



## Review Article

### PANCHAKOLA SIDDHA MUKKUDI - A TRADITIONAL AYURVEDIC FERMENTED FORMULATION WITH POTENTIAL IMPLICATIONS FOR GUT HEALTH AND MICROBIOME HOMEOSTASIS

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#### Article info

##### Article History:

Received: 17-06-2026

Accepted: 12-07-2026

Published: 10-09-2026

#### KEYWORDS:

Panchakola mukku, Takra, Gut health, Agni, Dipana, Pachana.

#### ABSTRACT

Gut health has emerged as a key determinant of overall health, with alterations in gut microbiome homeostasis being increasingly implicated in the pathogenesis of several lifestyle and metabolic disorders. In Ayurveda, maintenance of gastrointestinal health is primarily dependent on *Sama agni*, whereas *Mandagni* and *Ama* are considered the fundamental factors underlying disease initiation. *Panchakola Siddha Mukkudi*, a classical Kerala Ayurvedic fermented formulation prepared with *Panchakola* and *Takra*, embodies the principles of *Dipana*, *Pachana*, and *Vatanulomana* for restoring digestive and metabolic homeostasis. This narrative review critically examines the classical Ayurvedic concepts and current scientific evidence supporting its potential role in maintaining gut health and gut microbiome homeostasis. The bioactive phytoconstituents of *Panchakola*, together with the fermented matrix of *Takra*, may improve digestive function, preserve intestinal barrier integrity, reduce inflammation, and support a balanced gut microbial ecosystem. Further microbiome-based investigations and well-designed clinical studies are warranted to validate its therapeutic potential as an evidence-based Ayurvedic intervention for gut health.

#### INTRODUCTION

In Ayurveda, *Agni* is regarded as the cornerstone of health, as it governs the transformation, absorption, and utilization of nutrients. When *Agni* becomes impaired, digestion is compromised, leading to the formation of *Ama*, a pathological by-product that disrupts normal physiological processes and contributes to diseases of the gastrointestinal tract, including *Grahani*, *Ajirna*, *Atisara*, and *Anaha*. Consequently, therapies that rekindle *Agni* and facilitate the digestion of *Ama* are considered fundamental for restoring digestive balance and maintaining overall health.

*Panchakola Siddha Takra* is one such formulation mentioned in *Chikitsa manjari*, *Grahani chikitsa adhyaya* [1]. *Panchakola* is the group of 5 drugs, which includes *Pippali*, *Pippalimula*, *Chavya*, *Chitraka* and *Nagara*. [2] Owing to their predominantly *Katu Rasa*, *Ushna Virya*, and *Dipana-Pachana* attributes, these herbs are traditionally employed to stimulate digestion, eliminate *Ama*, relieve abdominal discomfort, and improve gastrointestinal function. Several constituents also possess *Grahi* or *Sangrahi* actions, supporting normal intestinal absorption and bowel regulation.

Among Ayurvedic dietary interventions, *Takra* (buttermilk) is highly valued for its beneficial effects on the gastrointestinal system. Classical texts recommend *Takra* in disorders characterized by impaired digestion and altered bowel habits, attributing to it properties such as *Dipana* (enhancing digestive capacity), *Grahi* (improving absorption and stool consistency), and *Laghu* (light and easy to digest) [3]. In the traditional practices of Kerala, *Mukkudi* refers to a medicated fermented buttermilk

#### Access this article online

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<https://doi.org/10.47070/ayushdhara.v13i4.2842>

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preparation in which selected herbs are incorporated into *Takra* to augment its therapeutic efficacy. *Chikitsamanjari* and *Arogya kalpa dhruma* are the traditional books in Kerala where diverse applications of drugs in form of *Mukkkudi* are explained<sup>[4]</sup>. *Mukkudi kalpana* in *Keraleeya chikitsa* is variant of *Pramathya kalpana* one of the *Upakalpanas* of *Kashaaya kalpana* explained in *Sharangdhara samhitha*.<sup>[5]</sup>

Recent pharmacological studies have shown that the bioactive compounds present in these herbs exhibit gastro protective, anti-inflammatory, antimicrobial, antioxidant, and prokinetic effects, providing a scientific basis for many of their traditional applications. The combination of these medicinal plants with fermented *Takra* may therefore offer complementary benefits for digestive physiology and intestinal homeostasis. In this context, *Panchakola Siddha Mukkudi* represents a promising traditional formulation whose potential relevance to gut health and microbiome balance merits critical evaluation.

This narrative review aims to integrate classical Ayurvedic concepts with current scientific evidence to explore the possible role of *Panchakola Siddha Mukkudi* in supporting digestive function and maintaining gastrointestinal health.

## MATERIALS AND METHOD

This narrative review was conducted by systematically collecting information from classical

Ayurvedic texts, including the *Charaka Samhita*, *Bhavaprakasha Nighantu*, *Dhanvantari Nighantu*, *Raja Nighantu*, and the Ayurvedic Pharmacopoeia of India. Relevant scientific literature on *Panchakola*, *Mukkudi*, *Takra*, gut health, and the gut microbiome was retrieved from electronic databases such as PubMed, Scopus, Google Scholar, and ScienceDirect. Data on traditional indications, *Rasapanchaka*, phytochemistry, pharmacological activities, and gut health-related mechanisms were critically reviewed and synthesized to correlate Ayurvedic concepts with contemporary scientific evidence.

## Panchakola

The earliest documented reference to *Panchakola* occurs in the *Charaka Samhita*, *Sutrasthana (Apamarga Tanḍuliya Adhyaya)*, where it is described as a combination of five pungent herbs used in preparations such as *Panchakola Siddha Yavagu* to enhance digestive function, improve metabolism, and facilitate the digestion of *Ama*<sup>[6]</sup>. In *Chikitsa manjari*, *Grahani roga chikitsa panchakola* is advised to process along with *Takra* and administered internally.<sup>[7]</sup> In Ayurveda *Rasayana* commentary of *Ashtanga Hridaya*, the commentator Hemadri explains the action of *Panchakola* as '*Gulmaadighnam cha athyantham agner Dipanam cha*'.<sup>[8]</sup> Ayurvedic literary analysis of each drug in *Panchakola* is as follows.

**Table 1: Drugs in Panchakola**

| S.No | Drug                                | Botanical name                    | Family                | Officinal part |
|------|-------------------------------------|-----------------------------------|-----------------------|----------------|
| 1    | <i>Pippali</i> <sup>[9]</sup>       | <i>Piper longum</i> Linn          | <i>Piperaceae</i>     | Fruit          |
| 2    | <i>Pippali mula</i> <sup>[10]</sup> | <i>Piper longum</i> Linn          | <i>Piperaceae</i>     | Root           |
| 3    | <i>Chavya</i> <sup>[11]</sup>       | <i>Piper retrofractum</i> vahl    | <i>Piperaceae</i>     | Root           |
| 4    | <i>Chithraka</i> <sup>[12]</sup>    | <i>Plumbago zeylanica</i> Linn    | <i>Plumbaginaceae</i> | Root           |
| 5    | <i>Nagara</i> <sup>[13]</sup>       | <i>Zingiber officinale</i> Roscoe | <i>Zingiberaceae</i>  | Rhizome        |

**Table 2: Rasapanchaka of Panchakola**

| S.No | Drug                                | Rasa                                     | Guna                          | Virya          | Vipaka         |
|------|-------------------------------------|------------------------------------------|-------------------------------|----------------|----------------|
| 1    | <i>Pippali</i> <sup>[14]</sup>      | <i>Madhura Katu Thiktha (Katu in BP)</i> | <i>Laghu, Snigdha</i>         | <i>Anushna</i> | <i>Madhura</i> |
| 2    | <i>Pippali mula</i> <sup>[15]</sup> | <i>Katu</i>                              | <i>Laghu, Tikshna</i>         | <i>Ushna</i>   | <i>Madhura</i> |
| 3    | <i>Chavya</i> <sup>[16]</sup>       | <i>Katu</i>                              | <i>Laghu, Ruksha, Tikshna</i> | <i>Ushna</i>   | <i>Katu</i>    |
| 4    | <i>Chithraka</i> <sup>[17]</sup>    | <i>Katu</i>                              | <i>Laghu, Ruksha, Tikshna</i> | <i>Ushna</i>   | <i>Katu</i>    |
| 5    | <i>Nagara</i> <sup>[18]</sup>       | <i>Katu</i>                              | <i>Laghu, Snigdha</i>         | <i>Ushna</i>   | <i>Madhura</i> |

**Table 3: Action of Panchakola in Koshta and Agni**

| S.No | Drug                         | Action on Dosha                                      | Action on Agni | Action on Ama | Action on Koshta / mala |
|------|------------------------------|------------------------------------------------------|----------------|---------------|-------------------------|
| 1    | Pippali <sup>[14]</sup>      | Vata-Kaphahara<br>Tridosahara - DN                   | Dipana         | Pachana       |                         |
| 2    | Pippali mula <sup>[15]</sup> | Vata-Kaphahara Pithakaram – (B.P)                    | Dipana         | Pachana       | Anaha nasanam (Charaka) |
| 3    | Chavya <sup>[16]</sup>       | Kapha Vataharam (API) Kapha pithaharam Pithalam (KN) | Dipana         | Pachana       |                         |
| 4    | Chithraka <sup>[17]</sup>    | Kapha-Vatahara                                       | Dipana         | Pachana       | Grahi                   |
| 5    | Nagara <sup>[18]</sup>       | Kapha-Vatahara                                       | Dipana         | Pachana       | Sangrahi                |

**Table 4: Major chemical constituents and Proven pharmacological activities of drugs in Panchakola**

| S.No | Drug         | Chemical constituents                                                                                                                                                              | Proven pharmacological activity related to Gut                                                                                                                                                               |
|------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Pippali      | Piperine, piperlongumine (piplartine), piperlonguminine, pellitorine, piperettine, methyl piperine, sesamin, essential oils ( $\beta$ -caryophyllene, zingiberene) <sup>[19]</sup> | Digestive stimulant, carminative, anti-ulcer, gastroprotective, antimicrobial against enteric pathogens, anti-inflammatory, enhances nutrient/drug bioavailability, modulates gut microbiota <sup>[19]</sup> |
| 2    | Pippali mula | Piperine, piperlongumine, tetrahydropiperlongumine, piperlonguminine, piperic acid derivatives, lignans <sup>[19]</sup>                                                            | Gastroprotective, anti-inflammatory, digestive stimulant, antioxidant <sup>[19]</sup>                                                                                                                        |
| 3    | Chavya       | Piperine, guineensine, piperlonguminine, pellitorine, retrofractamides, amide alkaloids, lignans, phenylpropanoids <sup>[20]</sup>                                                 | Carminative, antimicrobial, anti-inflammatory, digestive stimulant, antioxidant <sup>[20]</sup>                                                                                                              |
| 4    | Chithraka    | Plumbagin (major marker compound), chitranone, zeylanone, plumbagic acid, sitosterol, campesterol, stigmasterol <sup>[21]</sup>                                                    | Digestive stimulant, anti-ulcer, antimicrobial, antioxidant activity, Wound healing and tissue repair anti-inflammatory, promotes digestive secretions <sup>[22]</sup>                                       |
| 5    | Nagara       | 6-Gingerol, 8-gingerol, 10-gingerol, 6-shogaol, zingerone, paradols, zingiberene, $\beta$ -sesquiphellandrene <sup>[23]</sup>                                                      | Improves gastric emptying, antiemetic, gastroprotective, anti-inflammatory, modulates gut microbiota, relieves dyspepsia <sup>[24]</sup>                                                                     |

### Takra

*Takra* is a fermented dairy preparation extensively utilised for promoting *Agni*, and maintaining the gut health. While analysing the Ayurvedic literature, there is an extensive explanation related to *Takra* is given in both *Brihatthrayee* as well as *Laghuthrayee*. The literature review of *Takra* is as follows.

#### Method of Preparation of Takra

Curd is taken in a mud vessel and subjected to churning using a stirrer after adding water. Churning is to be continued for 1 *Prahara kaala* to get *Takra*. Depending upon the quantity of water added 10 types of *Takra* are mentioned which include *Mathitha*, *Udasvita*, *Takra*, *Dandahata*, *Kalseya*, *Karamathita*, *Ghola*, *Galita*, *Swetamatha* and *Sadava*. <sup>[25]</sup>

#### Types of Takra as in Different Literature

As per *Acharya Charaka*, 3 types of *Takras* are there; *Ruksha*, *Ardha udrutha* and *Anudrutha*. *Ruksha* is

the *Takra* with all the butter removed. *Ardha udrutha* and *Anudrutha* are the *Takra* were half the butter and full butter are respectively left behind. <sup>[26]</sup> *Bhavamisra* explains 5 types of *Takra* depending upon the amount of *Snehaamsha* present and ratio of water added. <sup>[27]</sup>

- *Ghola*- Curd is churned well without adding water and butter is not removed.
- *Mathitha*- Curd is churned well without adding water and butter is separated.
- *Takra*- Curd is churned with quarter part water and butter is removed.
- *Udasvita*- Curd is churned with half part water and butter not removed.
- *Chacchika*- Curd is churned well, butter removed and churned again after adding sufficient quantity of water.

**Table 5: Properties of *Takra*** <sup>[27]</sup>

|               |                                                                          |
|---------------|--------------------------------------------------------------------------|
| <i>Rasa</i>   | <i>Amla, Madhura</i>                                                     |
| <i>Virya</i>  | <i>Ushna</i>                                                             |
| <i>Vipaka</i> | <i>Madhura</i>                                                           |
| <i>Guna</i>   | <i>Grahi, Laghu, Ruksha, Agni deepaka, Vrishyam, Preenam, Vatanasaka</i> |

**Table 6: Change in pharmacological properties of *Takra* based on its preparation** <sup>[28]</sup>

| Method of preparation        | Properties and actions                  |
|------------------------------|-----------------------------------------|
| <i>Samudrutha ghrita</i>     | <i>Laghu, Pathya and Ruksha</i>         |
| <i>Sthoka udrutha ghrita</i> | <i>Guru, Vrishya, Kapha vriddhikara</i> |
| <i>Anudrutha ghrita</i>      | <i>Sandra, Guru, Pushti, Kaphaprada</i> |

**Table 7: Change in pharmacological properties of *Takra* based on cooking** <sup>[28]</sup>

| Cooked / Uncooked                         | Properties and actions                            |
|-------------------------------------------|---------------------------------------------------|
| <i>Ama takra</i> (uncooked <i>Takra</i> ) | <i>Koshta kapha samana, Kantha kapha vardhana</i> |
| <i>Pakwa takra</i> (cooked <i>Takra</i> ) | <i>Peenasa swaasa kaasaadi roga samana</i>        |

**Table 8: Indications and contra indications of *Takra*** <sup>[29]</sup>

| Indications             | Contra indications              |
|-------------------------|---------------------------------|
| <i>Seeta kaala</i>      | <i>Greeshma and Sarat kaala</i> |
| <i>Agni maandhya</i>    | <i>Kshata</i>                   |
| <i>Vishamaagni</i>      | <i>Vrana</i>                    |
| <i>Kapha rogas</i>      | <i>Kaarshyam</i>                |
| <i>Sroto rodha</i>      | <i>Daaha</i>                    |
| <i>Kostha gata Vata</i> | <i>Bhrama, Sosha, Moorcha</i>   |
| <i>Gara visha</i>       | <i>Rakta pitha</i>              |

### **Mukkudi and *Khala kalpana***

*Takra* occupies a significant place in Ayurvedic dietetics and therapeutics due to its *Agni Dipana* action. Ayurveda describes several butter milk formulations including *Khala kalpana*, *Arishta kalpanas* like *Takrarishta* etc. In Kerala lots of indigenous preparations of butter milk like *Mukkudi* is available.

*Mukkudi* is a special preparation of drug combinations used in postnatal care and *Karkidaka chikitsa* especially in Kerala. These preparations contain different choice of drugs with *Dipana pachana* action. Pounded drugs cooked in buttermilk and made into a liquid form is called *Mukkudi*. *Mukkudi seva* or consuming the preparation as a temple offering is a famous ritual in many temples across Kerala. *Chikitsamanjari* and *Arogya kalpa dhruma* are the traditional books in Kerala where diverse applications of drugs in form of *Mukkudi* are explained. <sup>[30]</sup>

*Mukkudi kalpana* in *Keraleeya chikitsa* is variant of *Pramathya kalpana* one of the *Upakalpanas* of *Kashaaya kalpana* explained in *Sharangdhara samhitha*. In *Pramathya kalpana* drugs are made into *Kalka*, boiled in 8 times of water and reduced into 1/4<sup>th</sup>. Since the drugs are added in the form of *Kalka*

maximum *Veerya* will be extracted to water. Only difference noted between *Mukkudi* and *Pramathya* is in the use of butter milk. <sup>[31]</sup>

*Khala kalpana* is included under *Pathyakalpana* in which drugs are pounded and cooked in buttermilk. The *Khala* preparation is a good choice for digestive disorders of all kinds and is a cross between food and medicine. <sup>[32]</sup> *Khala* is of two types. *Satakra samidhanya Khala* and *Satakra saka Khala* (*Khala* prepared with buttermilk and vegetables). *Satakra samidhanya Khala* is the type of *Khala* in which the *Takra* is added with *Sami dhanyas* (pulses and legumes) and cooked over fire. Then it is reduced to 1/2 or 1/4. Required quantity of fried *Jiraka*, *Marica churna*, *Lavana* may also be added. In the other type of *Khala*, *Satakra saka Khala takra* is added with *Saaka* (vegetable) like *Kapittha*, *Charngeri*, *Maricha*, *Ajaji* and *Chitraka* cooked in an earthen vessel and reduced to 1/4<sup>th</sup> or 1/2<sup>th</sup>. To this *Lavana*, fried *Jiraka* and other spices may be added. <sup>[33]</sup>

*Khala* preparations are mostly used in *Atisara*, *Grahani*, *Arsas*, *Udara* and *Arochaka*. Also, it is used in conditions like *Jwara*, *Kasa Ajeerna*, *Mootrakruhra*, *Panduroga*, *Kamala*, *Mandanidra*, *Pravahika*, *Visarpa*,

*Jadaravrana, Agnimandya, Rajayakshma, Udavartha, Vidradi, Vruddhi, Gulma, Asthisrava, RaktaPitha, Svarasada, Prameha, Anthravriddhi, Sopha, Krumi, Vatavikara, Garbhatisara, Visha, and Vruna.*<sup>[32]</sup>

## Gut Microbiome and Digestive Health

### Gut Microbiome Homeostasis

Gut microbiome homeostasis refers to a healthy and balanced relationship between the intestinal microorganisms and the host, which is essential for normal digestive function and overall well-being. This balance is continuously influenced by factors such as diet, age, genetics, medications, and lifestyle, making the gut microbiome a highly dynamic ecosystem that adapts to both internal and external changes.<sup>[34,35]</sup>

A healthy gut microbiome is characterized by a rich and diverse microbial community capable of carrying out essential metabolic functions. These microorganisms ferment indigestible dietary components to produce short-chain fatty acids (SCFAs), including acetate, propionate, and butyrate. SCFAs provide energy to intestinal epithelial cells, strengthen the gut barrier, regulate host metabolism, and help maintain an anti-inflammatory environment within the intestine.<sup>[36,37]</sup>

Beyond digestion, the gut microbiota plays a vital role in regulating immune function. Constant communication between intestinal microbes and the gut-associated lymphoid tissue promotes the maturation of regulatory T cells, enhances mucosal IgA secretion, and maintains immune tolerance toward commensal microorganisms and dietary antigens. At the same time, beneficial microbes limit the growth of pathogens by competing for nutrients and attachment sites and by producing antimicrobial substances, thereby preserving intestinal microbial balance.<sup>[34,35]</sup>

Among the various factors influencing the gut microbiome, diet is the most important modifiable determinant. Diets rich in dietary fibre, polyphenols, and fermented foods encourage microbial diversity and increase SCFA production, whereas frequent consumption of ultra-processed foods, saturated fats, and refined sugars is associated with reduced microbial diversity and impaired microbial function.<sup>[37,38]</sup>

Loss of microbial balance, referred to as dysbiosis, is characterized by reduced microbial diversity, altered metabolic activity, disruption of the intestinal barrier, and dysregulated immune responses. Persistent dysbiosis has been associated with several gastrointestinal and systemic disorders, including inflammatory bowel disease, obesity, type 2 diabetes mellitus, colorectal cancer, cardiovascular diseases, and neuroinflammatory disorders.

Consequently, dietary modification and microbiota-directed interventions, such as fermented foods, prebiotics, and probiotics, are increasingly recognized as effective strategies for restoring gut microbial balance and promoting long-term health.<sup>[36,38]</sup>

## DISCUSSION

In Ayurveda, healthy digestion begins with the proper functioning of *Samagni*, the balanced state of *Jatharagni*, which governs the digestion of food (*Ahara Paka*), the formation of *Rasa*, and the nourishment of the *Dhatus*. When the digestive fire becomes weak (*Mandagni*), food is not completely processed, leading to the formation of *Ama*. The accumulation of *Ama* blocks the *Srotas*, disturbs the *Doshas*, and hampers the proper absorption and utilization of nutrients. Therefore, restoring *Agni* and removing *Ama* remain the primary objectives in maintaining gastrointestinal health from an Ayurvedic perspective.

*Panchakola*, comprising *Pippali*, *Pippalimula*, *Chavya*, *Chitraka*, and *Nagara*, is a well-known *Dipaniya–Pacaniya* formulation traditionally used to improve digestive function. The dominance of *Katu Rasa*, *Laghu-Tikshna Guna*, and *Ushna Virya* enables the formulation to kindle *Jatharagni*, promote *Amapachana*, and support the proper digestion and metabolism of food. By reducing *Kapha* and *Kleda* while clearing *Ama* from the channels, it helps restore the normal functioning of the *Annavaaha Srotas*. Once *Ama* is digested, the *Grahi* and *Sangrahi* properties of the formulation may improve intestinal absorption and help regulate bowel function, thereby interrupting the progression of *Atisara* and *Grahani Samprapti*. In addition, its *Ushna* and *Tikshna* qualities facilitate *Vatanulomana*, normalize the movement of *Apana Vata*, and relieve symptoms such as *Anaha* and *Adhmana*, resulting in better coordination of gastrointestinal functions.

The pharmacological activities reported for the constituent herbs provide a scientific basis for these classical Ayurvedic actions. Piperine, the major alkaloid present in *Pippali* and *Pippalimula*, stimulates digestive enzyme secretion, enhances intestinal absorption, and improves the bioavailability of other phytoconstituents. Piperlongumine exhibits antioxidant and anti-inflammatory properties that may protect intestinal tissues from oxidative damage. Plumbagin, the principal constituent of *Chitraka*, possesses antimicrobial, antioxidant, and anti-inflammatory activities that may help preserve mucosal integrity and reduce intestinal inflammation. Likewise, gingerols and shogaols from *Nagara* improve gastric emptying, enhance gastrointestinal motility, and reduce oxidative stress, while piperamide derivatives from *Chavya* contribute digestive

stimulant, carminative, and antimicrobial effects. Collectively, these phytochemicals may improve digestive efficiency, support intestinal barrier function, reduce inflammatory responses, and help maintain a favourable intestinal microbial environment.

*Takra*, the fermented buttermilk used as the vehicle in *Mukkudi*, complements the actions of *Panchakola* through its unique Ayurvedic properties. Classical texts describe *Takra* as *Laghu*, *Dipana*, and *Sangrahi*, making it particularly suitable for correcting *Mandagni* while supporting normal bowel function. Its *Kashaya* attribute, together with *Ushna*, *Ruksha*, and *Vikasi Gunas*, helps alleviate *Kapha*, whereas *Madhura Vipaka* contributes to *Pitta Shamana*. The *Amla* component supports the normal movement of *Vata*, thereby helping maintain *Dosa Samya*. Besides its Ayurvedic attributes, *Takra* also provides nutritional components that may contribute to immune regulation and general health.

From a modern perspective, fermented *Takra* contains lactic acid bacteria, organic acids, bioactive peptides, and fermentation-derived metabolites that positively influence the intestinal ecosystem. These components may strengthen the intestinal epithelial barrier, suppress the growth of pathogenic microorganisms, and support microbial diversity and metabolic activity within the gut. Processing *Panchakola* in *Takra* is therefore likely to enhance the therapeutic potential of both the herbal ingredients and the fermented vehicle, resulting in a formulation with complementary actions on digestive physiology.

Overall, *Panchakola Siddha Mukkudi* can be understood as a synergistic Ayurvedic formulation that restores *Samagni*, promotes *Amapachana*, facilitates *Srotovisodhana* and *Vatanulomana*, and helps maintain *Dosa Samya*, particularly of *Vata* and *Kapha*. When viewed alongside current scientific evidence, these classical actions may correspond to improved digestive function, better intestinal metabolism, preservation of mucosal integrity, regulation of gut motility, and maintenance of gut microbiome homeostasis, thereby supporting overall gastrointestinal health.

## CONCLUSION

*Panchakola Siddha Mukkudi* represents a unique Keralaleeya Ayurvedic fermented formulation in which the *Dipaniya-Pacaniya* properties of *Panchakola* are complemented by the therapeutic attributes of *Takra*. From an Ayurvedic perspective, the formulation is designed to restore *Samagni*, facilitate *Amapachana*, promote *Vatanulomana*, and maintain *Dosa Samya*, thereby supporting the normal physiological functions of the *Annavaha Srotas*. These classical actions provide a rational basis for preserving digestive health and

preventing the initiation of disease associated with impaired digestion.

Emerging scientific evidence further supports the traditional rationale of this formulation. The phytoconstituents of *Panchakola* possess digestive stimulant, antioxidant, anti-inflammatory, antimicrobial, and gastroprotective activities, while the fermented *Takra* matrix provides beneficial microorganisms and bioactive metabolites that may help preserve intestinal barrier integrity and support a balanced gut microbial ecosystem. Together, these complementary actions suggest that *Panchakola Siddha Mukkudi* may contribute to gut microbiome homeostasis by improving the intestinal environment rather than acting solely on the microbial population.

Although the available evidence is encouraging, direct scientific validation of this classical formulation remains limited. Future research integrating Ayurvedic principles with modern approaches such as phytochemical standardization, microbiome profiling, metabolomics, and well-designed clinical studies will be essential to elucidate its mechanisms of action and establish its role as an evidence-based dietary and therapeutic intervention for maintaining gut health and microbiome homeostasis.

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**Cite this article as:**

Krishna Priya A, Manju Raj K, Sethu R. Panchakola Siddha Mukkudi - A Traditional Ayurvedic Fermented Formulation with Potential Implications for Gut Health and Microbiome Homeostasis. AYUSHDHARA, 2026;13(4):377-384. <https://doi.org/10.47070/ayushdhara.v13i4.2842>

**Source of support: Nil, Conflict of interest: None Declared**

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