Therapeutic role of vegetables in Respiratory Diseases – A critical review from Ayurvedic classics.

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INTRODUCTION

According to Ayurveda, proper nutrition/diet is the basic need of good health and also acts as causative factor for disease as well as preservation and promotion of health.¹ It is also said that in both the conditions, viz. health and disease, diet is a prime factor to be thought about, as it is told that, without proper diet, the use of any drug is futile.² Though Ayurveda recognized the importance of a good diet for the prevention of disease, clinical nutrition has emerged only recently as an important discipline in modern medicine.³

In Ayurveda, Pranavaha Srotas is correlated to respiratory system due to similarity in its function.⁴ General causes of vitiation of Pranavaha Srotas include suppression of natural urges; lifestyle and dietary patterns; seasonal and environmental factors. They produce different symptoms like Kasa (cough), Shvasa (dyspnoea/asthma), Hikka (hiccup) etc.⁵

Diet is a modifiable risk factor for the development of respiratory diseases, which appears to be more than an option to prevent and modify the disease. Changes

ABSTRACT

The concept of Pathya (wholesome diet) is an unique contribution of Ayurveda, which plays an important role in prevention and management of many diseases. “Shakavarga”, a category under dietetics in classical texts of Ayurveda enlisted different vegetables with their properties and indications in different disease conditions. These vegetables can be prescribed as Pathya (wholesome diet) in clinical practice. In the present review, plants described under Shakavarga, indicated as Pathya in different diseases related to Pranavaha Srotas (Respiratory system) were compiled from 15 different Ayurvedic classical texts. Critical analysis of the compiled data reveals that out of 332 vegetables described under Shakavarga, 44 are indicated in respiratory disease like Shvasa (Dyspnoea/Asthma), Kasa (Cough), Peenasa (Chronic rhinitis) and Hikka (Hiccup). Among them, botanical identity of 42 classical plants has been established and maximum number of vegetables belongs to the family cucurbitaceae (10) followed by solanaceae (4). Some of these vegetables have been reported for their various pharmacological activities related to prevention and management of diseases related to Pranavaha Srotas (Respiratory system). These vegetables are reported for their anti-inflammatory (16), antioxidant (14), anti-allergic (6) and antitussive (3) activities. The observed result may be helpful in use of vegetables as Pathya (wholesome diet) and planning further scientific studies about the efficacy of these plants on prevention as well as management of respiratory diseases.

Key words: Pathya, Pranavaha Srotas, Shakavarga, Respiratory diseases, Vegetables.

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in diet over the past few decades have been suggested to contribute to the increased prevalence of obstructive lung diseases, including Chronic obstructive pulmonary diseases (COPD). Evidence from human studies and experimental investigations have shed new light on the relationship between diet, lung function and COPD development, showing role of certain foods, nutrients and dietary patterns on pulmonary function. Some studies also concluded that, high intake of fresh fruit and some vegetables appears to have a beneficial effect on lung health and their consumption should be recommended on a daily basis.

Ayurveda, being the foremost life science, describes ways to prevent and manage diseases through proper dietary management, explained different vegetables under the group “Shakavarga” where the properties and indications of individual Shaka (vegetables) has been explained. Recent literature review suggest that the vegetables recommended in classical texts of Ayurveda are time tested and have potential to prevent or reduce the risk of developing cardio vascular disorders, diabetes and skin diseases and gastrointestinal diseases. In the present review, various classical vegetables mentioned as diet in the diseases of Pranavaha Srotas were reviewed along with their reported activities in different respiratory disorders. The review will provide a scientific rationale of using classical vegetables as Pathya in clinical practice.

**Materials and Methods**

Plants described in Shakavarga, under the category of Patrashaka (Leafy vegetables), Phalashaka (Fruit vegetables), Mulashaka (Tubers) etc, indicated in combating the diseases of Pranavaha Srotas (respiratory system) were compiled from Charaka Samhita, Sushruta Samhita, Astanga Sangraha, Astanga Hridaya and 11 different Nighantus i.e, Dhanvantari Nighantu, Shodhala Nighantu, Madhava Dravyaguna, Madanapala Nighantu, Kalyadeva Nighantu, Bhavaprakasha Nighantu, Raja Nighantu, Priya Nighantu, Gunaratanamala, Dravyaguna Sangraha and Dravyaguna Shataslok. Various research journals and books were referred to collect published scientific research data on the role of these vegetables in the prevention and management of respiratory disorders. The collected data are presented in a scientific manner with regards to their part used, botanical identity and reported activities in respiratory disorders.

**Results and Discussion**

All the Samhitas and majority of Nighantus allotted a separate chapter known as Shakavarga for different vegetables. It is observed that, out of about 324 classical vegetables described under Shakavarga, 44 are indicated in disorders related to respiratory system. Different parts of the plants like leaves (17), fruits (12), Rhizome/tuber (3), flowers (2) are used as vegetable in diseases related to Pranavaha Srotas (Respiratory system). Maximum vegetables are indicated in Shvasa (39) followed by Kasa (36) and Hikka (4). (Table 1)

**Table 1: Classical vegetables used in common respiratory diseases as mentioned in classical texts of Ayurveda.**

<table>
<thead>
<tr>
<th>Indication</th>
<th>Patra (leaf)</th>
<th>Pusha (Flower)</th>
<th>Phala (fruit)</th>
<th>Kanda (tuber)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hikka (hiccups)</td>
<td>Kakamachi</td>
<td>Devadali</td>
<td>Karkotaki</td>
<td>Lashun</td>
</tr>
<tr>
<td>Kasa (cough)</td>
<td>Arkapushpi,</td>
<td>Agastya</td>
<td>Aralu,</td>
<td>Kemuka,</td>
</tr>
<tr>
<td></td>
<td>Brahmni,</td>
<td></td>
<td>Brahhati,</td>
<td>Soorana</td>
</tr>
<tr>
<td></td>
<td>Dronapushpi,</td>
<td></td>
<td>Devadali,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ghoti, Gajihva,</td>
<td></td>
<td>Eranda,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Guduchi,</td>
<td></td>
<td>Kantakari,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kakamachi,</td>
<td></td>
<td>Karavelaka,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Karchari,</td>
<td></td>
<td>Karkotaki,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kasamarda,</td>
<td></td>
<td>Katutumbi,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kiratitkta,</td>
<td></td>
<td>Koshataki,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kuntali, Loni,</td>
<td></td>
<td>Patala, Phanphata,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mandukaparni,</td>
<td></td>
<td>Rajakoshatoki,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Patola, Phanjii,</td>
<td></td>
<td>Vrintaka,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Saptali, Sateena,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Suvachala, Triparnika,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agastya</td>
<td></td>
<td>Vasa</td>
<td></td>
</tr>
<tr>
<td>Peenasa (chronic rhinitis)</td>
<td>Agastya</td>
<td>Lashuna</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shvasa (dyspnoea /asthma)</td>
<td>Arkapushpi, Bakuchi, Brahmni, Chakramarda, Dronapushpi, Guduchi, Gajihva,</td>
<td>Brihati, Devadali, Eranda, Kantakari, Karavelaka, Patola, Karkotaki,</td>
<td>Kemuka, Soorana</td>
<td></td>
</tr>
</tbody>
</table>
Among 44 vegetables classically indicated as Pathya (wholesome diet) for different respiratory tract diseases, botanical identity of 42 vegetables have been established and remaining 2 are yet to be identified botanically (Table 2). Maximum vegetables belong to the family cucurbitaceae (10) followed by solanaceae (4). Majority of these vegetables are identified botanically (Table 2). Maximum vegetables classical vegetables used in respiratory disorders. have been established and remaining 2 are yet to be identified botanically. According to Charaka, the drugs which are useful in diseases of Pranavaha Srotas should possess Ushna, Vatanulomana and Kaphavatahara properties.

Table 2: Botanical equivalents and properties of classical vegetables used in respiratory disorders.
On critical analysis, it is observed that some of these vegetables have been well studied and proved to be having multi-pharmacological actions related to prevention of diseases related to respiratory tract. Maximum number of vegetables are reported for their Anti-inflammatory activity (16) followed by antioxidant (14), anti-allergic (6) and antitussive activities (3). (Table 3)

**Table 3: Classical vegetables reported for different pharmacological activities related to prevention of respiratory diseases.**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Shaka (Vegetables)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anti-inflammatory</strong></td>
<td>Agastya (S. grandiflora), Brihati (S. indicum), Dronapushpi (L. cephalotes), Kakamachi (S. nigrum), Karavelaaka (M. charantia), Karkotaki (M. dioica), Kasamarda (C. occidentalis), Kebuka (C. speciosus), Kiratapaktha (S. chirata), Loni (P. oleracea), Mandukaparni (C. asiatica), Palanka (S. oleracea), Patola (T. dioica), Shigru (M. pterygosperma), Shitivara (C. argentea), Vasa (A. vasica)</td>
<td>16</td>
</tr>
<tr>
<td><strong>Antioxidant</strong></td>
<td>Brihati (S. indicum Linn.), Chakramarda (C. tora Linn.), Gojihua (L. pinatifida), Guduchi (T. cordifolia), Kakamachi (S. nigrum Linn.), Karavelaaka (M. charantia), Karkotaki (M. dioica), Kasamarda (C. occidentalis), Kebuka (C. speciosus), Kiratapaktha (S. chirata), Koshatak (L. acutangula), Lashuna (A. sativum Linn.), Loni (P. oleracea L), Mandalaparni (C. asiatica)</td>
<td>14</td>
</tr>
</tbody>
</table>
Anti-inflammatory

Recent research works show that systemic inflammation exists in stable COPD and that this systemic inflammation is related to functional performance.[29] Several studies have found that systemic inflammatory markers, such as high-sensitivity C-reactive protein (hs-CRP) and cytokines, are higher in patients with COPD when compared with subjects without COPD, and are related to mortality in COPD patients.[30,31] Systemic inflammation is considered a hallmark of COPD and one of the key mechanisms that may be responsible for the increased rate of comorbidities, including and osteoporosis.[32] Among the classical vegetables indicated for respiratory diseases 16 are reported for their Anti-inflammatory activity. (Table 4)

Table 4: Anti-inflammatory activity of classical vegetables indicated in respiratory diseases.

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agastya (S. grandiflora)</td>
<td>The methanol extract of Sesbania grandiflora L. flowers showed significant inhibitory activity against carrageenan and cotton pellet induced inflammatory models.[33]</td>
</tr>
<tr>
<td>Mandukaparni (C. asiatica)</td>
<td>Chloroform and methanol extracts of Centella asiatica at 100 and 200 mg doses showed significant anti-inflammatory activity in carrageenan induced paw edema of Wistar albino rat.[34]</td>
</tr>
<tr>
<td>Brihati (S. indicum)</td>
<td>Methanol extract of S. indicum fruit at the dose of 250 mg/kg and 500 mg/kg exhibited comparable anti-inflammatory activity after 6 hours of treatment on Wistar rats in comparison to the reference drug diclofenac sodium (1mg/kg).[35]</td>
</tr>
<tr>
<td>Dronapushpi (L. cephalotes)</td>
<td>Alkaloidal fractions of the leaves of L. cephalotes showed significant reduction in inflammation i.e 80 % (100 mg/kg) followed by crude methanol extract i.e. 61 % (100 mg/kg) and aqueous extract i.e. 58 % (100 mg/kg) as compared to standard anti-inflammatory drug aspirin i.e. 68.62% (25mg/kg).[36]</td>
</tr>
<tr>
<td>Kakamachi (S.nigrum L.)</td>
<td>Methanolic extract of berries of Solanum nigrum Linn. at the dose of 375 mg/kg showed good anti-inflammatory activity against carrageenan induced paw edema.[37]</td>
</tr>
<tr>
<td>Karavellaka (M. charantia)</td>
<td>Ethanol extract of M. charantia fruit showed 42.10% anti-inflammatory effect at the dose of 500mg/kg in carrageenan induced paw oedema.[38]</td>
</tr>
<tr>
<td>Karkotaki (M. dioica)</td>
<td>Hexane and methanol extracts of Momordica dioica fruit pulp in a dose of 50 and 100 mg/kg exhibited significant anti-inflammatory activities when compared to standard drug.[39]</td>
</tr>
<tr>
<td>Kasamarda (C. occidentalis)</td>
<td>Cassia occidentalis leaf powder showed maximum anti-inflammatory activity at the dose of 2000 mg/kg in carrageenan-induced rat paw edema. In cotton pellet granuloma assay, the transudative, exudative and proliferative components of chronic inflammation were suppressed by the test drug.[40]</td>
</tr>
<tr>
<td>Kebuka (C. speciosus)</td>
<td>The ethanolic extract of the rhizome of Costus speciosus possesses anti-inflammatory property.[41]</td>
</tr>
<tr>
<td>Kiratatikta (S. chirata)</td>
<td>Xanthone derivative (1,5-dihydroxy-3,8 dimethoxy xanthone) of S. chirata at the dose of 50 mg/kg, significantly reduced carrageenan - induced pedal edema (57%) and formalin - induced pedal oedema in rats (58%).[42]</td>
</tr>
<tr>
<td>Loni (P. oleracea)</td>
<td>Petroleum ether extract of Portulaca oleracea exhibited significant anti-inflammatory activity in carrageenan induced hind paw oedema.[43]</td>
</tr>
</tbody>
</table>
Palankya (S. oleracea) The water extract of Spinacia oleracea and its methanolic aqueous fraction at 600 mg/ kg dose showed significant inhibition of inflammation in both acute and chronic anti-inflammatory models. [44]

Patola (T dioica) Methanol extract along with its organic soluble fractions at the dose of 100, 200, 400 mg/kg, exerted a significant and dose dependent inhibition on carrageenan induced rat paw edema compared to control group. [45]

Shigru (M. pterygosperma) Seed infusion of M. pterygosperma 1000 mg/kg showed significant anti-inflammatory effect in carrageenan induced rat paw edema. [46]

Shitivaraka (C. argentea) Flavonoid fraction from alcoholic extract of C. argentea at the dose of 10 mg/kg exhibited significant dose dependent anti-inflammatory activities in carrageenan induced rat paw edema and cotton pellet induced chronic inflammation. [47]

Vasa (A. vasica) Vasicine, vasicinone, vasicine acetate, 2-acetyl benzyl amine, vasicinolone present in chloroform fraction of A. vasica leaves showed most potent anti-inflammatory effects at the dose of 20.0mg/kg after 6 hours in carrageenan induced paw oedema. [48]

Antioxidants

Fruits and vegetables contain high levels of antioxidants including vitamins C and E, carotenoids and flavonoids, which might explain their beneficial effects on respiratory function. [49] Protective effects on lung function have also been described for vitamin E, vitamin A, vitamin D, carotenoids and flavonoids, [50, 51, 52, 53, 54, 55] thus supporting the antioxidant hypothesis. This article reports antioxidant activity of 14 classical vegetables. (Table 5)

Table 5: Antioxidant activity of classical vegetables indicated in respiratory diseases.

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brihati (S. indicum Linn.)</td>
<td>In DPPH assay, aqueous extract of S. indicum showed more IC50 value than ethanol extract. In β - Carotene assay the ethanol extract possesses more antioxidant activity than water extract. [54]</td>
</tr>
<tr>
<td>Chakramarda (C. tora Linn.)</td>
<td>Ethanol extract showed strong antioxidant activities in total antioxidant capacity, DPPH-scavenging activity and ferric ion reducing assay. [57]</td>
</tr>
<tr>
<td>Gojihva (L. pinnatifida)</td>
<td>The ethanol extract of leaves exhibited the significant antioxidant activity against DPPH free radical and hydroxyl radical scavenging activities. [58]</td>
</tr>
<tr>
<td>Guduchi (T. cordifolia)</td>
<td>Ethyl acetate, methanol, butanol and water extracts of leaves at 250 μg/ml, showed significant DPPH radical scavenging activity, reducing power, phosphomolybdenum and metal chelating activity. [59]</td>
</tr>
<tr>
<td>Kakamachi (S. nigrum Linn.)</td>
<td>Pretreatment with methanol extract of S. nigrum berries at the dose of 250, 500 and 1000 mg/kg normalized the decreased levels of antioxidant enzymes and increased mucosal injury. [60]</td>
</tr>
<tr>
<td>Karavellaka (M. charantia)</td>
<td>The IC50 values of alcoholic extract of M. charantia in DPPH and hydrogen peroxide radical scavenging activity was found to be 120.07 ± 0.77μg/ml and 175.78 ± 0.63 μg/ml respectively. [61]</td>
</tr>
<tr>
<td>Kiratatikta (S.chirata)</td>
<td>Methanol extract of S. chirata exhibited significant DPPH scavenging activity and hydroxyl radical scavenging activity. [62]</td>
</tr>
<tr>
<td>Koshataki (L. acutangula)</td>
<td>Aqueous extract showed effective DPPH radical screening activity, superoxide radical scavenging activity and reducing power assay. [63]</td>
</tr>
<tr>
<td>Lashuna (A. sativum Linn)</td>
<td>In nicotine-induced lipid peroxidation, A. sativum oil at the dose of 100 mg/kg showed effective antioxidant activity by reducing oxidative damage in rats. [64]</td>
</tr>
<tr>
<td>Loni (P. oleracea L)</td>
<td>Methanol extract has showed significant DPPH radical-scavenging activity, reducing power, nitric oxide radical scavenging assay. [65]</td>
</tr>
<tr>
<td>Mandukaparni (C. asiatica L)</td>
<td>Total reducing power and DPPH-radical scavenging activity of 50% ethanol extract of C. asiatica were significantly higher when compared to those of the 100% ethanol and water extracts. [66]</td>
</tr>
</tbody>
</table>
Anti-allergic

Various epidemiological studies have identified the causes for an increase in the prevalence of upper and lower respiratory tract allergic diseases. Intensive research during the last several decades has highlighted the role of lymphocytes, immunoglobulins, mast cells, and various autacoids in the etiopathogenesis of allergic conditions. Despite the voluminous literature on the subject, the treatment of allergic diseases continues to be far from satisfactory. The available treatment options for upper and lower respiratory tract allergic diseases have major limitations owing to low efficacy, associated adverse events and compliance issues. Present review reports 6 plants for their anti-allergic activity (Table 6) and hence can be used against various allergic respiratory diseases.

Table 6: Anti-allergic activity of classical vegetables indicated in respiratory diseases.

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kakamachi</strong> <em>(S. nigrum)</em></td>
<td>The petroleum ether extract of <em>S. nigrum</em> at the dose of 50, 100 and 200mg/kg, significantly inhibited clonidine-induced catalepsy, increased leukocyte and eosinophil count due to milk allergen and showed maximum protection against mast cell degranulation by clonidine.</td>
</tr>
<tr>
<td><strong>Kantakari</strong> <em>(S. xanthocarpum)</em></td>
<td>Apigenin, a flavonoid isolated from <em>Solanum xanthocarpum</em>, has shown anti-allergic effect on ovalbumin induced asthma model by significantly inhibiting allergic airway reactions in mice.</td>
</tr>
</tbody>
</table>

Anti-tussive

Anti-tussive drugs act in the CNS to raise the threshold of the cough centre or act peripherally in the respiratory tract to reduce tussal impulses, or both these actions. They aim to control rather than eliminate the cough. The most frequently used antitussive drugs in clinical conditions belong to the group of narcotic analgesics, the antitussive dose is lesser than analgesic dose. Adverse effects like depression of the respiratory center, decreased secretion in the bronchioles and inhibition of ciliary activity, increased sputum viscosity, decreased expectoration, hypotension and constriction acts as limitation to the therapy. In the present review, 3 vegetables are found to be reported for their anti-tussive activity (Table 7).
Table 7: Anti-tussive activity of classical vegetables indicated in respiratory diseases.

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Loni</strong> (P. oleracea)</td>
<td>The antitussive effects of two different concentrations of boiled extract (2.5% w/v and 5% w/v), codeine and saline were tested by counting the number of coughs induced by citric acid aerosol. The results showed significant reduction in cough numbers following the use of both concentrations of the boiled extract compared to saline. In addition there was a significant difference between the cough numbers of the 5% extract with that of codeine. [81]</td>
</tr>
<tr>
<td><strong>Sunishannaka</strong> (M. minuta)</td>
<td>Methanol, ethyl acetate, and petroleum ether extracts of M. minuta significantly increased mice's cough latent period and inhibited the frequency of cough induced by ammonia and sulfur dioxide. Methanol extract at 500 mg/kg showed 59.5% and 55.8% inhibition in the number of coughing induced by ammonium liquor and SO2, respectively. [82]</td>
</tr>
<tr>
<td><strong>Vasa</strong> (A. vasica)</td>
<td><em>Adhatoda vasica</em> extract showed a good antitussive activity in anaesthetized guinea pigs and rabbits and in unaesthetized guinea pigs. After oral administration, the antitussive activity was similar to codeine against coughing induced by irritant aerosols. [83]</td>
</tr>
</tbody>
</table>

**CONCLUSION**

The observed results in the present review reports the use of different vegetables in prevention as well as management of diseases of respiratory system. These vegetables mentioned in classical texts of Ayurveda are time tested and have potential to prevent or reduce the risk of developing certain respiratory diseases. Based on many experimental studies it can be suggested that, intake of dietary vegetables might help to prevent many respiratory diseases through different mechanisms. The observed results also give an insight in planning further scientific studies about the efficacy of these plants in respiratory diseases. These vegetable can be cultivated in kitchen garden according to the season of availability to grow healthy, fresh vegetables.

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