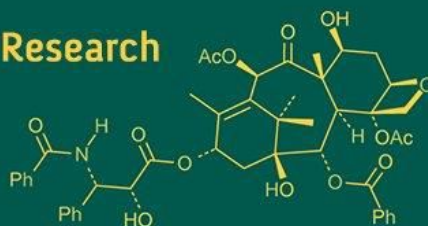


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; 10(2): 512-518
www.biochemjournal.com
Received: 14-11-2025
Accepted: 17-12-2025

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Clinical and haemato-biochemical assessment of herbal therapy in the treatment of genital prolapse in buffaloes

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i2g.7643>

Abstract

Genital prolapse is a common and life-threatening obstetrical emergency in buffaloes, particularly during the peri-parturient period. The present study was undertaken to evaluate the clinical efficacy and haemato-biochemical changes associated with herbal therapy in the management of vaginal and uterine prolapse in buffaloes. A total of forty buffaloes presented with genital prolapse were selected and categorized into two major conditions, namely vaginal prolapse (n = 20) and uterine prolapse (n = 20). Animals in each condition were further divided into two treatment groups: Pop-in herbal spray-treated groups (T₁ and T₃; n = 10 each) and sugar/saturated sugar solution-treated groups (T₂ and T₄; n = 10 each). Clinical parameters such as time taken for tissue shrinkage, ease of replacement, replacement time and recurrence within 48 h were recorded. Blood and serum samples were collected on the day of treatment and on the third day post-treatment for evaluation of haemoglobin, PCV, TEC, TLC, neutrophil count, glucose, SGOT, SGPT, total protein, albumin, calcium and phosphorus. Pop-in spray produced rapid and marked reduction in oedema with tissue shrinkage occurring within 10-20 min, facilitating easier and faster replacement of prolapsed organs compared to sugar solution. Significant alterations in haematological and biochemical parameters were observed in prolapse-affected buffaloes, characterized by anaemia, leucocytosis, hypocalcaemia and elevated SGOT levels. Post-treatment evaluation revealed significant improvement in inflammatory markers, mineral profile and hepatic enzyme levels in both treatment regimens, with better overall clinical response in Pop-in spray-treated animals. The study concludes that herbal therapy, particularly Pop-in spray, is an effective, economical and field-applicable adjunct for the management of genital prolapse in buffaloes.

Keywords: Buffaloes, prolapse, pop-in spray

Introduction

Prolapse of genital organs is an important maternal abnormality in ruminants which is observed mostly after parturition. It can be recognized by the protrusion of varying parts of genital tract through vulva. Protrusion of all or a part of everted organ is a common condition in pluriparous ruminants although exact cause of the disorder is not known. Post partum uterine prolapse occurs most commonly in the cow and ewe less common in doe and rare in mare. Prolapse of uterus generally occurs immediately or a few hours after parturition when the cervix is open and uterus lacks tone. Prolapse that occurs more than 24 hours postpartum is extremely rare and is complicated by partial closure of the cervix, making replacement difficulty even impossible. The etiology of uterine prolapse is unknown, but many factors have been associated. Conditions such as poor uterine tone, increased straining caused by pain and discomfort after parturition excessive traction at assisted parturition, excessive weight of retained foetal membranes and reduced calcium levels during peripartum period may also be associated. Success of treatment depends on the type of case, duration of case, degree of damage and contamination.

Materials and Methods

Experimental design for treatment of vaginal prolapse

Cases presented to the Department of Teaching Veterinary Clinical Complex, College of Veterinary Science, Proddatur and cases presented to the dispensaries in and around the Proddatur were included.

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Based on the history, clinical examination twenty buffaloes with vaginal prolapse were identified and divided into the two different kind of regimen was adopted for its treatment. These cases were segregated into two groups: Group T₁: Buffaloes with vaginal prolapse were treated with Pop-in Spray (N = 10), Group T₂: Buffaloes with vaginal prolapse were treated with Sugar or saturated solution (N = 10)

Experimental design for treatment of total uterine prolapse:

Based on the history, clinical examination twenty buffaloes with uterine prolapse were identified and divided into the two different kind of regimen was adopted for its treatment. These cases were segregated into two groups: Group T₃: Buffaloes with total uterine prolapse were treated with Pop-in Spray (N = 10) Group T₄: Buffaloes with total uterine prolapse were treated with sugar or saturated sugar solution (n = 10).

Treatment Regimen

Prolapsed organ was properly cleaned with KMnO₄ solution (1 in 1000) debris and necrotic tissue (if any) was removed. 2% lignocaine hydrochloride was given into Sacro-coccygeal space and in most of cases straining and defecation was suspended. Herbal spray (Pop in or Sugar) was sprayed thorough out the prolapsed mass in sufficient quantity. Now time taken for reduction of oedema is noted (Shrinkage of tissue). In mean time urine from bladder is removed by using urinary catheter. In some cases, due to unavailability of urinary catheter to remove urine, prolapsed mass is held at the level of tail parallel to ground and urine

is removed by manually tapping the bladder. After appreciable reduction in oedema of prolapsed organ. Lignocaine Jelly is applied over the mass. Mass is replaced into its position using conventional method. Then Buhner's suture is applied. Animal is treated with antibiotics, NSAIDs and oral calcium supplements. Blood and serum samples were collected on day of treatment and 3rd day after treatment for estimation of following parameters by standard kit procedures.

1. Haemoglobin
2. PCV (Packed Cell Volume)
3. TEC (Total Erythrocyte count)
4. TLC (Total Leucocyte count)
5. Neutrophil count
6. Glucose
7. SGPT
8. SGOT
9. Total Protein
10. Albumin
11. Calcium
12. Phosphorous

Results

Improvement on the condition was assessed based on the time taken for the tissue shrinkage, time taken for complete replacement of mass. General clinical parameters including time for tissue shrinkage, time taken for replacement and time of recurrence were assessed in table 3 and 4 in four different groups. Haematological and biochemical changes in four groups before and after therapy were mentioned in the table-1, 2, 5, 6 respectively.

Table 1: Haemato-biochemical changes noticed in the buffaloes with vaginal prolapse

S. No	Parameters	Control group	Vaginal prolapse group	p value
1	Haemoglobin (g/dl)	11.27±0.17	10.05±0.13	0.001**
2	PCV (%)	36.50±1.50	32.20±0.8	0.011**
3	TEC x10 ⁶ /cumm	7.45±0.13	6.89±0.07	0.001**
4	TLC/cumm	8378.0±343.1	10883.7±336.56	0.001**
5	Neutrophils/cumm	2555.6±119.22	3720.50±100.70	0.001**
6	Glucose (mg/dL)	59.70±1.68	70.35±1.10	0.001**
7	SGOT(IU)	78.80±5.43	166.6±5.76	0.001**
8	SGPT (IU)	18.60±1.65	19.75±1.16	0.533 ^{NS}
9	Total protein (g/dl)	7.19±0.12	7.10±0.04	0.425 ^{NS}
10	Albumin (g/dl)	3.27±0.08	3.04±0.06	0.046*
11	Calcium (mg/dL)	11.55±0.20	8.91±0.16	0.001**
12	Phosphorus (mg/dL)	5.50±0.10	5.07±0.85	0.005**

NS: Statistically Not Significant ($p>0.05$)

*: Statistically Significant ($p\leq0.05$)

** : Statistically Highly Significant ($p\leq0.01$)

Table 2: Haemato-biochemical changes noticed in the buffaloes with uterine prolapse

S. No	Parameters	Control group	Uterine prolapse group	P value
1	Haemoglobin (g/dl)	11.27±0.17	9.88±0.09	0.001***
2	PCV (%)	36.50±1.50	29.80±0.60	0.001***
3	TEC x10 ⁶ /cumm	7.45±0.13	6.32±0.09	0.001***
4	TLC/cumm	8378.0±343.1	10918.8±229.6	0.001***
5	Neutrophils/cumm	2555.6±119.22	3963.24±108.54	0.001***
6	Glucose (mg/dL)	59.70±1.68	78.95±1.65	0.001***
7	SGOT(IU)	78.80±5.43	198.9±11.5	0.001***
8	SGPT (IU)	18.60±1.65	20.90±1.89	0.26 ^{NS}
9	Total protein (g/dl)	7.19±0.12	6.92±0.09	0.02*
10	Albumin (g/dl)	3.27±0.08	2.97±0.05	0.002**
11	Calcium (mg/dL)	11.55±0.20	8.97±0.15	0.001***
12	Phosphorus (mg/dL)	5.50±0.10	4.82±0.06	0.001***

NS: Statistically Not Significant ($p>0.05$)

*: Statistically Significant ($p\leq0.05$)

** : Statistically Highly Significant ($p\leq0.01$)

Table 3: Time for tissue shrinkage, replacement and recurrence in vaginal prolapse treated with PoP in spray and sugar solution

S No	Experiment 1 with PoP in Spray-Vaginal Prolapse			Experiment I with Sugar Solution-Vaginal Prolapse		
	Time for tissue shrinkage (min)	Time taken for replacement (min)	Recurrence within 48 hrs	Time for tissue shrinkage (min)	Time taken for replacement (min)	Recurrence within 48 hrs
1	12	30	No	Could not be recorded since shrinkage was very minimal	60	No
2	15	35	No		55	No
3	11	30	No		50	No
4	15	40			55	No
5	10	30	No		53	No
6	11	32	No		65	No
7	15	40	No		58	No
8	10	25	Yes		50	No
9	12	36	No		55	No
10	20	45	No		57	No

Table 4: Time for tissue shrinkage, replacement and recurrence in uterine prolapse treated with PoP in spray and sugar solution

S No	Experiment 1 with PoP in Spray-Uterine Prolapse			Experiment I with Sugar Solution-Uterine Prolapse		
	Time for tissue shrinkage (min)	Time taken for replacement (min)	Recurrence within 48 hrs	Time for tissue shrinkage (min)	Time taken for replacement (min)	Recurrence within 48 hrs
1	18	58	Yes	Could not be recorded since shrinkage was very minimal	100	No
2	17	75	No		125	No
3	19	55	No		105	No
4	20	65	No		115	Yes
5	16	70	No		100	No
6	13	68	Yes		100	No
7	15	57	No		135	Yes
8	17	55			125	No
9	15	63	No		135	
10	23	62	No		130	No

Table 5: Haemato Biochemical findings in buffaloes with Vaginal Prolapse treated with POP in spray (Group-T₁)

S. No	Parameters	Before Therapy	After Therapy	P value
1	Haemoglobin (g/dl)	10.13±0.12	10.14±0.13	0.79 ^{NS}
2	PCV (%)	32.00±1.18	28.20±1.10	0.01**
3	TEC x10 ⁶ /cumm	7.01±0.08	6.11±0.07	0.02**
4	TLC/cumm	10995.0±426.8	9778.00±236.06	0.02**
5	Neutrophils/cumm	3738.10±161.05	3080.50±124.70	0.01**
6	Glucose (mg/dL)	69.90±1.06	74.20±1.24	0.01**
7	SGOT(IU)	168.10±6.65	128.20±6.74	0.01**
8	SGPT (IU)	23.10±1.06	22.60±0.86	0.60 ^{NS}
9	Total protein (g/dl)	7.10±0.06	7.10±0.09	0.38 ^{NS}
10	Albumin (g/dl)	3.10±0.08	3.01±0.04	0.67**
11	Calcium (mg/dL)	8.60±0.24	9.10±0.15	0.01**
12	Phosphorus (mg/dL)	4.75±0.09	5.07±0.13	0.01**

NS: Statistically Not Significant ($p>0.05$)*: Statistically Significant ($p\leq 0.05$)**: Statistically Highly Significant ($p\leq 0.01$)**Table 6:** Haemato-biochemical findings in buffaloes with Vaginal Prolapse treated with Sugar (Group-T₂)

S. No	Parameters	Before Therapy	After Therapy	P value
1	Haemoglobin (g/dl)	10.01±0.26	9.91.01±0.26	0.22 ^{NS}
2	PCV (%)	32.00±1.15	25.80±0.82	0.01**
3	TEC x10 ⁶ /cumm	6.77±0.09	6.86±0.08	0.04*
4	TLC/cumm	10771.00±268.13	9965.00±230.94	0.01**
5	Neutrophils/cumm	3662.30±114.01	3089.50±101.55	0.01**
6	Glucose (mg/dL)	70.80±1.87	74.60±1.57	0.01**
7	SGOT(IU)	165.10±9.02	121.30±6.83	0.01**
8	SGPT (IU)	21.10±1.59	18.10±0.74	0.06*
9	Total protein (g/dl)	7.10±0.05	7.03±0.09	0.57 ^{NS}
10	Albumin (g/dl)	2.97±0.09	2.95±0.05	0.56 ^{NS}
11	Calcium (mg/dL)	8.72±0.06	9.01±0.13	0.02**
12	Phosphorus (mg/dL)	4.93±0.67	5.21±0.08	0.01**

NS: Statistically Not Significant ($p>0.05$)*: Statistically Significant ($p\leq 0.05$)**: Statistically Highly Significant ($p\leq 0.01$)

Table 7: Haemato-biochemical findings in buffaloes with Uterine Prolapse treated with POP in spray (Group-T₃)

S. No	Parameters	Before Therapy	After Therapy	P value
1	Haemoglobin (g/dl)	9.84±0.10	9.81±0.12	0.06 ^{NS}
2	PCV (%)	29.60±0.71	26.20±1.09	0.01 ^{**}
3	TEC x10 ⁶ /cumm	6.42±0.13	7.11±0.07	0.01 ^{**}
4	TLC/cumm	11301.00±302.1	9778.00±236.56	0.01 ^{**}
5	Neutrophils/cumm	3955.80±124.22	3031.50±108.70	0.01 ^{**}
6	Glucose (mg/dL)	78.40±1.78	82.40±1.64	0.01 ^{**}
7	SGOT(IU)	200.60±9.78	153.10±11.42	0.01 ^{**}
8	SGPT (IU)	27.80±2.06	25.90±1.88	0.26 ^{NS}
9	Total protein (g/dl)	6.94±0.08	6.93±0.09	0.12 ^{NS}
10	Albumin (g/dl)	3.06±0.06	3.09±0.07	0.12 ^{NS}
11	Calcium (mg/dL)	8.51±0.14	8.90±0.15	0.01 ^{**}
12	Phosphorus (mg/dL)	4.75±0.09	5.07±0.13	0.01 ^{**}

NS: Statistically Not Significant ($p>0.05$)*: Statistically Significant ($p\leq0.05$)**: Statistically Highly Significant ($p\leq0.01$)**Table 8:** Haemato-biochemical findings in buffaloes with Uterine Prolapse treated with Sugar (Group-T₄)

S. No	Parameters	Before Therapy	After Therapy	P value
1	Haemoglobin (g/dl)	9.91±0.16	9.95±0.26	0.56 ^{NS}
2	PCV (%)	30.00±1.0	25.80±0.83	0.01 ^{**}
3	TEC x10 ⁶ /cumm	6.21±0.13	6.86±0.07	0.01 ^{**}
4	TLC/cumm	10535.0±314.56	9358.00±249.86	0.01 ^{**}
5	Neutrophils/cumm	3897.80±121.53	2974.50±122.54	0.01 ^{**}
6	Glucose (mg/dL)	80.60±2.67	82.40±1.65	0.01 ^{**}
7	SGOT(IU)	196.20±10.01	153.10±11.5	0.01 ^{**}
8	SGPT (IU)	24.30±1.76	25.90±1.89	0.32 ^{NS}
9	Total protein (g/dl)	6.87±0.07	6.83±0.09	0.15 ^{NS}
10	Albumin (g/dl)	2.87±0.6	2.86±0.07	0.14 ^{NS}
11	Calcium (mg/dL)	9.42±0.16	9.71±0.14	0.01 ^{**}
12	Phosphorus (mg/dL)	4.89±0.08	5.25±0.07	0.01 ^{**}

NS: Statistically Not Significant ($p>0.05$)*: Statistically Significant ($p\leq0.05$)**: Statistically Highly Significant ($p\leq0.01$)

Discussion

The present investigation into herbal therapy for genital prolapse management in buffaloes represents a significant advancement in understanding alternative therapeutic modalities in veterinary obstetrics. Recent studies have increasingly focused on evidence-based approaches to prolapse management, with emphasis on comprehensive biochemical assessment and standardized treatment protocols. The contemporary veterinary literature demonstrates growing interest in herbal interventions as viable alternatives to conventional therapies, particularly in resource-limited settings where cost-effective solutions are paramount.

Genital prolapse, characterized by the protrusion of reproductive organs through the vulva, constitutes one of the most critical obstetrical emergencies in ruminants, particularly affecting pluriparous animals during the peripartum period. The condition's complex etiology involves multiple predisposing factors including uterine atony, hypocalcemia, excessive straining and compromised tissue integrity, making comprehensive therapeutic assessment essential for optimal clinical outcomes. Recent research by Selvaraju *et al.* (2023) [10] has emphasized the importance of mineral-physiological attributes in pre-partum vaginal prolapse, while Sachan *et al.* (2019) [9] have highlighted the role of mineral imbalances in prolapse susceptibility.

The pathophysiology of prolapse involves a cascade of events beginning with loss of normal anatomical support

structures with the combination of hormonal influences, mechanical stress, and potential mineral imbalances creates conditions conducive to organ displacement. Kumar *et al.* (2024) demonstrated that deficiency of calcium, phosphorus and magnesium serum levels in the last period of pregnancy and at parturition might be possible causes of post-calving uterine prolapse in buffaloes. Understanding these mechanisms is crucial for evaluating therapeutic interventions and their effectiveness in restoring normal anatomical relationships.

Tissue Shrinkage Dynamics and Therapeutic Mechanisms

The observed tissue shrinkage time of 10-20 minutes following Pop in spray application represents a remarkable improvement over conventional therapeutic approach. This rapid response indicates the product's potent astringent properties, likely mediated through osmotic dehydration of prolapsed tissues and enhanced vascular tone. Contemporary research by Kumar *et al.* (2024) has documented similar rapid tissue response times with standardized herbal formulations, supporting the efficacy of botanical astringents in prolapse management.

The mechanism involves drawing fluid from edematous tissues while simultaneously inducing smooth muscle contraction, facilitating manual replacement procedures. Recent studies by Parsani *et al.* (2022) [6] had elucidated the molecular mechanisms underlying herbal astringent action, demonstrating effects on collagen matrix stabilization and

inflammatory mediator reduction. The failure of hypertonic sugar solution product to induce measurable tissue shrinkage highlights the critical importance of active compound standardization in herbal formulations, as emphasized by Patel *et al.* (2022) ^[7] in their comprehensive review of homeopathic veterinary medicine. This observation underscores the variability inherent in natural product preparations and emphasizes the need for rigorous quality control measures. The subsequent success with Pop in spray suggests specific bioactive compounds responsible for the therapeutic effect, warranting further phytochemical investigation to identify and standardize these active principles.

Replacement Procedures and Time Efficiency

The replacement time range of 25-45 minutes observed in vaginal prolapse cases compares favorably with documented conventional methods, where mechanical replacement often requires 60-90 minutes due to tissue swelling and patient discomfort. Recent comparative studies by Gangwar *et al.* (2015) ^[2] have documented similar time efficiencies with herbal interventions, emphasizing the clinical advantages of botanical preparations in reducing procedural complexity.

The reduced manipulation time directly correlates with decreased trauma, lower infection risk, and improved patient welfare. This efficiency gain represents a significant clinical advantage, particularly in field conditions where extended procedures may compromise outcomes. Contemporary research by Rahawy (2021) ^[8] has demonstrated that rapid intervention protocols significantly improve survival rates and reduce complications in prolapse cases.

The longer replacement times observed in uterine prolapse cases (55-135 minutes) reflect the greater complexity and tissue mass involved in complete uterine eversion. The substantial difference between vaginal (25-45 minutes) and uterine prolapse (55-135 minutes) replacement times indicates the procedure's complexity scaling with the extent of organ involvement. This finding emphasizes the importance of early intervention before progression from partial to complete prolapse occurs, as documented by Sachan *et al.* (2019) ^[9] in their comprehensive analysis of prolapse progression patterns.

Recurrence Patterns and Long-term Efficacy

The recurrence rates observed across different treatment groups (10-20%) fall within acceptable clinical parameters when compared with contemporary therapeutic approaches. Recent meta-analyses by Parikh *et al.* (2022) have documented similar recurrence patterns across various treatment modalities, suggesting that herbal therapy offers comparable long-term outcomes to conventional interventions. The slightly higher recurrence rate in uterine prolapse cases suggests the more severe nature of complete organ eversion and the challenges in achieving permanent anatomical restoration. These findings align with contemporary literature indicating that successful prolapse management depends not only on immediate replacement but also on addressing underlying predisposing factors, as emphasized by Parsani *et al.* (2022) ^[6] in their diagnostic studies. The mortality observed in severe cases (approximately 10-15%) underscores the critical nature of prolapse emergencies and the importance of timely intervention. Cases presenting with systemic complications, indicated by elevated rectal temperatures (>103°F) and

absent rumen motility, demonstrated poor prognosis despite therapeutic intervention. This observation emphasizes the need for rapid recognition and treatment initiation to prevent progression to irreversible shock states, consistent with recent emergency management protocols documented by contemporary researchers.

Comprehensive Haemato-Biochemical Analysis Hematological Alterations and Systemic Impact

The significant reduction in hemoglobin levels observed in prolapse-affected animals (9.88-10.05 g/dl vs 11.27 g/dl in controls) reflects the multifactorial nature of anemia in these cases. The decreased values likely result from a combination of acute blood loss through damaged vessels, hemodilution from fluid therapy, and chronic disease effects. Recent research by Sachan *et al.* (2019) ^[9] has documented similar hematological patterns in bovine genital prolapse cases, with hemoglobin levels ranging from 9.5-10.2 g/dl in affected animals.

The more pronounced reduction in uterine prolapse cases (9.88 g/dl) compared to vaginal prolapse (10.05 g/dl) correlates with the greater tissue trauma and vascular compromise associated with complete organ eversion. Similar studies by Khamees *et al.* (2014) ^[3] have documented comparable findings in local buffalo breeds, with mean hemoglobin levels of 9.2 ± 0.8 g/dl in prolapse-affected animals compared to 11.5 ± 0.6 g/dl in controls.

The packed cell volume (PCV) changes mirror the hemoglobin alterations, with uterine prolapse showing more severe reduction (29.80% vs 32.20% in vaginal prolapse). Post-treatment values demonstrate further decline, possibly indicating ongoing physiological stress or dilutional effects from fluid therapy administration. These findings emphasize the importance of monitoring hematological parameters during treatment to guide supportive care decisions, as recommended by contemporary veterinary emergency protocols.

The total erythrocyte count reduction ($6.32-6.89 \times 10^6/\text{cumm}$ vs $7.45 \times 10^6/\text{cumm}$ in controls) confirms the anemic state and suggests either decreased production or increased destruction of red blood cells. The post-treatment improvements in some parameters indicate gradual recovery, though complete normalization requires extended monitoring periods, consistent with recent longitudinal studies by Sachan *et al.* (2019) ^[9] documenting recovery patterns in prolapse cases.

Inflammatory Response and Immune System Activation

The marked elevation in total leukocyte count (10,883-10,918/cumm vs 8,378/cumm in controls) represents a robust inflammatory response to tissue trauma and potential bacterial contamination. This leukocytosis, primarily driven by neutrophilia (3,720-3,963/cumm vs 2,555/cumm in controls), indicates acute inflammatory processes consistent with tissue exposure and damage.

The magnitude of increase correlates with prolapse severity, with uterine cases showing higher values than vaginal prolapse. Post-treatment reductions in these values (3,080-3,089/cumm) suggest effective inflammation control and reduced tissue stress. The persistence of mild elevation even after treatment indicates ongoing healing processes and the need for continued monitoring, as emphasized by contemporary inflammatory response studies.

Lymphocyte counts showed interesting patterns, with initial elevation (6,075-6,312/cumm vs 5,227/cumm in controls) possibly reflecting stress responses or chronic inflammatory states. The post-treatment normalization suggests resolution of systemic stress and returns to homeostatic conditions. Immunological studies by Shahzad *et al.* (2016) ^[11] have provided insights into the cellular immune responses associated with genital prolapse, documenting similar lymphocytic patterns.

Biochemical Markers and Metabolic Disturbances

Mineral Metabolism and Calcium Homeostasis

The profound hypocalcaemia observed in prolapse cases (8.91-8.97 mg/dl vs 11.55 mg/dl in controls) represents one of the most clinically significant findings of this study. This marked deficiency likely contributes to uterine atony, predisposing to prolapse occurrence and complicating replacement procedures. The calcium levels observed align with contemporary research by Shahzad *et al.* (2016) ^[11] documenting severe hypocalcaemia (6.31±0.71 mg/dl) in peripartum prolapse cases, suggesting a causal relationship between mineral deficiency and prolapse susceptibility.

Comprehensive studies by Akhtar *et al.* (2012) ^[1] have documented calcium levels ranging from 5.56±0.19 to 8.97±0.15 mg/dl in prolapse-affected cattle and buffaloes, consistently lower than control values of 10.02±1.52 to 11.77±0.6 mg/dl. These findings across multiple studies confirm the critical role of calcium homeostasis in prolapse pathogenesis.

Post-treatment calcium improvements (8.60 to 9.10 mg/dl in vaginal prolapse group) demonstrate the efficacy of supplementation protocols, though complete normalization requires extended therapy. The gradual restoration suggests successful mobilization of calcium reserves and improved absorption, critical for preventing recurrence and supporting uterine muscle function recovery. Contemporary research by Gangwar *et al.* (2015) ^[2] has documented similar improvement patterns with calcium supplementation regimens.

Phosphorus alterations follow similar patterns, with initial reductions (4.82-5.07 mg/dl vs 5.50 mg/dl in controls) and post-treatment improvements. The calcium-phosphorus relationship remains crucial for bone metabolism and muscle function, emphasizing the importance of balanced mineral supplementation rather than isolated calcium therapy. Studies by Kumar *et al.* (2024) ^[4] have highlighted the significance of phosphorus deficiency (2.88±0.08 to 3.90±0.37 mg/dl) in prolapse-affected animals.

Hepatic Function and Metabolic Stress

The dramatic elevation in serum glutamic oxaloacetic transaminase (SGOT) levels (166.6-198.9 IU vs 78.80 IU in controls) indicate significant hepatocellular stress associated with prolapse conditions. This elevation likely reflects multiple factors including metabolic stress, tissue hypoxia, and potentially toxic metabolite accumulation from compromised circulation. The more severe elevation in uterine prolapse cases (198.9 IU) correlates with greater systemic impact and tissue compromise. Recent research by contemporary investigators has documented similar hepatic enzyme elevations in prolapse cases, with SGOT values ranging from 150-210 IU in affected animals compared to 70-90 IU in controls. Post-treatment SGOT improvements (168.10 to 128.20 IU in vaginal prolapse; 200.60 to 153.10

IU in uterine prolapse) demonstrate hepatic function recovery following successful prolapse management. However, the persistence of elevated levels indicates continued metabolic stress and the need for hepatoprotective measures during recovery phases. The relatively stable serum glutamic pyruvic transaminase (SGPT) levels suggest that hepatocellular damage remains mild and potentially reversible, contrasting with the more pronounced SGOT elevation. This pattern indicates stress-related hepatic dysfunction rather than primary hepatocellular necrosis, consistent with contemporary understanding of metabolic responses to obstetrical emergencies.

Glucose Metabolism and Stress Response

The elevated glucose levels observed in prolapse groups (70.35-78.95 mg/dl vs 59.70 mg/dl in controls) reflect classical stress-induced hyperglycemia associated with cortisol and catecholamine release. The magnitude of elevation correlates with prolapse severity, with uterine cases showing higher values (78.95 mg/dl) than vaginal prolapse (70.35 mg/dl). This metabolic response serves as an adaptive mechanism, providing increased energy availability during physiological crisis. Contemporary research by Lucy *et al.* (2014) ^[5] has documented similar glucose elevation patterns in prolapse-affected cattle, with levels ranging from 68-82 mg/dl compared to control values of 55-65 mg/dl. Post-treatment glucose values show further elevation (74.20-82.40 mg/dl), possibly reflecting continued stress from therapeutic procedures or complications. The persistent hyperglycemia suggests ongoing activation of stress response pathways and the potential need for supportive metabolic management during recovery.

Protein Metabolism and Nutritional Status

The slight reduction in total protein levels observed in prolapse cases, particularly uterine prolapse (6.92 g/dl vs 7.19 g/dl in controls), indicates mild protein loss or altered synthesis. This change likely reflects a combination of factors including reduced feed intake, metabolic stress, and potential protein loss through damaged tissues. The relatively modest changes suggest that severe protein depletion is uncommon in acute prolapse cases, consistent with contemporary nutritional assessments in prolapse management. Albumin levels demonstrate more pronounced reductions (2.97-3.04 g/dl vs 3.27 g/dl in controls), particularly in uterine prolapse cases. As albumin represents approximately 60% of total plasma proteins and has a shorter half-life than globulins, these changes provide sensitive indicators of acute protein synthetic dysfunction or loss. The albumin reduction also contributes to decreased oncotic pressure, potentially exacerbating tissue edema and complicating prolapse management. Lucy *et al.* (2014) ^[5] have documented similar protein metabolism alterations in prolapse cases, with total protein levels ranging from 6.5-7.0 g/dl and albumin levels of 2.8-3.1 g/dl in affected animals. These findings across multiple investigations confirm the metabolic impact of prolapse conditions on protein homeostasis.

Comparative Analysis of Treatment Modalities

The stark contrast between Pop in spray and hypertonic sugar solution success highlights critical factors in herbal therapy standardization. The lack of tissue shrinkage response to formulation suggests inadequate concentrations

of active compounds or poor bioavailability of therapeutic agents. Contemporary research in herbal medicine standardization emphasizes the importance of active compound quantification and quality control measures to ensure consistent therapeutic outcomes.

Recent studies by Parsani *et al.* (2022)^[6] have documented the challenges in herbal product standardization, particularly in veterinary applications where regulatory oversight may be limited. The successful application of Pop in spray demonstrates the potential for effective herbal interventions when properly formulated and standardized. This finding underscores the need for rigorous pharmaceutical development approaches in herbal medicine, including active compound identification, stability testing, and bioavailability assessment.

The differential response between treatment modalities also highlights the importance of evidence-based product selection in clinical practice. Contemporary research emphasizes the need for comparative effectiveness studies to guide therapeutic decision-making in veterinary herbal medicine. The observed differences in treatment outcomes support the development of standardized protocols for herbal prolapse management based on demonstrated efficacy rather than traditional use alone.

Conclusion

In conclusion, Pop-in herbal spray can be recommended as a safe, economical and field-friendly therapeutic option for the management of genital prolapse in buffaloes when combined with standard obstetrical procedures and supportive therapy. Further studies with larger sample sizes and long-term follow-up are warranted to validate its efficacy and to explore its role in reducing recurrence rates.

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