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

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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.

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

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ISSN: 2456-3110 REVIEW ARTICLE Sep-Oct 2016

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).[6] 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.[7] 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.[8]

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,[9] diabetes[10] and skin diseases[11] and gastrointestinal diseases.[12] 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 diseases. 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,[13] Sushruta Samhita,[14] Astanga Sangraha,[15] Astanga Hridaya[16] and 11 different Nighantus i.e, Dhanvantari Nighantu,[17] Shodhala Nighantu,[18] Madhava Dravyaguna,[19] Madanapala Nighantu,[20] Kaiyadeva Nighantu,[21] Bhavaprakasha Nighantu,[22] Raja Nighantu,[23] Priya Nighantu,[24] Gunaratnamala,[25] Dravyaguna Sangraha[26] and Dravyaguna Shatasloki.[27] 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.

Indication	*Patra* (leaf)	*Pushpa* (Flower)	*Phala* (fruit)	*Kanda (tuber)*
Hikka (hiccup)	*Kakamachi*		*Devadali, Karkotaki*	*Lashun*
Kasa (cough)	*Arkapushpi, Brahmi, Dronapushpi, Ghoti, Gojihva, Guduchi, Kakamachi, Karchari, Kasamarda, Kiratatikta, Kuntali, Loni, Mandukaparni, Patola, Phanji, Saptala, Sateena, Suvarchala, Triparnika, Vasa*	*Agastya*	*Alabu, Brahati, Devadali, Eranda, Kantakari, Karavellaka, Karkotaki, Katutumbi, Koshataki, Patola,Phanphata, Rajakoshataki, Vrintaka.*	*Kemuka, Soorana*
Peenasa (chronic rhinitis)		*Agastya*		*Lashuna*
Shvasa (dyspnoea /asthma)	*Arkapushpi, Bakuchi, Brahmi, Chakramarda, Dronapushpi, Guduchi, Gojihva,*		*Brihati, Devadali, Eranda, Kantakari, Karavellaka, Patola, Karkotaki,*	*Kemuka, Soorana*

ISSN: 2456-3110 REVIEW ARTICLE Sep-Oct 2016

	Kakamachi, Kuntali, Kiratatikta, Loni, Mandukaparni, Vasa,Palankya, Patha, Phanji, Punarnava, Saptala, Sateena, Shitivara, Triparnika, Sunnishanaka, Suvarchala, Ghoti.		*Katutumbi, Koshataki, Phanphata, Rajakoshataki, Shigru, Vrintaka*	

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 having *Katu-tikta Rasa, Laghu-Ruksha Guna* and *Ushna Veerya*. According to Charaka, the drugs which are useful in diseases of *Pranavaha Srotas* should possess *Ushna, Vatanulomana* and *Kaphavatahara* properties.[28]

Table 2: Botanical equivalents and properties of classical vegetables used in respiratory disorders.

Shaka Vegetable	Botanical name / Family	*Rasa*	*Guna*	*Veerya*	*Vipaka*
Agastya[14]	*Sesbania grandiflora* Linn. (Fabaceae)	T, Ks	Sh	Sh	Kt
Alabu[12], [13], [15], [17-21], [23], [25]	*Lagenaria vulgaris* Ser. (Cucurbitaceae)	M	G, R	Sh	M
Arkapushpi[14]	*Holostemma rheedianum* Spreng. (Asclepiadaceae)	-	L	-	-
Bakuchi[13], [14], [16], [21]	*Psoralea corylifolia*Linn. (Papilionaceae)	T, Kt	L	U	Kt
Brihati[14-16], [19], [26]	*Solanum indicum* Linn. (Solanaceae)	Kt, T	L	-	Kt
Brahmi[19], [21]	*Bacopa monnieri* (L.) Pennell (Scrophulariaceae)	Ks, T, M	Sr, L	Sh	M
Chakramarda[13-16], [19], [21-23]	*Cassia tora* Linn. (Caesalpiniaceae)	Ks, M, L	G, R	Sh	-
Devadali[21]	*Luffa echinata* Roxb. (Cucurbitaceae)	T	-	-	-
Dronapushpi[13], [14], [16], [18], [21], [22], [25]	*Leucas cephalotes* Spreng. (Labiateae)	Kt, L	G, R	U	M
Eranda[14], [15]	*Ricinus communis*Linn. (Euphorbiaceae)	Kt, T, A	Sn	U	-
Ghoti[25]	-	A	Sr	U	-
Gojihva[13-16], [19], [21], [22], [25]	*Elephantopus scaber* Linn. (Compositae)	Ks, M, T	L	Sh	M
Guduchi[13-16], [19], [22], [23]	*Tinospora cordifolia* (Willd.) Miers (Menispermaceae)	Ks, Kt, T	L	U	M
Kakamachi[13-16], [19], [21], [26]	*Solanum nigrum* Linn. (Solanaceae)	Kt, T	Sn	Sh	Kt
Kantakari [14],[16],[22],[25]	*Solanum xanthocarpum* Schrad. (Solanaceae)	T, Kt	L, R, U	U	-
Karavellaka [13-22],[25],[26]	*Momordica charantia* Linn. (Cucurbitaceae)	T	Sh, L	-	Kt
Karchari [14]	*Cucumis species* (Cucurbitaceae)	-	-	-	-
Karkotaki [13-23],[25]	*Momordica dioica* Roxb. (Cucurbitaceae)	M, T	-	U	Kt
Kasamarda [14-16], [19-21],[22],[25], [26]	*Cassia occidentalis* Linn. (Leguminoseae)	M, T, Kt	L, Sr	U	Kt
Katutumbi [17],[19-21]	*Lagenaria vulgaris* Ser. (Cucurbitaceae)	T, Kt	Sh	Sh	Kt
Kemuka [13-16], [22], [24]	*Costus speciosus*(Koenig) Sm. (Zingiberaceae)	T	L	Sh	Kt
Kiratatikta [14]	*Swertia chirata* (Buch-Ham) (Gentianaceae)	T	-	-	-
Koshataki [14-16],[18-20], [24],[27]	*Luffa acutangula* (Linn) Roxb. (Cucurbitaceae)	T	L, R, Sh	-	-
Kuntali [12],[13],[19]	*Zanonia indica*Linn. (Cucurbitaceae)	T, Ks, M,	R, Sr	Sh	Kt
Lashuna [12-	*Allium sativum* Linn.	M, A L,	Sn, G Sr,	-	Kt

ISSN: 2456-3110 REVIEW ARTICLE Sep-Oct 2016

14], [18], [23]	(Liliaceae)	Kt, T, Ks	Tk,		
Loni [13-16], [18], [20-22], [24], [25]	*Portulaca oleraceae* Linn. (Portulaceae)	A, Kt, L	G, R		
Mandukaparni [13-16],[18]	*Centella asiatica* (Linn)Gaertn. (Umbelliferae)	Ks, T, M	L	Sh	Kt
Palankya [13-16], [20-26]	*Spinacia oleracea* Linn. (Chenopodiaceae)	M	G, R, Sr	Sh	M
Patha [13],[15],[19]	*Cissampelospareira* Linn. (Menispermaceae)	T, Kt	L, U	U	Kt
Patola [13-16],[18-25]	*Trichosanthes dioica* Roxb. (Cucurbitaceae)	T, M	L, S, U	-	Kt
Phanji [13-15],[21-23]	*Rivea hypocrateriformis* (Desr.) Choisy (Convolvulaceae)	M, Ks	G , R,	-	-
Phanphata [21]	-	T	G, U	-	Kt
Punarnava [13-15], [17], [20], [22], [24-26]	*Boerhaavia diffusa* Linn. (Nyctaginaceae)	T, Kt,Ks	R, Sr	U	-
Rajakoshataki [19],[21],[22],[25]	*Luffa acutangula* Roxb. (Cucurbitaceae)	T, M	Sh	Sh	-
Saptala [14-16]	*Acacia concinna*(Willd.) DC. (Mimosaceae)	T	L	-	Kt
Sateena [13-15], [18],[23-25]	*Pisum sativum* Linn. (Papilionaceae)	T, M	L	-	Kt
Shigru [13],[14],[16], [17],[19],[24]	*Moringa pterygosperma* Gaertn. (Moringaceae)	Kt	-	U	-
Shitivara [20],[22],[25]	*Celosia argentea* Linn. (Amaranthaceae)	Kt, T, Lv	Sr, R, L	Sh	M
Surana [15],[16],[19],[20],[22-26]	*Amorphophallus campanulatus* (Roxb.) Blume ex Decne. (Araceae)	Kt, Ks	R, V, L	U	-
Sunnishana ki [13-16], [18], [19], [25], [26]	*Marsilea minuta* Linn. (Marseliaceae)	M, A, Ks	L, R	Sh	M
Suvarchala [14-16]	*Malva rotundifolia*Linn. (Malvaceae)	M,Lv	G, R	Sh	M
Triparnika [13-16],[25]	*Uraria logopoides* DC. (Papilionaceae)/ *Clematis triloba* Heyne ex Roth (Ranunculaceae)	M, Lv	G, R	S	M
Vasa [13-16],[24]	*Adathoda vasica* Nees. (Acanthaceae)	Kt, T	L	Sh	Kt
Vrintaka [13-16], [18-27]	*Solanum melongena* Linn. (Solanaceae)	M	U, L	-	Kt

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.

Activity	*Shaka* (Vegetables)	Total
Anti-inflammatory	*Agastya* (*S. grandiflora), Brihati (S. indicum), Dronapushpi (L. cephalotes), Kakamachi* (*S. nigrum), Karavellaka (M. charantia), Karkotaki (M. dioica), Kasamarda (C. occidentalis), Kebuka (C. speciosus), Kiratatikta (S. chirata), Loni (P. oleracea), Mandukaparni (C. asiatica), Palankya (S. oleracea), Patola (T. dioica), Shigru (M. pterygosperma), Shitivara (C. argentea), Vasa (A. vasica)*	16
Antioxidant	*Brihati (S. indicum* Linn.), *Chakramarda (C. tora* Linn.), *Gojihva (L. pinnatifida*), *Guduchi* (*T. cordifolia), Kakamachi* (*S. nigrum* Linn.), *Karavellaka* (*M. charantia), Kiratatikta* (*S.chirata*), *Koshataki* (*L. acutangula), Lashuna* (*A. sativum* Linn), *Loni* (*P. oleracea* L), *Mandukaparni* (*C.*	14

ISSN: 2456-3110 REVIEW ARTICLE Sep-Oct 2016

	asiatica L), *Patola* (*T. dioica*Roxb), *Shitivara* (*C. argentea* L), *Vrintaka* (*S. melogena* L.)	
Anti-allergic	*Kakamachi (S. nigrum), Kantakari (S. xanthocarpum), Kasamarda (C. occidentalis), Mandukaparni (C. asiatica), Patola (T. dioica), Vasa (A. vasica)*	6
Antitussive	*Loni (P. oleracea), Sunishannaka (M. minuta), Vasa (A. vasica)*	3
Bronchodilator	*Loni (P. oleracea)*	1
Expectorant	*Sunishannaka* (*M. minuta)*	1

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.

Vegetable	Results
Agastya (S. grandiflora)	The methanol extract of *Sesbania grandiflora* L. flowers showed significant inhibitory activity against carrageenan and cotton pellet induced inflammatory models.[33]
Mandukaparni (C. asiatica)	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]
Brihati (S. indicum)	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]
Dronapushpi (L. cephalotes)	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]
Kakamachi (S.nigrum L.)	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]
Karavellaka (M. charantia)	Ethanol extract of *M. charantia* fruit showed 42.10% anti-inflammatory effect at the dose of 500mg/kg in carrageenan induced paw oedema.[38]
Karkotaki (M. dioica)	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]
Kasamarda (C. occidentalis)	*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]
Kebuka (C. speciosus)	The ethanolic extract of the rhizome of *Costus speciosus* possesses anti-inflammatory property.[41]
Kiratatikta (S. chirata)	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]
Loni (P. oleracea)	Petroleum ether extract of *Portulaca oleracea* exhibited significant anti-inflammatory activity in carrageenan induced hind paw oedema.[43]

ISSN: 2456-3110 REVIEW ARTICLE Sep-Oct 2016

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*at 1000 mg/kg showed significantanti-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.

Vegetable	Results
Brihati *(S. indicum Linn.)*	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.[56]
Chakramarda *(C. tora Linn.)*	Ethanol extract showed strong antioxidant activities in total antioxidant capacity, DPPH-scavenging activity and ferric ion reducing assay.[57]
Gojihva *(L. pinnatifida)*	The ethanol extract of leaves exhibited the significant antioxidant activity against DPPH free radical and hydroxyl radical scavenging activities.[58]
Guduchi *(T. cordifolia)*	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]
Kakamachi *(S. nigrum Linn.)*	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]
Karavellaka *(M. charantia)*	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]
Kiratatikta *(S.chirata)*	Methanol extract of *S. chirata* exhibited significant DPPH scavenging activity and hydroxyl radical scavenging activity.[62]
Koshataki *(L. acutangula)*	Aqueous extract showed effective DPPH radical screening activity, superoxide radical scavenging activity and reducing power assay.[63]
Lashuna *(A. sativum Linn)*	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]
Loni *(P. oleracea L)*	Methanol extract has showed significant DPPH radical-scavenging activity, reducing power, nitric oxide radical scavenging assay.[65]
Mandukaparni *(C. asiatica L)*	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]

ISSN: 2456-3110 REVIEW ARTICLE Sep-Oct 2016

Patola *(T. dioicaRoxb)*	Methanol extract along with its organic soluble fractions showed concentration dependent DPPH radical-scavenging activity, reducing power, nitric oxide radical scavenging assay.[67]
Shitivara *(C. argentea L)*	Methanol extracts of *C. argentea* showed significant DPPH, Nitric oxide and hydrogen peroxide scavenging activity.[68]
Vrintaka *(S. melogena L.)*	IC50 value of crude and ethyl acetate fractions of *S. melogena*was found to be 66.745 + 1.008 µg/mL and 58.735 + 1.734µg/mL, respectively in DPPH assay.[69]

Anti-allergic

Various epidemiological studies have identified the causes for an increase in the prevalence of upper and lower respiratory tract allergic diseases.[70] 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. Inspite of 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.[71] 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.

Vegetable	Results
Kakamachi *(S. nigrum)*	The petroleum ether extract of *S. nigrum* 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.[72]
Kantakari *(S.xanthocarpum)*	Apigenin, a flavonoid isolated from *Solanum xanthocarpum,* has shown anti allergic effect on ovalbunin induced asthma model by significantly inhibiting allergic airway reactions in mice.[73]
Karkotaki *(M. dioica)*	Petroleum ether, ethyl acetate, methanol and aqueous extracts of *M. dioica* (200 mg/kg) were screened for anti-allergic activity in models of milk induced leukocytosis, milk induced eosinophilia and differentia leukocytes count in mice. Methanol extract showed more significant anti-allergic activity as compared to other extracts.[74]
Kasamarda *(C. occidentalis)*	Ethanol extract of *Cassia occidentalis* at the dosage of 250 mg/ kg inhibited mast cells degranulation, stabilized HRBC membrane there by alleviating immediate hypersensitivity.[75]
Mandukaparni *(C. asiatica)*	Aqueous and alcoholic extracts at the dose of 100mg/kg showed a better protection of mast cell degranulation induced by sheep serum (76–83 %) than the standard drug Ketotifen fumarate (75%).[76]
Vasa *(A. vasica)*	The extract containing the alkaloid vascinol and 20% vasicine inhibited ovalbumin-induced allergic reactions by about 37% at a concentration of 5 mg. [77] Vasicinone has been proven to be a potent anti-allergen in tests on mice, rats and guinea pigs.[78]

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.[79] 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 constipation acts as limitation to the therapy.[80] In the present review, 3 vegetables are found to be reported for their anti-tussive activity. (Table 7)

ISSN: 2456-3110 REVIEW ARTICLE Sep-Oct 2016

Table 7: Anti-tussive activity of classical vegetables indicated in respiratory diseases.

Vegetable	Results
Loni *(P. oleracea)*	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]
Sunishannaka *(M. minuta)*	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]
Vasa *(A. vasica)*	*Adhatoda vasica* extract showed a good antitussive activity in anaesthetized guinea pigs and rabbits and in unanaesthetized guinea pigs. After oral administration, the antitussive activity was similar to codeine against coughing induced by irritant aerosols.[83]

Bronchodilators

Bronchospasm can induce or aggravate cough. Stimulation of pulmonary receptors can trigger both cough and bronchoconstriction, especially in individuals with bronchial hyperactivity. Bronchodilators can relieve cough in such individuals and improve the effectiveness of cough in clearing secretions by increasing surface velocity of airflow during cough.[79] Bronchodilatory activity of methanolic extract of classical vegetable *Loni* (*Portulaca oleracea)* was studied on histamine dihydrochloride induced asthma in guinea pigs. The extract at the dose of 40, 60 and 80 mg/kg, when administered orally, 30 min prior to their exposure to histamine aerosol showed marked but insignificant bronchodilatory activity.[84]

Expectorants

Expectorants are drugs believed to increase bronchial secretions or reduce its viscocity, facilitating its removal by coughing.[79] In an experimental study, methanol, ethyl acetate and petroleum ether extracts of classical vegetable *Sunishannaka* (*Marsilea minuta)* were evaluated for expectorant activity by calculating volume of phenol red in mice's tracheas. All the extracts significantly improved tracheal phenol red output in expectorant evaluation. Methanol extract at 500 mg/kg showed superior activity compared to other extracts by exhibiting 89.3% increase in phenol red secretion.[85]

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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