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**Dr. Carlos R Lopez**  
Department of Pharmacology,  
School of Pharmacy, Sunfield  
University, Sunfield, Brazil

## Effect of myrobalan plum on gut microbiota and digestive health

**Carlos R Lopez**

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### Abstract

Myrobalan Plum (*Terminalia chebula*) has been traditionally used in various medicinal systems for its therapeutic properties. Recent studies suggest its potential benefits on gut microbiota and digestive health. This study aims to investigate the effects of Myrobalan Plum extract on gut microbiota composition and digestive health in a controlled animal model. Our findings indicate that Myrobalan Plum extract significantly enhances beneficial gut bacteria populations and improves digestive functions, supporting its use as a natural remedy for gastrointestinal issues.

**Keywords:** Myrobalan plum, *Terminalia chebula*, gut microbiota, digestive health, probiotics, gastrointestinal tract

### Introduction

The gastrointestinal (GI) tract hosts a complex and dynamic community of microorganisms, collectively known as the gut microbiota, which plays a crucial role in maintaining overall health. These microorganisms, including bacteria, fungi, viruses, and protozoa, contribute to a variety of physiological processes such as digestion, nutrient absorption, metabolism, and immune system modulation. A balanced gut microbiota is essential for these functions, while an imbalance, known as dysbiosis, has been linked to a wide range of health issues, including digestive disorders like irritable bowel syndrome (IBS) and inflammatory bowel disease (IBD), metabolic conditions such as obesity and type 2 diabetes, and immune dysfunctions including allergies and autoimmune diseases.

Traditional medicine systems, such as Ayurveda, have long utilized various natural products for their therapeutic benefits. Myrobalan Plum (*Terminalia chebula*), a key component in many Ayurvedic formulations, has garnered attention for its broad spectrum of medicinal properties. *Terminalia chebula* is renowned for its potent antioxidant, anti-inflammatory, and antimicrobial activities, which are attributed to its rich phytochemical profile, including compounds like chebulagic acid, chebulinic acid, and ellagic acid. These properties make Myrobalan Plum a candidate for influencing gut health and microbiota composition, potentially offering a natural remedy for managing gut-related health issues.

Recent advances in microbiome research have highlighted the intricate relationship between dietary components and gut microbiota. Dietary interventions using prebiotics, probiotics, and natural extracts are being explored for their ability to modulate the gut microbiome, thereby improving health outcomes. However, scientific investigations specifically focusing on Myrobalan Plum and its effects on gut microbiota are limited. Understanding how this medicinal plant influences the gut microbial community and digestive health could pave the way for developing novel therapeutic strategies using natural products.

This study aims to explore the effects of Myrobalan Plum on gut microbiota and its implications for digestive health. By employing a controlled animal model, this research seeks to elucidate how the extract of Myrobalan Plum affects the composition of gut microbiota, digestive enzyme activity, gastrointestinal transit time, and inflammatory markers. Additionally, histopathological examinations will provide insights into the structural integrity of the gastrointestinal tract under the influence of Myrobalan Plum extract. These findings are expected to offer valuable data on the potential of Myrobalan Plum as a natural therapeutic agent for promoting gut health and managing digestive

**Corresponding Author:**  
**Dr. Carlos R Lopez**  
Department of Pharmacology,  
School of Pharmacy, Sunfield  
University, Sunfield, Brazil

disorders, thereby bridging the gap between traditional knowledge and modern scientific research.

**Main Objective**

The main objective of this study is to investigate the effects of Myrobalan Plum (*Terminalia chebula*) extract on gut microbiota composition and digestive health in a controlled animal model.

**Materials and Methods**

This study employed a controlled animal model to investigate the effects of Myrobalan Plum (*Terminalia chebula*) extract on gut microbiota and digestive health. Myrobalan Plum fruits were sourced from a certified supplier, dried, and powdered. The powdered fruits were subjected to ethanol extraction, and the resulting extract was concentrated under reduced pressure and lyophilized to obtain a dry powder.

Thirty male Wistar rats, aged 8 weeks, were used for the experiment. The rats were randomly divided into two groups: a control group (n=15) and a treatment group (n=15). The treatment group received a daily oral dose of Myrobalan Plum extract at 200 mg/kg body weight for 8 weeks, while the control group received an equivalent volume of saline.

Fecal samples were collected from all rats at the start and end of the study. DNA was extracted from the fecal samples using the QIAamp DNA Stool Mini Kit, following the manufacturer's protocol. The V3-V4 region of the 16S rRNA gene was amplified and sequenced using the Illumina

MiSeq platform. Sequencing data were analyzed using QIIME2 software to determine the relative abundance of bacterial taxa. Observed changes included a significant increase in the relative abundance of beneficial bacteria, such as Bifidobacterium and Lactobacillus, in the treatment group compared to the control group, along with a decrease in harmful bacteria like Clostridium.

Gastrointestinal transit time was assessed using carmine red dye. Each rat was administered the dye orally, and the time taken for the dye to appear in the feces was recorded. The treatment group exhibited a significantly reduced gastrointestinal transit time, indicating improved digestive motility.

Serum levels of digestive enzymes (amylase and lipase) and inflammatory markers (IL-6 and TNF-α) were measured using commercially available ELISA kits. The treatment group showed significantly higher levels of digestive enzymes and lower levels of inflammatory markers compared to the control group, suggesting enhanced digestive function and reduced inflammation.

Histopathological examination of the gastrointestinal tract was performed to assess tissue integrity and inflammation. Tissue samples from the stomach, small intestine, and colon were fixed in formalin, embedded in paraffin, sectioned, and stained with hematoxylin and eosin. Microscopic analysis revealed that the treatment group had better-preserved mucosal architecture and reduced inflammatory cell infiltration compared to the control group.

**Results**

**Table 1:** Relative Abundance of Gut Microbiota

Bacterial Taxa	Control Group (%)	Treatment Group (%)	p-value
Bifidobacterium	5.2±0.8	12.4±1.2	<0.001
Lactobacillus	8.7±1.0	15.6±1.4	<0.001
Clostridium	13.5±1.1	6.2±0.7	<0.001
Firmicutes/Bacteroidetes Ratio	2.3±0.2	1.5±0.1	<0.001

The treatment group showed a significant increase in the relative abundance of beneficial bacteria such as Bifidobacterium and Lactobacillus compared to the control group. This suggests that Myrobalan Plum extract promotes the growth of probiotic bacteria, which are known for their positive effects on gut health. Conversely, there was a significant reduction in Clostridium, a genus that includes pathogenic species, indicating a potential protective effect of the extract against harmful bacteria. The Firmicutes/Bacteroidetes ratio, often used as an indicator of gut health, was also more favorable in the treatment group, suggesting a healthier gut microbial balance.

**Table 2:** Gastrointestinal Transit Time

Group	Gastrointestinal Transit Time (minutes)
Control Group	160 ± 10
Treatment Group	120 ± 8
p-value	<0.01

The significantly reduced gastrointestinal transit time in the treatment group indicates improved digestive motility. Faster transit times are often associated with better digestive health and reduced risk of gastrointestinal disorders such as constipation. This improvement may be attributed to the

modulation of gut microbiota and the bioactive compounds present in Myrobalan Plum extract, which could enhance gut motility.

**Table 3:** Serum Levels of Digestive Enzymes and Inflammatory Markers

Parameter	Control Group	Treatment Group	p-value
Amylase (U/L)	75.3±5.2	98.7±6.1	<0.01
Lipase (U/L)	45.6±4.3	72.1±5.0	<0.01
IL-6 (pg/mL)	32.4±3.2	18.7±2.1	<0.001
TNF-α (pg/mL)	27.6±2.9	15.3±1.8	<0.001

The treatment group exhibited significantly higher levels of digestive enzymes (Amylase and lipase), indicating enhanced digestive function. This could be due to the positive modulation of gut microbiota and the presence of bioactive compounds in the Myrobalan Plum extract that stimulate enzyme secretion. Additionally, the significantly lower levels of inflammatory markers (IL-6 and TNF-α) in the treatment group suggest an anti-inflammatory effect of the extract, which could further contribute to improved gut health and reduced risk of inflammatory gastrointestinal disorders.

**Table 4:** Histopathological Analysis

Tissue Sample	Control Group (Score)	Treatment Group (Score)	p-value
Stomach	3.2±0.3	1.4±0.2	<0.001
Small Intestine	2.8±0.4	1.2±0.3	<0.001
Colon	3.0±0.4	1.6±0.3	<0.001

Histopathological analysis revealed that the treatment group had significantly better-preserved mucosal architecture and reduced inflammatory cell infiltration in the stomach, small intestine, and colon compared to the control group. These findings indicate that Myrobalan Plum extract not only supports gut microbiota but also protects the integrity of the gastrointestinal lining and reduces inflammation. This dual action of promoting beneficial bacteria and protecting gut tissue may underlie the overall improvement in digestive health observed in the treatment group.

### Discussion

The results of this study demonstrate a significant impact of Myrobalan Plum extract on gut microbiota composition and digestive health. The observed increase in beneficial bacteria, such as Bifidobacterium and Lactobacillus, in the treatment group suggests that Myrobalan Plum has a prebiotic-like effect, promoting the growth of these probiotic species. These bacteria are known for their positive effects on gut health, including enhancing nutrient absorption, modulating the immune system, and protecting against pathogenic microorganisms. The decrease in harmful bacteria, such as Clostridium, further supports the potential of Myrobalan Plum extract to maintain a healthy gut microbial balance. The reduction in gastrointestinal transit time in the treatment group indicates improved digestive motility. Faster transit times are beneficial as they reduce the risk of constipation and other digestive disorders. This improvement in motility could be attributed to the positive modulation of the gut microbiota and the bioactive compounds present in Myrobalan Plum extract, which may enhance gut muscle contractions and peristalsis. Serum levels of digestive enzymes, specifically amylase and lipase, were significantly higher in the treatment group, indicating enhanced digestive function. This suggests that Myrobalan Plum extract not only affects gut microbiota but also stimulates the secretion of digestive enzymes, facilitating better digestion and nutrient absorption. Additionally, the lower levels of inflammatory markers (IL-6 and TNF- $\alpha$ ) in the treatment group highlight the anti-inflammatory properties of Myrobalan Plum extract. Chronic inflammation in the gut can lead to various digestive disorders, and the reduction in these markers suggests a protective effect of the extract against gut inflammation. Histopathological analysis revealed that the treatment group had better-preserved mucosal architecture and reduced inflammatory cell infiltration in the stomach, small intestine, and colon. This indicates that Myrobalan Plum extract not only supports gut microbiota but also protects the integrity of the gastrointestinal lining. Maintaining the integrity of the gut lining is crucial for preventing conditions such as leaky gut syndrome, which can lead to systemic inflammation and other health issues. The combined effects observed in this study suggest that Myrobalan Plum extract could be a valuable natural therapeutic agent for improving gut health. The ability to enhance beneficial gut bacteria, improve digestive enzyme activity, reduce inflammation, and protect gut tissue integrity underscores its potential for managing

various gastrointestinal disorders. These findings align with traditional uses of Myrobalan Plum in herbal medicine for treating digestive issues and provide a scientific basis for its efficacy. However, it is important to note that this study was conducted on an animal model, and further research involving human subjects is necessary to confirm these effects. Additionally, the mechanisms underlying the observed benefits need to be elucidated through detailed biochemical and molecular studies. Future research should also explore the optimal dosage and long-term safety of Myrobalan Plum extract to ensure its efficacy and safety for human use. In conclusion, the study provides compelling evidence that Myrobalan Plum extract positively influences gut microbiota and digestive health. These findings support its potential use as a natural remedy for promoting gastrointestinal health and managing digestive disorders. Further research will be instrumental in translating these findings into practical applications for human health.

### Conclusion

This study provides strong evidence that Myrobalan Plum (*Terminalia chebula*) extract significantly benefits gut microbiota composition and digestive health. The extract increased the relative abundance of beneficial bacteria such as Bifidobacterium and Lactobacillus, while reducing harmful bacteria like Clostridium. These changes in gut microbiota were associated with improved digestive motility, as indicated by reduced gastrointestinal transit time, and enhanced digestive function, demonstrated by higher levels of digestive enzymes. Furthermore, the extract exhibited anti-inflammatory properties, as evidenced by lower levels of inflammatory markers and better-preserved mucosal architecture in the gastrointestinal tract. These findings highlight the potential of Myrobalan Plum extract as a natural therapeutic agent for promoting gut health and managing digestive disorders. However, further research involving human subjects is necessary to confirm these effects and explore the underlying mechanisms. The promising results of this study pave the way for future investigations into the clinical applications of Myrobalan Plum in enhancing gastrointestinal health.

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