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# Ehela Kola Kayama (Traditional Polyherbal Preparation) Mentioned in Deshiya Chikitsa Samgrahaya Introduced as a Functional Food for Malnutrition

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## *Abstract*

*Ehela Kola Kayama* (EKK) in *Deshiya Chikitsa Samgrahaya* is a distinctive Sri Lankan traditional preparation for malnutrition. WHO defines malnutrition as deficiencies, excesses, imbalances, and impaired utilization; Sri Lanka's underweight children rise to 15.3% in 2022. The study aimed to review the ingredients of EKK with pharmacodynamic properties and introduce it as a functional food for malnutrition. The study follows PRISMA guidelines and searches 64 journal articles in PubMed, Scopus, Web of Science databases, and Google Scholar search engine from 2021 to 2023. The ingredients of *EKK* are *Ehela Kola* (*Cassia fistula*), *Parana Siyambala* (*Tamarindus indica* L.), *Suduru* (*Cuminum cyminum*), *Mahaduru* (*Foeniculum vulgare*), *Asamodagam* (*Trachyspermum ammi*), *Sudu Lunu* (*Allium arenarium*), *Sungu* (*Pistacia integerrima*), *Aralu* (*Terminalia Chebula*), *Viyali Iguru* (*Zingiber officinale*), *Gammiris* (*Piper nigrum),* and *Thippili* (*Piper longum*). Upon analyzing *Katu* (pungent) and *Kashaya* (astringent) tastes, *Laghu* (lightness) and *Ruksha* (roughness) properties were prominent. *Ushna Veerya* (hot potency) and *Katu Vipaka* (post-digestive effect) are found in most ingredients. *Deepana* (appetizer) and *Pachana* (digestive)*, Ushna Veerya*, *Katu* and *Tikta Rasa*, *Laghu*, *Ruksha,* and *Thikshna Guna* promote *Agni* (digestive fire) and relieve *Srotorodha* (channel obstruction), which corrects *Dhatu Poshana Krama* (nourishes the tissues). Ayurveda emphasizes the correction of *Agni*, a vital factor for health, and treating ailments including malnutrition. It improves *Ojas* (immunity) and provides V*yadhikshamathva* (resistance to diseases). Most components contain active chemicals, such as Glycosides, Fatty Acids, Flavonoids, vitamin B complexes, and Iron, which are nutritional and digestive stimulators with anti-inflammatory, antioxidant, and immunomodulatory properties. As per the reviewed data, it can be concluded that EKK is a potent digestion promoter in individuals, enhances metabolism, and empowers the process of *Saptha Dhatu* (essential body tissues) formation and *Ojas,* thereby having potential qualities as a functional food. Further clinical and chemical studies must be conducted to introduce it as a functional food for malnutrition.

***Key Words:*** *Deshiya Chikitsa Samgrahaya, Ehela Kola Kayama, Functional food, Malnutrition, Traditional Medicine*

## 1. Introduction

Ayurveda is a system of natural medicine, that originated in India more than 3,000 years ago. The term Ayurveda is derived from the Sanskrit words *Ayur* (life) and *Veda* (Science or knowledge). Hence this system of medicine gives the meaning as knowledge of life (Buddhadasa, 1960). Ayurveda encourages certain lifestyle interventions and natural therapies to regain a balance between the body, mind, spirit, and the environment (Buddhadasa, 1960).

According to statistical data, about 70–80% of the world's population rely on nonconventional medicines mainly herbal sources in their healthcare (World Health Organization, 2023). Public interest in the treatment with complementary and alternative medicine is mainly due to increased side effects in synthetic drugs, lack of curative treatment for several chronic diseases, high cost of new drugs, microbial resistance, and emerging diseases. In this regard, most people are keen on practising a system of medicine with herbals as well as with natural ingredients.(Wachtel-Galor & Benzie, 2011).

Worldwide traditional medical practices may have developed along with human evolution as they have to search for remedies to overcome daily accidents and diseases. As a result of this, traditional treatment methods, though often differing from each other to suit the locality, have been developed and established everywhere in the world. Many countries in the world have several traditional medical practices that have developed with the evolution of human societies. Indigenous Medicine of Sri Lanka (IMSL) "*Helawedakama*" is a unique heritage of Sri Lanka coming over centuries based on a series of ancient indigenous medical literature handed down from one generation to another. During the past 2500 years of the history of Sri Lanka, there is evidence to prove the existence of developed traditional medicine and skillful doctors involved in more advanced treatments (Senevirathna, 1984).

*Ajeerna* (indigestion), *Jwara* (fever), *Suthika Roga* (illnesses of women after childbirth), *Agnimandya* (digestive insufficiency), and other conditions have all been effectively treated with *Ehela Kola Kayama* (EKK), a polyherbal preparation that has drawn significant interest from the traditional Sri Lankan society. By consuming this traditional functional meal, one can obtain several phytochemicals and micronutrients that may have antioxidant properties. Because EKK is high in vital nutrients, it may be regarded as both a good promoter of digestion and beneficial in cases of *Mandam* (malnutrition). *Aralu* (fruit of *Terminalia chebula*), *Sungu* (*Pistacia integerrima*), *Gammiris* (seeds of *Piper nigrum*), *Thippili* (fruit of *Piper longum), Ehela Kola* (leaves of *Cassia fistula*), *Parana Siyambala* (ancient *Tamarindus indica* L.), *Suduru* (seeds of *Cuminum cyminum*), *Mahaduru* (seeds of *Foeniculum vulgare*), *Asamodagam* (seeds of *Trachyspermum ammi*), *Sudu Lunu* (*Allium sativum b*ulb), *Viyali Iguru* (rhizome of *Zingiber officinale*), and *Suduru* (seeds of *Cuminum cyminum*). Senevirathna, 1984). EKK is one of the distinctive indigenous medicines used in Sri Lankan traditional medicine to treat malnutrition, as mentioned in Deshiya Chikitsa Samgrahaya.(Senevirathna, 1984). Deshiya Chikitsa Samgrahaya is one of the most important texts on Sri Lankan traditional medicine. This book includes traditional herbal preparations and their constituents, production techniques, and a list of conditions for which they can be used. These preparations

include *vati* (tablets),*Churna* (powders), *Kashaya* (decoctions), and *Paththu* (pastes.) (Senevirathna, 1984a)

Foods that have been given an extra purpose, such as promoting health or preventing illness, by the addition of new or more components to their present composition are sometimes referred to as functional foods. Food's functional components are essential for delivering positive physiological effects that promote health. Given their high concentrations of antioxidants, dietary fiber, probiotics, prebiotics, vitamins, and minerals, traditional Sri Lankan food preparations can be regarded as "functional." Numerous health benefits associated with the consumption of functional foods have been shown by epidemiological randomized clinical trials conducted in various countries. These benefits include a lower risk of cancer, benefit to the cardiovascular system, immune system stimulation, reduction of menopausal symptoms, improvement to gastrointestinal health, maintenance of urinary tract health, reduction of blood pressure, improvement to vision, antibacterial and antiviral effects, reduction of osteoporosis, and anti-obesity effects.

Inadequate or excessive food intake, an unbalanced supply of vital nutrients, or poor nutrient use are all considered forms of malnutrition. The combined effects of undernutrition, overweight, obesity, and noncommunicable illnesses linked to food constitute the double burden of malnutrition. There are four main ways that undernutrition presents itself: underweight, stunting, wasting, and micronutrient deficiencies. Being low weight relative to height is called wasting. It might also last for a very long period. Usually, it signifies recent and significant weight reduction. It generally happens when a person hasn't eaten enough food in sufficient quantities or of sufficient quality, or if they've been sick frequently or for a long time. If left untreated, child wasting is linked to an increased risk of mortality. The definition of stunting is low height for age. It is the outcome of persistent or repeated undernutrition, which is typically linked to poverty, inadequate nutrition and health of mothers, a high rate of sickness, and/or improper early life feeding and care. Children who are stunted are unable to develop to their full physical and mental potential. Low weight for age is referred to as underweight. Underweight children might be wasted, stunted, or both.

Food security and nutrition concerns have become more pressing in Sri Lanka throughout the epidemic and the ensuing economic downturn. The energy crisis has caused supply chain disruptions, higher food costs, and shortages of basic items, among other factors, which have all added to the already severe problems the populace faces. Sri Lanka has South Asia's second-highest rate of child malnutrition and the sixth most malnourished country in the world. Among youngsters, wasting affects 17% of them. According to the 2018 Global Hunger Index (GHI) report by the National Food Policy Research Institute (IFRI), India ranks 84th out of 119 nations. Around the world, one-fifth of children under five are underweight, according to the WHO. Malnutrition is causing an upsurge in child mortality (UNICEF). Every newborn has a low birth weight of one in five. Underweight children represent 29% of children under the age of five. Anemia affects 38% of children between the ages of 12 and 23 months and 58% of newborns between the ages of 6 and 11 months. These priceless traditional Sri Lankan preparations will be crucial in addressing these challenges. (World Health Organization, 2023)

Growing childhood malnutrition has emerged as a major policy concern in Sri Lanka due to increased family food insecurity brought on by a variety of social and economic problems that got worse during the financial crisis of the country in 2022. According to Sri Lanka's Child Multidimensional Poverty Indicator (CMPI), which is based on the Household Income and Expenditure Survey 2019, one-third of children between the ages of 0 and 4 are multidimensionally poor and either stunted or underweight. The Sustainable Development Report 2022 (Sachs et al., 2022) indicates that moderate improvements in hunger indicators, which remained insufficient to achieve the Sustainable Development Goals targets as intended, show that Sri Lanka is falling behind in moving towards the zero hunger target by 2030. Therefore, a long-term, practical solution must be found for this grave issue. Because Sri Lankan traditional medicine possesses a vast array of highly potent polyherbal formulations that may be used to both prevent and cure malnutrition, understanding this field is crucial. Malnutrition is referred to as Mandam yoga in traditional Sri Lankan medicine. The traditional books of Sri Lanka provide a wealth of traditional recipes.

Objectives

- To analyze ingredients and their effects on *Ehela Kola Kayama*.
- To potentially reposition them as a scientifically supported functional food for malnutrition in Sri Lanka.

## 2. Materials and Methods

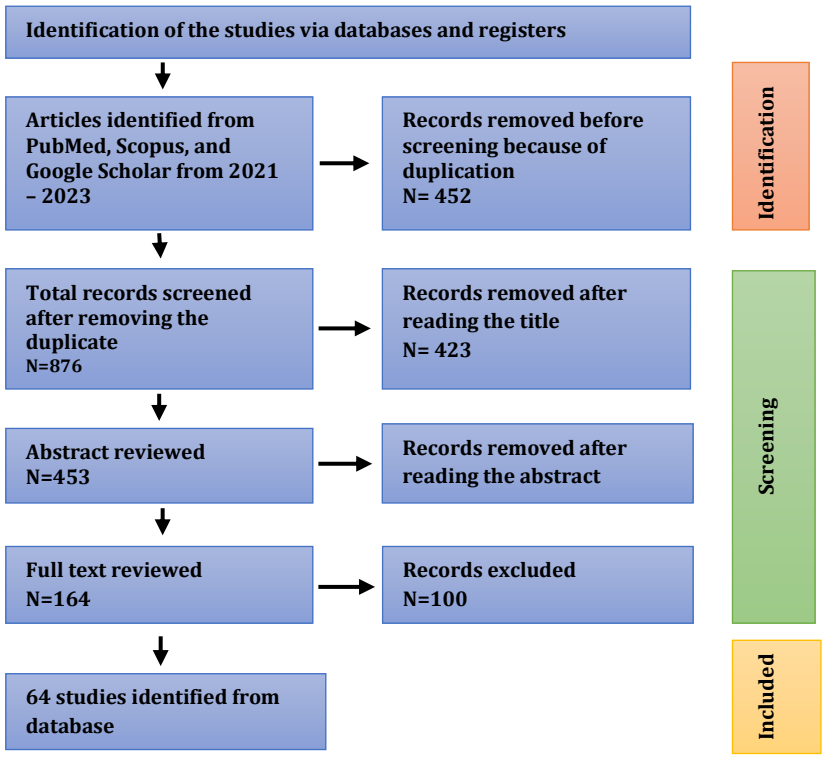


Figure 2. Methodology of the study

The review examines *Ehela Kola Kayama*, a traditional polyherbal formulation documented in *Deshiya Chikitsa Samgrahaya* and acknowledged as a functional food for addressing malnutrition. The literature review is structured into two distinct sections. The first section delves into traditional authentic texts, providing insights into the principles and applications of Traditional Medicine. The second section focuses on contemporary research, evaluating the individual components of the formulation and their roles as functional foods. This part of the study was conducted following Figure 1, adhering to PRISMA guidelines. A comprehensive search of 64 journal articles published between 2013 and 2023 was performed using databases such as PubMed, Scopus, and Google Scholar.

The review included studies from PubMed, Scopus databases, and Google Scholar search engine spanning from 2021 to 2023. The used key words were "Functional food", "Malnutrition", "*Terminalia chebula", "Pistacia integerrima", "Piper nigrum", "Piper longum", "Cassia fistula", "Tamarindus indica", "Cuminum cyminum, Foeniculum vulgare, Trachyspermum ammi, Allium sativum, and Zingiber officinale.* Initially, 1,328 articles were identified, and after removing 452 duplicates, 876 records were screened. Of these, 423 records were excluded based on their titles, leaving 453 abstracts for further review. After the abstract screening, 289 records were removed, resulting in 164 full-text articles being reviewed. Finally, 100 records were excluded, leading to the identification of 64 relevant studies for inclusion in the review.

## 3. Results

### Morphological features of Ingredients in EKK

*Ehela Kola Kayama*, as documented in the *Deshiya Chikitsa Sangrahaya*, is a traditional Sri Lankan polyherbal formulation specifically designed to address malnutrition (Senevirathna, 1984b). This preparation consists of 11 primary ingredients, as outlined in Table 1. The table provides a detailed description of the used parts of herbs and the precise quantities of each ingredient included in the formulation.

**Table 1.** Ingredients of *Ehela Kola Kayama*

| Name of Ingredients (Name in Sinhala) | Scientific Name | Used Part | Amount |
|---|---|---|---|
| 1. *Aralu* | *Terminalia chebula* | Fruits | Equal quantity |
| 2. *Sungu* | *Pistacia integerrima* | Resin | |
| 3. *Gammiris* | *Piper nigrum Linn* | Seeds | |
| 4. *Thippili* | *Piper longum* | Dry Fruit | |
| 5. *Ehela kola* | *Cassia fistula* | Leaves | |
| 6.*Parana Siyambala* | *Tamarindus indica* L. | Fruit | |
| 7. *Suduru* | *Cuminum cyminum* | Seeds | |
| 8. *Maduru* | *Foeniculum vulgare* | Seeds | |
| 9. *Asamodagam* | *Trachyspermum ammi* | Seeds | |
| 10. *Sudu Lunu* | *Allium arenarium* | Bulb | |
| 11. *Viyali Inguru* | *Zingiber officinale* | Rhizome | |

***Aralu* (fruit of *Terminalia chebula*)**

The *Terminalia chebula* tree, a medium-to-large deciduous tree, can reach up to 30 meters with a trunk diameter of up to 1 meter. Its oval leaves are 7-8 cm long and 4.5-10 cm wide, with a 1-3 cm petiole. The fruit is blackish and drupe-like, measuring 2-4 cm in length and 1.2-2.5 cm in width. The monoecious, drab white to yellow blooms has a strong, disagreeable smell and are carried in panicles or terminal spikes.(Bag et al., 2013).

***Sungu (Pistacia integerrima*)**

The deciduous *Pistacia integerrima* tree, which can grow up to 25 meters tall, has deep roots and a low crown base. It has large, pinnate leaves with two to six pairs of lanceolate leaflets. The terminal leaflet is smaller than the lateral one's red inflorescence. Pistacia fruits are apiculate, globular, blue, or purple, and have a bony endocarp. The genus is classified based on distribution patterns and leaf shape.(Ahmad et al., 2020).

***Gammiris* (seeds of *Piper nigrum*)**

The pepper plant is a perennial vine that can grow up to 4 meters when supported by poles, trellises, or trees. It spreads easily and roots itself where its branches touch the ground. Its leaves are alternating, and whole, and produce tiny flowers on pendulous spikes, which can grow up to 7 to 15 cm in length as the fruit ages.(Bermawie et al., 2019)

***Tippili* (fruit of *Piper longum*)**

Leaves in plants have long petioles near the stem, ranging from ovate to reniform. Closer to the stem, they are oblong to ovate-oblong and clasp the stem. Male and female flowers bloom on different plants. Male flowers are placed in a row, while female flowers are grouped in a spike inflorescence. Pollen production structures have short stalks and oval-shaped anthers on male flowers (Yadav et al., 2020).

***Ehela Kola* (leaves of *Cassia fistula*)**

The golden shower tree is a medium-sized tree with deciduous, 15-60 cm long pinnate leaves and five yellow petals. It grows quickly, reaching heights of 10-20 m. The flowers are produced in pendulous racemes, with a diameter of 4-7 cm. The fruit is a legume, 1.5-2.5 cm wide and 30-60 cm long, with a strong smell and several seeds (Mwangi et al., 2021).

**Parana *Siyambala* (ancient *Tamarindus indica* L.)**

*Tamarindus indica* is an evergreen tree with a height of up to 24 meters and a circumference of 7 meters. It is moderate to big and is grown in various parts of the country, except for western arid areas and the Himalayas. The tree has compound, alternating leaves with 10-18 pairs of opposing leaflets. It produces beautiful flowers with small spikes and two early falling bracteoles surrounding the buds. The fruit is a velvety, rusty-brown, indehiscent subcylindrical pod, with a fragile shell and seeds immersed in a sticky pulp (Bhadoriya et al., 2011).

***Suduru* (seeds of *Cuminum cyminum*)**

The cumin plant has finely divided leaves, tiny, thin, herbaceous blooms, and distinctive flat-topped umbel clusters. Its seeds, called Comino, are dry fruits called schizocarps, measuring 6mm in length. Each has five longitudinal dorsal ridges and a small grid-like pattern. Cumaldehyde is the main constituent of the 2.5-4.5 percent essential oil (Johri, 2011)

***Mahaduru* (seeds of *Foeniculum vulgare*)**

Foeniculum vulgare is a perennial plant with a glaucous green stem and leaves that can reach up to 40 centimeters in length. Its leaves resemble dills but are narrower. Blooms occur in terminal compound umbels, with 20-50 small yellow flowers on short pedicels. The fruit is a dry schizocarp, 4-10 mm in length and half that width (Badgujar et al., 2020)

***Asamodagam* (seeds of *Trachyspermum ammi*)**

*Trachyspermum ammi* is a fragrant annual plant with soft, fine hair, a high branching height, and numerous green stems. Its fruits are tiny, oval, and encircle Cremo carps, 2-3 mm long. They resemble parsley in size and form, and are highly aromatic, with a strong thyme taste. When rubbed, they release a potent scent (Bairwa et al., 2012).

***Sudu Lunu* (*Allium sativum* bulb)**

*Allium sativum* is a perennial blooming plant with a bulb that can grow up to 1 m tall. Its leaf blade is flat, linear, and solid, and blooms pink to purple from July to September in the Northern Hemisphere. The bulb consists of 10-20 cloves with a pungent smell, and each clove is encased in an inner sheathing leaf (Kıraç et al., 2022).

***Viyali Iguru* (rhizome of *Zingiber officinale*)**

This perennial herbaceous plant can grow up to one meter tall, with elongated, alternating-growing leaves. It produces white and pink flower buds that turn into yellow blooms, held by a cone-shaped spike. The plant has monocotyledons and a rhizome, a commonly used spice, producing leafy branches with eight to twelve distichous leaves. The rhizome is the source of the inflorescence (Zhang et al., 2022).

In Ayurveda and Traditional Medicine, a formulation's therapeutic efficacy is determined by its unique ingredients' unique properties. Each component of *Ehela Kola Kayama* (EKK) contributes to its overall pharmacodynamic profile, which is defined by several fundamental attributes: *Rasa* (taste), *Guna* (qualities), *Veerya* (potency), *Vipaka* (post-digestive effect), *Dosha Karma* (action on the doshas), and Specific Therapeutic Value. These attributes are critical in shaping how each ingredient interacts with the body and influences physiological processes.

A collective analysis of these properties, as detailed in Table 2, offers a holistic understanding of the mechanism of action of EKK within the framework of Ayurveda and Traditional Medicine. By leveraging the synergistic interplay of its ingredients, EKK addresses malnutrition through a balanced approach that harmonizes bodily

functions, corrects imbalances, and promotes overall health and well-being. This formulation exemplifies the integration of traditional wisdom with therapeutic principles to achieve targeted health outcomes.

**Table 2.** Ayurveda pharmacodynamics properties of ingredients of EKK

| Ingredients | *Rasa* (taste) | *Guna* (properties) | *Veerya* (potency) | *Vipaka* (post-digestive effect) | *Dosha Karma* (action on *dosha*) | Specific Therapeutic Value |
|---|---|---|---|---|---|---|
| *Terminalia chebula* (*The Ayurvedic Pharmacopoeia of India*, 1986) | *Katu* (pungent) *Tikta* (bitter) *Kashaya* (astringent) *Madhura* (sweet) *Amla* (sour) | *Laghu* (lightness) *Ruksha* (roughness) | *Ushna* (hot) | *Madhura* (sweet) | *Thridosha Hara* (Pacify tridosha) | *Deepana* (digestive), *Jvaraghna* (reduce fever), *Krimighna* (anti-helminthic), *Ama Pachana* (digestive), *Sanghrahi* (laxative), *Rochana* (increases appetite), *Hridya* (good for the heart), *Rasayana* (rejuvenate) |
| *Pistacia integerrima* (*The Ayurvedic Pharmacopoeia of India*, 1986) | *Katu* (pungent) *Tikta* (bitter) | *Laghu* (lightness) *Ruksha* (roughness) | *Ushna* (hot) | *Madhura* (sweet) | *Vata Kapha Shamaka* (pacify *Vata* and *Pitta dosha*) | *Kshayahara* (chronic respiratory disorders), *Jwarahara* (fever), *Shwasa* (asthma, bronchitis), *Kasa* (cough), *Hikka* (hiccup), and *Vamana* (vomiting), *Aruchi* (anorexia), *Trut* (excessive thirst), *Atisara* (diarrhea) and *Asrapitta* (bleeding disorders) |
| *Piper nigrum Linn* (*The Ayurvedic Pharmacopoeia of India*, 1986) | *Katu* (pungent) | *Laghu* (lightness) *Theekshna* (sharpness) | *Ushna* (hot) | *Katu* (pungent) | *Kapha Vata Shamaka* (pacify *Kapha* and *Vata*) | *Agni Deepana* (promote digestive fire), *Ama pachana* (digestive), *Ykrit uttejaka* (good for the liver), *Rasayana* (rejuvenate) *Shwasa* (asthma, bronchitis), *Kasa* (cough), *Hikka* (hiccup), and *Vamana* (vomiting) *Krimighna* (anti-helminthic) |
| *Piper longum* (*The Ayurvedic Pharmacopoeia of India*, 1986) | *Katu* (pungent) | *Laghu* (lightness) *Theekshna* (sharpness) | *Ushna* (hot) | *Madhura* (sweet) | *Kapha Vata Shamaka* (pacify *Kapha* and *Vata*) | *Deepana* (digestive), *Jvaraghna* (reduce fever), *Krimighna* (anti-helminthic), *Ama Pachana* (digestive), *Sanghrahi* (laxative), *Rochana* (increases appetite), *Hridya* (good for the heart), *Rasayana* (rejuvenate) |
| *Cassia fistula* (*The Ayurvedic Pharmacopoeia of India*, 1986) | *Madhura* (sweet) | *Mrudu* (smoothness) *Guru* (heaviness) *Snigdha* (unctuousness) | *Sheetha* (cold) | *Madhura* (sweet) | *Kapha Pitta Shamaka* (pacify *Kapha* and *Pitta*) | *Deepana* (digestive), *Jvaraghna* (reduce fever), *Krimighna* (anti-helminthic), *Ama Pachana* (digestive) |
| *Tamarindus indica* L. (*The Ayurvedic Pharmacopoeia of India*, 1986) | *Madhura* (sweet) *Amla* (sour) | *Guru* (heaviness) *Ruksha* (roughness) | *Ushna* (hot) | *Amla* | *Kapha Vata Shamaka* (pacify *Kapha* and *Vata*) | *Deepana* (digestive), *Jvaraghna* (reduce fever), *Krimighna* (anti-helminthic), *Ama Pachana* (digestive), *Sanghrahi* (laxative), *Rochana* (increases appetite), *Hridya* (good for the heart), *Rasayana* (rejuvenate) |
| *Cuminum cyminum* (*The Ayurvedic Pharmacopoeia of India*, 1986) | *Katu* (pungent) | *Laghu* (lightness) *Ruksha* (roughness) | *Ushna* (hot) | *Katu* (pungent) | *Kapha Vatahara* (pacify *Kapha* and *Vata)* | *Agni Deepana* (promote digestive fire), *Ama pachana* (digestive), *Ykrit uttejaka* (good for the liver), *Rasayana* (rejuvenate) |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | *Pitta Vardhaka* (increase *Pitta*) | *Shwasa* (asthma, bronchitis), *Kasa* (cough), *Hikka* (hiccup), and *Vamana* (vomiting) *Krimighna* (anti-helminthic) |
| *Foeniculum vulgare* (*The Ayurvedic Pharmacopoeia of India*, 1986) | *Madhura* (sweet) *Katu* (pungent) *Tikta* (bitter) | L*aghu* (lightness) *Ruksha* (roughness) | *Ushna* (hot) | *Madhura* (sweet) | *Kapha Vata Shamaka* (pacify *Kapha* and *Vata*) | *Agni Deepana* (promote digestive fire), *Ama pachana* (digestive), *Ykrit uttejaka* (good for the liver), *Rasayana* (rejuvenate) *Shwasa* (asthma, bronchitis), *Kasa* (cough), *Hikka* (hiccup), and *Vamana* (vomiting) *Krimighna* (anti-helminthic) |
| *Trachyspermum ammi* (*The Ayurvedic Pharmacopoeia of India*, 1986) | *Katu* (pungent) *Tikta* (bitter) | *Laghu* (lightness) *Ruksha* (roughness) *Theekshna* (sharpness) | *Ushna* (hot) | *Katu* (pungent) | *Kapha Vatahara* (pacify *Kapha* and *Vata*) | *Deepana* (digestive), *Jvaraghna* (reduce fever), *Krimighna* (anti-helminthic), *Ama Pachana* (digestive) |
| *Allium sativum* (*The Ayurvedic Pharmacopoeia of India*, 1986) | *Katu* (pungent) *Tikta* (bitter) *Kashaya* (astringent) *Madhura* (sweet) | *Guru* (heaviness) *Ruksha* (roughness) *Theekshna* (sharpness) | *Ushna* (hot) | *Katu* (pungent) | *Kapha Vatahara* (pacify *Kapha* and *Vata)* *Pitta Vardhaka* (increase *Pitta*) | *Agni Deepana* (promote digestive fire), *Ama pachana* (digestive), *Ykrit uttejaka* (good for the liver), *Rasayana* (rejuvenate) *Shwasa* (asthma, bronchitis), *Kasa* (cough), *Hikka* (hiccup), and *Vamana* (vomiting) *Krimighna* (anti-helminthic) |
| *Zingiber officinale* (*The Ayurvedic Pharmacopoeia of India*, 1986) | *Katu* (pungent) | *Guru* (heaviness) *Snigdha* (unctuousness) *Theekshna* (sharpness) | *Ushna* (hot) | *Madhura* (sweet) | *Kapha Vatahara* (pacify *Kapha* and *Vata)* *Pitta Vardhaka* (increase *Pitta*) | *Deepana* (digestive), *Jvaraghna* (reduce fever), *Krimighna* (anti-helminthic), *Ama Pachana* (digestive), *Sanghrahi* (laxative), *Rochana* (increases appetite), *Hridya* (good for the heart), *Rasayana* (rejuvenate) |

Table 3 offers a comprehensive breakdown of the ingredients in *Ehela Kola Kayama* (EKK), detailing the specific micronutrients and phytochemicals identified in each component. Table 3 underscores the nutritional and bioactive compounds present in the formulation, which collectively contribute to its efficacy as a functional food for combating malnutrition. The listed micronutrients include essential vitamins and minerals that play a vital role in addressing nutrient deficiencies. Additionally, the table highlights the diverse nutritional profile of EKK, demonstrating how its ingredients synergistically combine to deliver both nutritional support and therapeutic benefits. This integrated approach exemplifies the formulation's dual role in promoting health and addressing malnutrition through a blend of traditional and functional food principles.

### 3.4.2 Bioactivities of ingredients of EKK

Bioactivities refer to the specific biological effects exerted by the ingredients of herbal formulations on the body, including actions such as antioxidant, anti-inflammatory, and antimicrobial properties (Sorrenti et al., 2023). These

bioactivities enable herbal formulations to target and address a wide range of health concerns by promoting healing, enhancing immune function, and restoring physiological balance.

**Table 3.** Ingredients and list of detected micronutrients and phytochemicals of EKK

| **Ingredients and list of detected phytochemicals and micronutrients** | |
|---|---|
| *Terminalia chebula* (Ou-Yang et al., 2022) | Terminaliate A, gallic acid, methyl gallate, three chebulic acid derivatives, 1,2,6-tri-O-galloyl-β-D-glucopyranose, and arjungenin |
| *Pistacia integerrima* (Abbasi et al., 2015) | Alkaloids, Flavonoids, Tannins, Saponins, Sterols, Pistagremic Acid, Integrisides, Integrisides A And B, And Essential Oil Constituents Like A-Pinene and Terpinene-4-Ol. |
| *Piper nigrum Linn* (Ashokkumar et al., 2021) | Piperine, Piperethine, Piperolein A and B, Feruperine, Dihydroferuperine, Citronellol, Cryptone, Camphene,<br>Alkaloids, Tannins, Saponins, Glycosides, Flavonoids<br>Vitamins A, C, E, K, niacin and beta carotene, Iron, Calcium, Phosphorous. |
| *Piper longum* (D. Li et al., 2022) | Piperchabaoside, Piperine, (2E,4E,14Z)-N-isobutyleicosa-2,4,14-trienamide, and Piperlonguminine, calcium, |
| *Cassia fistula* (Meena et al., 2022) | Anthraquinone glycosides, cardiac glycosides, phenolic compounds, carbohydrate, protein, fats, alkaloids, tannins, saponins, steroids, ter-penoids and phloba-tannins, linoleic acid, oleic acid, stearic acid, rhein glycosides fistulic acids, sennosides A, B, anthraquinones, flavanoid-3-olderivatives, ceryl alcohol, kaempferol, bianthraquinone glycosides, fistulin, essential oils, volatile components, phytol (16.1%), 2- hexadecanone (12%), crystals and 4-hydroxy benzoic acids hydrate |
| *Tamarindus indica* L. (Bhadoriya et al., 2011). | β-amyrin, compesterol, β-sitosterol and seven hydrocarbons, tartaric acid, acetic acid, and succinic acid, gum, pectin, sugar, tannins, alkaloid, flavonoids, sesquiterpenes, and glycosides |
| *Cuminum cyminum* (Wanner et al., 2010) | monoterpenes beta-pinene, p-cymene and gamma-terpinene and the terpenoid aldehydes cuminic aldehyde and the isomeric menthadien carboxaldehydes |
| *Foeniculum vulgare* (Alam et al., 2019) | 4-Hexen-2-one, 3-Hydroxytetrahydropyran, 2-Pentanone, Delta-3-carene, Acetic acid, Sabinene, 1,3,8-P-menthatriene, DL-Limonene, Fenchone, Tetradecane, Trans-p-mentha-2,8-dienol, Camphor, 1,1′-Bicyclohexyl, 1-Undecanol, Benzene-1-methoxy-4-(2-propene), 1-Methyl-2-methylene-4-isopropyl |
| *Trachyspermum ammi* (Bairwa et al., 2012) | carbohydrates, glycosides, saponins, phenolic compounds, volatile oil (thymol, γ-terpinene, para-cymene, and α- and β-pinene), protein, fat, fiber and mineral matter containing calcium, phosphorous, iron and nicotinic acid |

| | |
|---|---|
| *Allium sativum* (Bastaki et al., 2021) | diallyl disulfide, diallyl trisulfide, diallyl sulfide, dipropyl disulfide, dipropyl trisulfide, 1-propenylpropyl disulfide, allyl methyl disulfide and dimethyl disulfide |
| *Zingiber officinale* (Mao et al., 2019) | gingerols, shogaols, and paradols. In fresh ginger, gingerols are the major polyphenols, such as 6-gingerol, 8-gingerol, and 10-gingerol |

Table 4 summarizes the bioactivities of the individual ingredients in *Ehela Kola Kayama* (EKK), emphasizing their therapeutic potential and functional roles within the formulation. The table provides a detailed overview of the specific biological activities associated with each component, offering insights into their mechanisms of action. These bioactivities are critical for understanding how EKK addresses malnutrition, as they contribute to the formula's ability to enhance immunity, improve digestive function, address nutritional deficiencies, and promote overall wellness. This multifaceted approach underscores the formulation's efficacy as a functional food with both nutritional and medicinal benefits.

**Table 4.** Bioactivities of ingredients of EKK

| **Ingredients** | **Actions** |
|---|---|
| *Terminalia chebula* (Bag et al., 2013) | Immunomodulatory, appetizer, antipyretic, antioxidant, anti-inflammatory, analgesic, antibacterial, antiviral, antifungal, anthelmintic, neuroprotective, cardioprotective, hepatoprotective, detoxification effects, antidiabetic, hypolipidemic, anticancer |
| *Pistacia integerrima* (Nazir, 2015) | Muscle Relaxant, Anti-Diarrheal, Gastroprotective, Anti Hyperglycaemic, Hepatoprotective, Cardio Protective, Immunomodulatory, Antioxidant, Anti-inflammatory, Anti-cancer, Anticonvulsant, Anti-microbial |
| *Piper nigrum Linn* (Dludla et al., 2023) | Immunomodulatory, antioxidant, anticancer, hypolipidemic, anthelmintic, anti-inflammatory, analgesic, antibiotic, antiviral, antibacterial, anti-helicobacter, anti-candida, anti-HIV, anti-ulcer, antimutagenic, anti-neuroinflammatory, neuroprotective, anti-osteoporosis, anti-parasitic. |
| *Piper longum* (Yadav et al., 2015) | Immunomodulatory, antioxidant, appetizer, analgesic, gastroprotective, anti-inflammatory, antimicrobial, anthelmintic, anticancer, hepatoprotective, chemoprotective, radioprotective, hypolipidemic, antimicrobial, antipyretic, antidiabetic. [34] |
| *Cassia fistula* (Ghosh et al., 2023) | Immunomodulatory, antioxidant, cardiac tonic, anticancer, laxative, liver tonic, stomachic, anthelmintic restorative, aphrodisiac, antipyretic, antidermatotic, nervine-brain tonic, anti-diabetic, antidepressant, anti-inflammatory |

| | |
|---|---|
| *Tamarindus indica* L. (Abdelrahman & Mariod, 2019) | Immunomodulatory, antioxidant, anti-inflammatory, antitumor, analgesic, anti-diabetic, anti-microbial, anti-bacterial, anthelmintic |
| *Cuminum cyminum* (Soleimanifar & Niazmand, 2020) | Immunomodulatory, antioxidant, anti-inflammatory, antitumor, analgesic, anti-diabetic, anti-microbial, anti-bacterial, anthelmintic, hepatoprotective, laxative, antihypertensive, anticholesterolemic, antiemetic, antipyretic |
| *Foeniculum vulgare* (He & Huang, 2010) | Immunomodulatory, antioxidant, anti-inflammatory, anti-diabetic, anti-microbial, anthelmintic, analgesic, antiemetic, antipyretic, carminative, anticancer, bioavailability enhancer, rejuvenate, aphrodisiac, laxative |
| *Trachyspermum ammi* (Moein et al., 2015) | Immunomodulatory, antioxidant, anti-microbial, anticancer, hypoglycaemic, Cardioprotective, hepatoprotective, analgesic, antipyretic, anti-inflammatory, antiemetic, anthelmintic, appetizer, anticholesterolemic, rejuvenate |
| *Allium sativum* (Shang et al., 2019) | Immunomodulatory, anti-inflammatory, antioxidant, anti-microbial, anticancer, hypoglycaemic, appetizer, anticholesterolemic, rejuvenate, anthelmintic, cardioprotective, hepatoprotective, antidiabetic, rejuvenate, antihypertensive, antiviral |
| *Zingiber officinale* (H.-B. Li et al., 2019) | Immunomodulatory, antioxidant, liver tonic, rejuvenate, antiseptic, anticancer, anti-inflammatory, cardioprotective, hepatoprotective, appetizer, analgesic, anticholesterolemic, rejuvenate, antidiabetic, anthelmintic, anti-microbial, antiemetic |

According to the reviewed Ayurveda pharmacodynamics properties of ingredients of EKK pungent *(Katu)*, sweet (*Madura*), and bitter (*Tikta*) tastes were predominant also astringent (*Kashaya*), sour (*Amla*) and salty taste (*Lavana*) were less present. Where the properties of EKK are considered, it was found that *Ruksha Guna* (rough) *Laghu Guna* (light), *Teekshna Guna* (sharp), and *Guru Guna* (heavy), were present in almost similar amounts whereas *Snigdha Guna* (oily) comparatively less. It was majority hot in potency (*Ushna Veerya*), and where the outcome of the digestive process, *Vipaka* (post-digestive effect) concerned it was calculated majority of ingredients had *Katuka* (pungent in post-digestive effect) and sweet in post digestive effect. Where the Dosha Karmas (actions on body humour) are concerned, EKK mainly pacifies *Vata* and *Kapha dosha*.

Where the therapeutic effects are concerned, those ingredients stimulate the digestive fire (*Agnideepana*), digest the partially-digested particles (*Amapachana*), and rejuvenate the body (*Rasayana*). They were also found to have antimicrobial and anthelminthic effects (*Krimighna*) and increased appetite (*Ruchikaraka*). Apart from that, they enhance vital energy, provide strength to the body, stimulate the liver also act as cardiac and brain tonic which are referred to the terms in Ayurveda (*Ojaskara*), (*Nadi-Indriya Balakara*), (*Yakrit Uttejaka*), (*Hrdaya*), (*Medya*), respectively.

The present literature review was carried out to study the pharmacodynamic properties of ingredients in EKK, and to introduce EKK as a functional food. As per the Ayurveda, pharmaco-dynamic properties were discussed based on the *Rasa* (taste), *Guna* (properties), *Veerya* (potency), *Vipaka* (post-digestive effect) and *Dosha Karma* (effects on body humors) of ingredients. As per the modern view, phytochemicals and the action of bioactive ingredients were considered.

Both Acharya Caraka and Acharya Vagbhata have clearly explained the different biological functions of six different tastes (Shad Rasa) in the human body. As per the results, *Katu* (Pungent), *Madura* (Sweet), and *Tikta* (Bitter) tastes are presented in EKK. Pungent taste cures the disease of the throat, skin diseases, kind of indigestion, and edema, reduces the swelling of ulcers, dries up the unctuous, fat and moisture, and increases hunger. It also improves the taste, cleans the *Srotas* (channels), and eliminates the *Dosas*.

Sweet taste being accustomed since birth, produces greater strength in the body tissues. It is very good for children, the aged, the wounded, and the emaciated, improves the skin complexion, hair, strength of the sense organs, and *Ojas* (immunity).

*Tikta* (bitter taste) by itself is not tasty, but it cures anorexia, worm infestations, thirst, poisons, skin diseases, loss of consciousness, fever, nausea, and burning sensation, mitigates *Pitta* and *Kapha*, dries up moisture, fat, faces, and urine. It is easily digestible, increases intelligence, cold in potency, and cleanses breast milk and throat. (Murthy KSR, 2018b). So, it is crystal clear that the actions of these predominant tastes enhance the digestive fire, all body channels (*Srotas*) are cleared and opened, as well as the transformation of seven *Dathu* (*Saptha Dathu Paripachna)* and circulation of the *Saptha Dhathu* (seven types tissues) is regularized, provide the nourishment to the body.

Among the 20 types of *Gurvadi Gunas* (Attributes), *Laghu Guna* (Lightness), *Teekshna Guna* (sharp) and *Ruksha Guna* (rough) were predominant in EKK. It was mentioned in the classics that Laghu Guna provides the lightness and it is easily digestible. *Ruksha Guna* is opposite to unctuous but clears the obstruction in the *Srotas* and pacifies the *Kapha* while increasing the Vata. Furthermore, it is mentioned that *Teekshna Guna* increases the *Pitta*, stimulates the *Jataraghni*, provides scraping action on *Srotas* in the body, mitigates the *Kapha* and *Vata*, and clears the *Srotas* (ducts and body channels). (Alwis V., 1967)

It was revealed that all the ingredients of EKK are hot in potency (*Ushna Veerya*). Hence, it increases the *Pitta* and promotes digestive functions, mitigates the *Vata* and *Kapha*, metabolizes the undigested substance termed as *Ama* which are obstructed in *Srotas*, and clears the obstruction of *Srotas* by digestion of undigested particles and bringing them to the *Koshta.* (Alwis V, 1967). So, all ingredients of EKK caused into–enhancement of digestive fire (*Deepana*) and digestion of partially digested particles (*Pachana*) remain in the alimentary tract.

Also, classical literature of Ayurveda emphasizes that the root cause of all diseases is *Mandagni* (digestive insufficiency) results in indigestion.(Murthy KSR, 2018a). Because of *Ama Pachana* (digestion of un-digested particles), it is very essential to

administer either medicaments or food which are having the *Deepana* effects. It was literarily revealed that ingredients of EKK naturally have these *Deepana* and *Pachana* properties, so that *Jataragni, Dhatvagni* (seven Agni responsible for the transformation of seven *Dathus* and *Panchabhutagnis* (Agni perform in five basic elements at the cellular level) are routinely corrected. It facilitates the proper formation of *Saptha Dhathus* (seven body tissues) and the Ojas which are formed as the essence of each Dhathus. (Sharma PV, 2013). The digestive fire is further improved due to the *Katu Rasa* and *Pitta Vardhaka* properties of ingredients.

Most of the ingredients in EKK were found to be having effects of subsiding fever (*Jvaraghna*), anti-microbial and de-worming effects (Krimighna), increasing appetite (*Ruchikaraka*), anti-diarrhoeal (*Athisarahara*), controlling passing of excessive urine (*Pramehahara*), suppressing breathing difficulties and cough (*Swasakasahara*), enhancing heart functions (*Hrdaya*), stimulating liver functions(*Yakrututtejaka*) properties, that facilitate the wide range of therapeutic effects that help to prevent from multisystemic diseases. This functional food has several properties such as *Athisarahara*, *Krimighna*, *Chardihara* (anti-vomiting effects), *Ruchikaraka*, etc. that can empower the physiology of the digestive system especially.

In the context of malnutrition, the functional food EKK presents promising attributes that could contribute to addressing nutritional deficiencies. The rich variety of bioactive phytochemicals, vitamins, and minerals present in EKK may play a crucial role in supplementing essential nutrients. The sweet taste (*Madura Rasa*) prevalent in EKK is particularly beneficial for individuals suffering from malnutrition, as it is known to enhance strength, improve skin complexion, and boost immunity. Additionally, the digestive properties of EKK, such as its ability to stimulate the digestive fire (*Agnideepana*) and promote the digestion of partially-digested particles (*Amapachana*), may aid in optimizing nutrient absorption and utilization.

The functional food's anti-diarrheal properties (*Athisarahara*) could also be advantageous in preventing nutrient loss due to gastrointestinal issues. Furthermore, the immunomodulatory, antioxidant, and anti-inflammatory effects of EKK's bioactive ingredients may contribute to overall health and resilience, addressing the multifaceted challenges associated with malnutrition. Incorporating EKK into the diet could potentially serve as a holistic approach to combat malnutrition by providing not only essential nutrients but also supporting the body's overall well-being.

According to the reviewed data of pharmaceutical analysis, the ingredients consisted of potential bioactive phytochemicals such as Alkaloids, Glycosides, Flavonoids, Tannins, and Saponins. Apart from that steroids, Phenolic, Terpenoids, and essential micronutrients such as vitamins and minerals were present. Furthermore, it was revealed that the bioactivities of the ingredients are immunomodulatory, antioxidant, anti-inflammatory, antimicrobial, and anticancer effects also presented.

Apart from that analgesic, antipyretic, antidiabetic, antihyperlipidemic, anti-parasitic, appetizer, hepatoprotective, cardioprotective, and neuroprotective properties were frequently recorded.

## 4. Conclusion and Recommendations

According to the reviewed data, it can be concluded that EKK stimulates the process of *Agni,* enhances metabolism, and empowers the process of *Saptha Dhatu* formation and Ojas thereby promoting the *Vyadhikshamatva* as well. Because the ingredients have *Rasayana* and immunomodulatory properties, body strength, and innate immunity can be improved. Multisystemic disorders can be prevented due to the widespread therapeutic value of EKK. Therefore, it can use EKK as a functional food for malnutrition and further research data need to be carried out to validate the health benefits of EKK. through clinical trials and observational studies. With a comprehensive knowledge of the pharmacodynamic properties of EKK, it is recommended to consider EKK in the dietary regimen as a functional food for individuals facing malnutrition. The documented effects on enhancing the digestive process, promoting the formation of essential body tissues (*Saptha Dhatu*), and strengthening the immune system make EKK a potentially valuable nutritional supplement. As part of a balanced and diverse diet, EKK may contribute to addressing nutritional deficiencies and promoting overall well-being.

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