10^{bAB}	6.83 ± 0.06^{b}	0.000
	III	7.33 ± 0.24^{aA}	6.50 ± 0.08^{bB}	6.95 ± 0.08^{ab}	0.008
Protozoal count ($\times10^5$/ml)	I	2.46 ± 0.12^{bA}	2.63 ± 0.14^{abB}	2.91 ± 0.12^{a}	0.074
	II	1.45 ± 0.12^{bB}	2.40 ± 0.13^{aB}	2.75 ± 0.18^{a}	0.000
	III	1.33 ± 0.13^{bB}	3.16 ± 0.08^{aA}	3.31 ± 0.07^{a}	0.000
TVFA	I	71.70 ± 0.61^{a}	67.52 ± 1.15^{a}	68.81 ± 1.65^{a}	0.209
	II	73.20 ± 0.45^{c}	69.68v1.40^{b}	72.63 ± 0.51^{b}	0.122
	III	72.25 ± 0.63^{b}	70.91 ± 0.56^{c}	74.81 ± 0.30^{c}	0.003
Ammonia nitrogen	I	18.37 ± 0.34^{aA}	16.14 ± 1.15^{a}	16.86 ± 0.99^{a}	0.961
	II	16.14 ± 1.15^{c}	17.03 ± 0.86^{b}	19.73 ± 1.04^{b}	0.356
	III	16.87 ± 0.99^{b}	18.20 ± 0.89^{c}	21.20 ± 1.14^{c}	0.034

Overall means bearing different superscripts in a row (a, b, c, d) differ significantly ($P<0.05$).

Overall means bearing different superscripts in a column (A, B, C, D) differ significantly ($P<0.05$).

Hematological findings

The results of hematological examination of all groups are presented in Table 4. Haemoglobin and total erythrocyte count increased significantly in Groups II and III, while total leukocyte count decreased significantly, indicating recovery. Other leukocyte parameters remained mostly unchanged. These findings align with earlier studies (Kasaralikar *et al.*, 2014; Syed *et al.*, 2017).

Fecal examination

Fecal examination showed normal greenish-brown, semisolid feces in Group I (Biswal *et al.*, 2016). In Groups II and III, feces were yellowish-brown, loose and foul-smelling, indicating impaired fermentation (Biswal *et al.*, 2016; Petrovski, 2016). Post-treatment, Group II partial improvement, while Group III showed rapid normalization and fastest resolution of diarrhea which was clinically significant (Handekar *et al.*, 2010; Bhatt *et al.*, 2009; Kasaralikar *et al.*, 2014; Syed *et al.*, 2017).

Milk production and quality

Milk examination results (Table 5) showed stable milk yield in Group I (P = 0.547), reflecting normal variation in healthy cows. In contrast, Groups II and III exhibited highly significant increases in milk yield (P = 0.000), with Group III showing the highest production by Day 7, consistent with reports on probiotic and herbal supplementation improving lactation (Bhatt *et al.*, 2009; Yalcin *et al.*, 2011; Garg *et al.*, 2025).

Milk pH showed a mild, significant rise in Groups II (P = 0.087) and III (P = 0.041), while remaining stable in Group I (P = 0.361), indicating improved udder health. Milk protein remained largely unchanged across all groups (3.07–3.77%) (Lingathurai *et al.*, 2009; Hossain *et al.*, 2010), with no significant variation (P>0.05), though Group III showed a slight increase.

Milk fat increased significantly in Groups II (P = 0.002) and III (P = 0.000), with highest values in Group III, reflecting improved metabolic status. Similarly, SNF increased significantly only in Group III (P = 0.002), while Groups I and II showed no significant change (P = 0.547; P = 0.397), aligning with Jawale *et al.* (2022); Chappalwar *et al.* (2014) and Ali Ibrahim *et al.* (2012). Overall, Group III showed the most consistent improvement across all milk parameters.

Table 4: Hematological parameters of all groups before and after treatment.

Parameters	Groups	Before treatment (0 Day)	After treatment (5th Day)	After treatment (7th Day)	Significance
Hemoglobin (Hb)	I	9.41±0.11^{c}	11.35±0.21^{b}	12.08±0.28^{a}	0.000
	II	8.75±0.14^{c}	10.50±0.50^{b}	12.05±0.58^{a}	0.000
	III	8.95±0.42^{b}	11.43±0.63^{a}	12.55±0.37^{a}	0.000
Packed cell volume (PCV)	I	32.66±0.95	32.86±0.94	35.33±1.11	0.148
	II	29.66±1.53^{b}	31.50±1.50^{b}	36.63±0.80^{a}	0.006
	III	30.15±0.76^{b}	34.30±1.90^{ab}	34.96±1.52^{a}	0.073
Total leukocyte count (TLC)	I	9.96±0.16^{a}	7.97±0.32^{b}	7.38±0.26^{b}	0.000
	II	10.35±0.51^{a}	8.74±0.31^{b}	7.82±0.17^{b}	0.001
	III	10.84±0.18^{a}	8.09±0.20^{b}	7.51±0.31^{b}	0.000
Total erythrocyte count (TEC)	I	7.49±0.29^{ab}	7.24±0.23^{b}	8.00±0.08^{a}	0.076
	II	7.11±0.28^{b}	7.30±0.08^{b}	8.09v0.18^{a}	0.008
	III	7.18±0.17^{b}	7.38±0.09^{b}	8.43±0.20^{a}	0.000
DLC Neutrophil (%)	I	29.16±1.04	29.83±0.83	28.66±2.10	0.850
	II	31.66±0.84	30.00±0.93	29.66±1.11	0.323
	III	32.66±1.49^{a}	29.66±0.76^{ab}	28.16±1.44^{b}	0.069
Eosinophil (%)	I	11.33±1.92	11.16±0.47	9.33±0.71	0.455
	II	9.16±0.60	10.16±0.60	8.50±0.34	0.114
	III	8.83±0.60^{b}	10.83±0.79^{a}	9.66±0.42^{ab}	0.108
Basophil (%)	I	1.33±0.21^{a}	0.83±0.30^{ab}	0.50±0.22^{b}	0.093
	II	1.16±0.30^{a}	1.00±0.25^{ab}	0.33±0.21^{b}	0.090
	III	0.83±0.30^{a}	0.83±0.16^{ab}	0.33±0.33^{b}	0.367
Monocyte (%)	I	5.66±0.42^{a}	4.66±0.42^{ab}	3.33±0.49^{b}	0.008
	II	5.83±0.47^{a}	4.83±0.40^{a}	3.33±0.21^{b}	0.001
	III	6.16±0.60^{a}	4.33±0.88^{ab}	3.00±0.51^{b}	0.017
Lymphocyte (%)	I	52.50±0.95	52.00±1.91	55.83±1.07	0.138
	II	52.16±0.98	53.66±1.81	53.16±0.74	0.702
	III	51.83±0.87	51.33±0.55	53.83±1.07	0.129

Overall means bearing different superscripts in a row (a, b, c, d differ significantly (P<0.05).

Overall means bearing different superscripts in a column (A, B, C, D) differ significantly (P<0.05).

Table 5: Mean ± SE values of milk parameters before and after treatment.

Parameters	Groups	Before treatment (0 Day)	After treatment (5th Day)	After treatment (7th Day)	Significance
Milk yield (Liters)	I	3.18±0.20^{A}	3.25±0.12	3.40±0.09	0.547
	II	1.62±0.15^{Bb}	2.96±0.13^{a}	3.25±0.07^{a}	0.000
	III	1.63±0.17^{Bb}	3.21±0.06^{a}	3.50±0.08^{a}	0.000
Milk pH	I	6.41±0.30^{A}	6.45±0.02	6.46±0.04	0.361
	II	6.25±0.05^{Bb}	6.33±0.04^{ab}	6.41±0.04^{a}	0.087
	III	6.30±0.05^{ABb}	6.41±0.06^{ab}	6.50±0.03^{a}	0.041
Protein	I	3.30±0.09	3.31±0.07	3.31±0.04	0.887
	II	3.17±0.06	3.20±0.04	3.23±0.07	0.793
	III	3.15±0.05	3.32±0. 04	3.35±0.08	0.086
Fat	I	3.43±0.18	3.48±0.13	3.50±0.05	0.938
	II	2.83±0.05^{Bb}	3.16±0.07^{Ba}	3.25±0.07^{Ba}	0.002
	III	2.85v0.07^{Bc}	3.25±0.07^{ABb}	3.55±0.09^{Aa}	0.000
SNF	I	8.33±0.08	8.35±0.08	8.46±0.04	0.547
	II	8.16±0.06^{b}	8.21±0.08^{a}	8.33±0.09^{a}	0.397
	III	8.15±0.06^{b}	8.25±0.06^{b}	8.48±0.03^{a}	0.002

Overall means bearing different superscripts in a row (a, b, c, d) differ significantly (P<0.05).

Overall means bearing different superscripts in a column (A, B, C, D) differ significantly (P<0.05).

The therapeutic efficacy of all treatment regimens was assessed based on clinical recovery, normalization of rumen function and milk parameters. Group III (nutritional supplement) showed the fastest and most effective recovery, with all cows fully recovered by days 3-5, whereas Group II (standard treatment) recovered by Days 5-7, indicating effectiveness but slower response. Overall, nutritional supplementation significantly improved rumen function, digestion and productivity, demonstrating superior efficacy in managing ruminal disorders in cattle.

CONCLUSION

Nutritional supplement used in this research, a Rumenotonic with digestive enzymes, amino acids, probiotic and herbal extract, offer an effective strategy for managing simple indigestion in lactating cows by modulating ruminal pH, enhancing rumen motility and promoting the growth and activity of beneficial microbial populations, thereby improving overall digestion and milk production. The supplement was safe and well-tolerated at recommended dose, showing no adverse effects, while also facilitating the restoration and stabilization of appetite and normal digestive functions, supporting both animal health and productivity.

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Disclaimers

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Conflict of interest

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