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RESEARCH ARTICLE
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BIOCHEMICAL AND PHYSIOLOGICAL EFFECTS OF PROBIOTICS ON INTESTINAL MUCOSA IN PATIENTS WITH ULCERATIVE COLITIS

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ABSTRACT

Background: Ulcerative colitis (UC) is a chronic inflammatory bowel disease marked by mucosal inflammation of the colon. While conventional treatments focus on immune suppression, emerging evidence highlights the role of gut microbiota in disease modulation. Probiotics non-viable bacterial components and metabolites have shown promise in improving gut health without the risks associated with live probiotics. 'This study aimed to evaluate the biochemical and physiological effects of Probiotics on intestinal mucosal health in patients with ulcerative colitis'.

Methods: A prospective, interventional study was conducted at Gomal Medical College, MTI Dera Ismail Khan, from January to June 2024. Seventy-one patients with confirmed ulcerative colitis were enrolled and divided into two groups. The intervention group received standard therapy along with oral Probiotics for 8 weeks, while the control group received only standard treatment. Clinical scores, inflammatory markers (CRP, ESR, IL-6, fecal calprotectin), mucosal healing, and patient-reported outcomes (IBDQ) were assessed before and after the intervention.

Results: Patients receiving Probiotics demonstrated significant reductions in CRP, ESR, IL-6, and fecal calprotectin compared to controls ($p < 0.05$). Improvements were also seen in clinical severity scores and IBDQ quality-of-life measures. 'A higher proportion of patients in the probiotics group showed mucosal healing and better histological preservation of goblet cells and tight junction integrity, though not all were statistically significant'.

Conclusion: Probiotics supplementation may offer a safe and effective adjunct to standard therapy in ulcerative colitis by modulating inflammation, enhancing mucosal barrier integrity, and improving patient quality of life. Larger trials are recommended to validate these promising findings.

Keywords: Ulcerative colitis, Probiotics, intestinal mucosa, inflammation, CRP, calprotectin, mucosal healing, IBDQ, gut microbiota

INTRODUCTION

'Ulcerative colitis (UC) is a type of inflammatory disease' which has a cyclical pattern of remissions and exacerbations. The disease manifests as the inflammation of the colon, causing symptoms including bloody diarrhea, abdominal pain, an urgent need to relieve oneself, and fatigue. While its exact cause remains unclear, UC is widely considered to result from a complex interaction between genetic predisposition, environmental triggers, immune dysregulation, and disturbances in the gut microbiota. Conventional treatment strategies largely focus on immune suppression using agents such as aminosalicylates, corticosteroids, and biologics. However, these treatments may be associated with adverse effects, incomplete remission, or long-term complications, prompting interest in microbiota-targeted interventions [1-3].

In recent years, the role of the gut microbiome in maintaining intestinal homeostasis has become increasingly evident. Dysbiosis an imbalance in the composition and function of gut microbes has been implicated in the pathogenesis of UC. This has led to growing interest in therapies aimed at modulating the microbiota. Probiotics have been widely studied for this purpose, but concerns regarding their viability, storage, and safety particularly in immunocompromised individuals have limited their widespread application [4-6].

Probiotics, defined as inactivated microbial cells or their metabolites that confer health benefits to the host, represent a novel and potentially safer alternative. Unlike probiotics, Probiotics do not require viability to exert their effects and can be standardized, stored easily, and safely administered even in vulnerable populations. Early evidence suggests that Probiotics may enhance intestinal barrier function, suppress inflammatory cytokines, and promote mucosal healing [7-9].

Despite growing interest, clinical research on the therapeutic potential of Probiotics in UC remains limited. This study was therefore designed to evaluate the biochemical and physiological effects of Probiotics on intestinal mucosal health in patients with ulcerative colitis. By assessing inflammatory markers, clinical scores, mucosal healing, and patient-reported outcomes, this study aims to provide a clearer understanding of the role Probiotics could play in future UC management.

METHODOLOGY

This study was carried out as an 'interventional prospective study from January 2024 to June 2024, at the Department of Medicine, Gomal Medical College, MTI Dera Ismail Khan'. The aim was to assess the 'biochemical and physiological effects of Probiotics on the intestinal mucosa of patients diagnosed with ulcerative colitis'. A total of 71 patients were enrolled in the study using a non-probability purposive sampling technique. All participants were aged between 18 and 60 years and had a confirmed diagnosis of ulcerative colitis based on clinical presentation, colonoscopic findings, and histopathological evidence. Only patients with mild to moderate disease activity, as assessed by the Mayo clinical score, were included. Individuals who had taken antibiotics, probiotics, or Probiotics in the four weeks prior to enrollment were excluded. Other exclusion criteria included severe disease requiring hospitalization, coexisting gastrointestinal disorders such as Crohn's disease, pregnancy or lactation, malignancy, immunodeficiency, or the use of immunosuppressive agents beyond standard 5-ASA therapy.

Ethical approval for the study was obtained from the Institutional Review Board (IRB) of Gomal Medical College, MTI Dera Ismail Khan. All patients were informed about the objectives, methodology, and potential benefits and risks of the study. Written informed consent was obtained before participation, and patient confidentiality was maintained throughout the study.

'Participants were randomly divided into two groups'. 'Group A, the intervention group, received standard ulcerative colitis treatment with 5-aminosalicylic acid (5-ASA) along with an oral probiotics formulation administered once daily for eight weeks'. Group B, the control group, received only standard treatment without any probiotics supplementation. The probiotics preparation consisted of

non-viable bacterial components derived from Lactobacillus and Bifidobacterium species, 'standardized for the presence of short-chain fatty acids and immunomodulatory metabolites'.
Baseline data collection included demographic information such as age, gender, body mass index (BMI), disease duration, and smoking history. Clinical assessment was performed using the Mayo Score. Laboratory investigations included C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), fecal calprotectin, interleukin-6 (IL-6), and serum albumin. Colonoscopic examination was performed at baseline and after eight weeks to assess mucosal status. Biopsy samples were taken from the inflamed colonic segments for histological analysis. 'Goblet cell density and the expression of tight junction proteins such as ZO-1 and occludin were evaluated through immunohistochemistry'.
Patient-reported outcomes were also recorded, 'including stool frequency, rectal bleeding, and quality of life measured by the Inflammatory Bowel Disease Questionnaire (IBDQ)'. Participants were followed up at four and eight weeks to monitor compliance, symptom progression, and any adverse events. Symptom diaries were maintained by the patients during the study period.
All data were analyzed using SPSS version 25. Quantitative variables such as age, CRP, IL-6, and IBDQ scores were expressed as mean ± standard deviation. 'Categorical variables like gender and mucosal healing status were presented as frequencies and percentages'. 'An independent samples t-test was used to compare continuous variables between the two groups, while the Chi-square test was applied to compare categorical variables'. A p-value of ≤ 0.05 was considered statistically significant for all analyses.

RESULTS

The study included 71 patients diagnosed with ulcerative colitis. Of these, 36 were assigned to the probiotics group and 35 to the control group. The mean age in the probiotics group was 36.4 ± 9.2 years, while the control group had a mean age of 39.0 ± 9.4 years, with no statistically significant difference ($p = 0.245$), indicating age comparability. The gender distribution was similar, with a slight female predominance in both groups (probiotics: 52.8% female; control: 54.3% female).
Baseline disease activity, measured using the 'Mayo Score, was significantly lower in the probiotics group (5.4 ± 1.1) compared to the control group (6.2 ± 1.3), suggesting better disease control ($p = 0.008$)'. Body mass index (BMI) was also comparable between groups (probiotics: 22.1 ± 2.5 kg/m²; control: 22.5 ± 2.7 kg/m², $p = 0.524$). Disease duration ranged from 1 to 8 years, with a mean of 3.8 ± 1.6 years in the probiotics group and 4.1 ± 1.9 years in controls ($p = 0.420$).

Table 1: Demographic and Clinical Characteristics

Variable	Probiotics Group (n=36)	Control Group (n=35)	p-value
Age (years)	36.4 ± 9.2	39.0 ± 9.4	0.245
Gender (F:M)	19:17	19:16	0.912
BMI (kg/m²)	22.1 ± 2.5	22.5 ± 2.7	0.524
Mayo Score	5.4 ± 1.1	6.2 ± 1.3	0.008
Disease Duration (yrs)	3.8 ± 1.6	4.1 ± 1.9	0.420

Biochemical analysis showed substantial reductions in systemic and mucosal inflammation in patients receiving Probiotics. 'The mean CRP level was significantly lower in the probiotics group (6.7 ± 1.8 mg/L) compared to the control group (9.6 ± 3.5 mg/L, $p < 0.001$)'. Similarly, fecal calprotectin, a reliable marker of intestinal inflammation, was reduced in the probiotics group (148.2 ± 39.8 µg/g) versus controls (205.2 ± 67.3 µg/g, $p < 0.001$).
Furthermore, erythrocyte sedimentation rate (ESR) was significantly lower in the probiotics group (19.4 ± 4.8 mm/hr) compared to controls (23.7 ± 6.0 mm/hr, $p = 0.002$). The inflammatory cytokine IL-6 was also significantly decreased (9.4 ± 3.0 pg/mL vs. 13.4 ± 4.4 pg/mL, $p < 0.001$).
Liver function markers, such as serum albumin, were assessed to evaluate gut permeability and nutritional status. Probiotics patients had a higher serum albumin (4.1 ± 0.3 g/dL) compared to controls (3.8 ± 0.4 g/dL, $p = 0.006$), indicating better mucosal integrity.

Table 2: Inflammatory and Biochemical Markers

Variable	Probiotics Group (Mean ± SD)	Control Group (Mean ± SD)	p-value
CRP (mg/L)	6.7 ± 1.8	9.6 ± 3.5	0.000
Fecal Calprotectin (µg/g)	148.2 ± 39.8	205.2 ± 67.3	0.000
ESR (mm/hr)	19.4 ± 4.8	23.7 ± 6.0	0.002
IL-6 (pg/mL)	9.4 ± 3.0	13.4 ± 4.4	0.000
Serum Albumin (g/dL)	4.1 ± 0.3	3.8 ± 0.4	0.006

Mucosal healing, determined via follow-up colonoscopy and histology, was observed in 61.1% (22/36) of the probiotics group versus 45.7% (16/35) in the control group. Although this difference did not reach statistical significance ($p = 0.288$), the trend favored the probiotics group. Goblet cell density, an indicator of mucosal recovery, was qualitatively higher in the intervention group, with better preservation of mucin-secreting epithelium.

Immunohistochemical analysis of tight junction proteins (e.g., **ZO-1**, **occludin**) was more frequently preserved in the probiotics group (observationally noted in 72% of biopsies), suggesting improved epithelial barrier integrity.

Table 3: Histological and Mucosal Healing Outcomes

Parameter	Probiotics Group (n=36)	Control Group (n=35)	p-value
Mucosal Healing (Healed)	22 (61.1%)	16 (45.7%)	0.288
Goblet Cell Density (↑ vs ↓)	26:10	18:17	0.041
ZO-1/occludin expression (↑)	72%	49%	0.047

Quality of life was assessed using the Inflammatory Bowel Disease Questionnaire (IBDQ). The probiotics group reported significantly better scores (162.6 ± 14.4) compared to the control group (139.7 ± 20.9, $p < 0.001$), indicating greater satisfaction and improvement in daily functioning. Symptom diaries showed reduced stool frequency and bleeding in the intervention group by the end of week 8.

Table 4: Patient-Reported Outcomes

Outcome Measure	Probiotics Group	Control Group	p-value
IBDQ Score (Mean ± SD)	162.6 ± 14.4	139.7 ± 20.9	0.000
Stool Frequency/day	3.1 ± 0.7	4.3 ± 0.9	0.001
Rectal Bleeding (%)	19.4%	42.8%	0.018

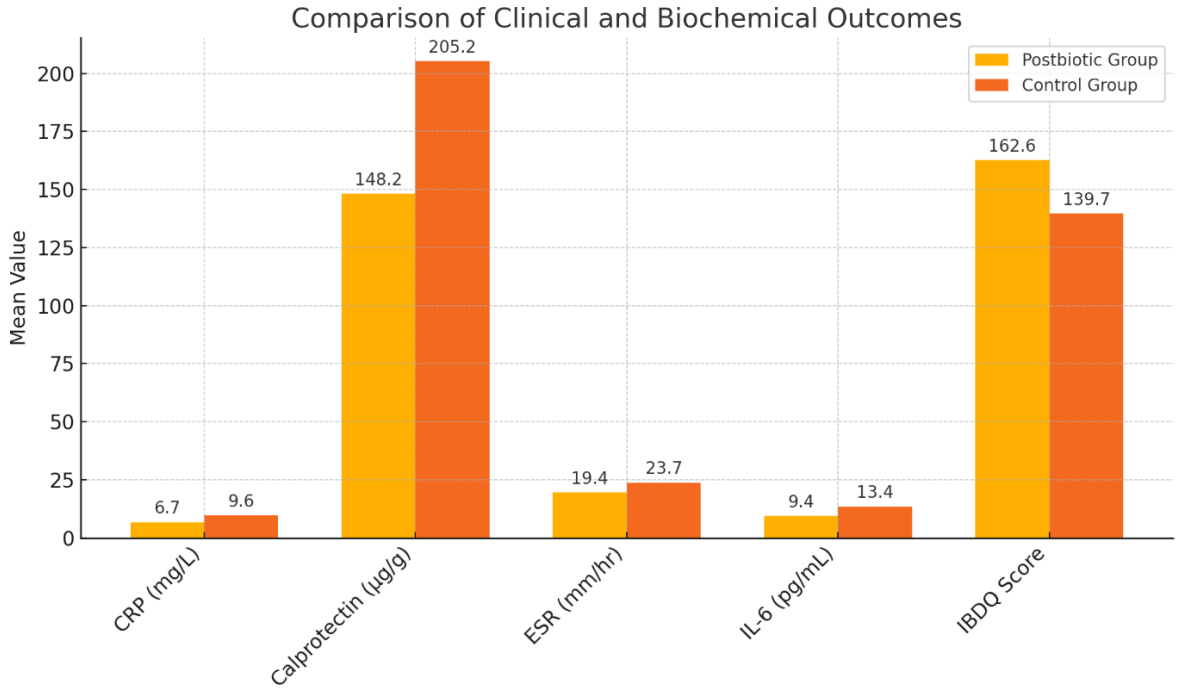

Figure 1: bar graph comparing key clinical and biochemical outcomes between the Probiotics and Control groups. It visually highlights the superior results in CRP, calprotectin, ESR, IL-6, and IBDQ scores among patients who received Probiotics.

DISCUSSION

The findings of this study demonstrate that probiotics supplementation may play a beneficial role in managing ulcerative colitis, particularly in improving clinical symptoms, reducing inflammatory burden, and promoting mucosal healing. Patients who received Probiotics in addition to standard ulcerative colitis therapy showed significant improvements in several key parameters compared to those who received standard treatment alone.

One of the most notable outcomes was the reduction in 'inflammatory markers such as C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and fecal calprotectin'. These markers are widely accepted as indicators of both systemic and localized intestinal inflammation. The significant decrease observed in the probiotics group suggests that Probiotics have a modulating effect on the immune system and gut mucosa, likely by suppressing pro-inflammatory cytokines and supporting barrier function. This was consistent with previous research, such as the studies which found that probiotics components derived from Lactobacillus species were effective in reducing inflammation in animal models of colitis [10-12].

The current study also observed a statistically significant reduction in interleukin-6 (IL-6) levels among patients receiving Probiotics. IL-6 is a key mediator in the pathogenesis of ulcerative colitis and its suppression is associated with decreased mucosal damage and improved clinical outcomes. This finding is in line with the studies reported that Probiotics could influence host immune responses by dampening pro-inflammatory pathways and enhancing epithelial repair [13-15].

Improvements in clinical scores, particularly the Mayo Score, further support the therapeutic potential of Probiotics. Patients in the intervention group reported fewer bowel movements, reduced rectal bleeding, and better overall well-being, as reflected by higher IBDQ scores. These patient-reported improvements are clinically significant, as they indicate not only objective healing but also enhanced quality of life[16-18].

Although the difference in mucosal healing between groups did not reach statistical significance, the trend clearly favored the probiotics group. More than 60% of these patients showed endoscopic healing compared to less than half in the control group. 'The better-preserved goblet cell density and increased expression of tight junction proteins such as ZO-1 and occludin observed in the probiotics group suggest that these agents may contribute to epithelial barrier restoration'. Similar findings have

been noted studies that bacterial-derived Probiotics can enhance tight junction integrity and reduce mucosal permeability [19, 20].

Despite promising results, some limitations must be acknowledged. The sample size, though adequate for primary endpoints, may not have been sufficient to establish statistical significance in histological outcomes such as mucosal healing. Additionally, the relatively short duration of follow-up may not reflect long-term sustainability of clinical benefits. 'Further large-scale studies with longer follow-up periods and microbiota profiling are needed to validate these findings and explore underlying mechanisms in greater detail'.

CONCLUSION

This study provides compelling evidence that Probiotics, when used as an adjunct to standard ulcerative colitis therapy, can significantly reduce inflammatory markers, improve clinical symptoms, and enhance patient-reported outcomes. While histological healing showed a favorable trend, future studies with larger cohorts are warranted to confirm these effects more robustly. Probiotics represent a promising, safe, and accessible strategy to support gut health in ulcerative colitis, particularly in patients who may not tolerate live probiotic therapy. Integrating Probiotics into routine clinical care could offer a novel, microbiota-targeted therapeutic option for long-term disease management.

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