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Review Article

ANTIOXIDANT ACTIVITY OF MADHURAPRABHAVA DRUGS DELINEATED IN MADHURASKANDHA OF CHARAKA'S MATERIA MEDICA

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ABSTRACT

Acharya Charaka had mentioned Madhuraskandha in the context of Asthapana Basti dravya. There are total 85 drugs mentioned in the Madhuraskandha. The drugs included in Madhuraskandha usually possess Madhurarasa or Madhuravipaka and Madhuraprabhava. Madhuraprabhava is the phenomenon in which the drug shows the action attributed to Madhurarasa or Madhuravipaka though it does not contain either of them. In Madhuraskandha, there are in total 25 drugs which exercise their action through Madhuraprabhava. In Ayurvedic pharmacology, Prabhava is referred as inexplicable principle. But, basing upon the active constituents of the medicinal plants their respective activities can be explained. The active constituents of plants have been recently isolated. They have been divided into16 main groups viz. alkaloids, anthocyanin, anthraquinones, glycosides, minerals etc. The active constituents in plants are the chemicals that have a medicinal effect on the body. Rasayana dravyas mainly possess Madhurarasa. The Rasayana activity (antioxidant activity one of the indices of Rasayana Karma) is well explained in the light of presence of phenol compounds, triterpenoids, flavonoids, gallic acids etc. In the present study, the anti-oxidant activity of the Madhuraskandha dravyas who act through their Madhuraprabhava can be explained by the presence of terpenoid, flavonoids and total phenol content etc. A review of such reported researches have been made to explain the activities of drugs having Madhuraprabhava.

Keywords: Antioxidant activity, Madhuraskandha, Madhuraprabhava

INTRODUCTION

Acharya Charaka had described Shadarasaskandha (Group of drugs having six different tastes) in the context of Asthapana Basti (Corrective enema) drugs. The main purpose of these skandhas was to describe the text neither to be elaborate nor too brief but at the same time should clearly explain the entire scientific truth. Substances are mostly composed of many tastes. Therefore drugs that are of Madhurarasa or Vipaka or those which produce the effects similar to Madhurarasa (Prabhava) are included under Madhuraskandha (group of the drugs having Sweet taste or potential). According to Ayurvedic pharmacology, Prabhava is inexplicable attribute (Achintya shakti). In pharmaceutical science, isolated active constituents are divided into 16 main groups i.e. Alkaloids, Anthocyanins, Anthraquinones, Bitter, Cardiac glycosides, Coumarins, Cyanogenic glycosides, Flavonoids, Glucosilinates, Minerals, Mucilage, Phenols, Saponins, Tannins, Vitamins and Volatile oils, which exert effect on the body[1]. Therefore, it may be possible to explain specific activities ascribed to Prabhava by presence of certain phytochemical constituents.

The drugs of Madhuraskandha are listed and identified with the help of Chakrapani commentary (Ayurved-dipika). The Botanical identification of the drugs was done by using 'Glossary of Vegetable drug in Bruhattrayi' authored by Thakur Balawant Singh and Indian medicinal Plant by C. P. Khare. The attributes of drugs (Rasa, Guna, Veerya, Vipaka) are compiled from Bhavaprakashanighatu, Kaiyadevanighantu and Rajanighantu. The research activities reported of these drugs has been collected from 'Selection of Prime Ayurvedic Plant Drugs' by Sukh Dev as well as relevant articles have been downloaded from Google.

DISCUSSION

The drugs of Madhuraskandha having Madhuraprabhava are listed below:

Table 1: Attributes of drugs of Madhuraskandha having Madhuraprabhava

No.	Dravya	Botanical source	Rasa (Bh. Ni, R. Ni, K, Ni)	Vipaka (Bh. Ni, R. Ni, K, Ni)	Karma (Bh. Ni, R. Ni, K, Ni)
1.	Asanaparni/ Shanaparni (Aparajita)	*Clitoria ternatea* Linn	Kashaya, Tikta, Katu	Katu	Medhya, Kanthya, Smriti-budhhida
2.	Ashwagandha	*Withania somnifera* Dunal	Tikta, Kashaya	Katu	Atishukrala, Balya, Rasayana
3.	Brihati	*Solanum indicum* Linn	Katu, Tikta	Katu	Hridya
4.	Dvarada	*Tectona grandis* Linn. f.	Kashaya	Katu,	Hridya
5.	Hansapadi	*Adiantum lunulatum* Burn	Katu	Katu	Rasayana
6.	Kakanasika	*Pentatropis microphylla* W and A *Trichosanthes cucumerina* Linn *Clitoria ternatea* Linn *Martynia annua* Linn	Kashaya, Katu, Tikta	Katu	Vamaka
			Madhura (R.Ni)		Rasayana (R.Ni)
7.	Kantakarika	*Solanum xanthocarpum* Schrad andWendle	Tikta, Katu	Katu	Deepana, Pachana
8.	Kapotavalli	*Elettaria cardamomum* Maton	Katu	Katu	-
9.	Karkatashringi	*Pistacia integerrima* Stew. ex.Brandis	Tikta, Kashaya	Katu	-
10.	Kataka	*Strychnos potatorum* Linn.f.	Madhura, Kashaya	Katu	Chakshushya
11.	Kshudrasaha	*Aloe vera* Tourn. ex Linn. (Kumari-Ck) *Teramnus labialis* Spreng (Mashaparni) *Barleria cristata* (Shweta Sahachara) [Ys, Gr]	Madhura, Tikta	Katu/ Madhura	Brihmana, Balya, Vrishya, Rasayana, Netrya
12.	Mahasaha	*Pheseolus trilobus* Ait (Mudgaparni) *Barleria cristata* Linn. (Rakta Sahachara) [Ys, Gr]	Tikta, Madhura	Katu	Grahi
13.	Mahashravani	*Sphaeranthus africanus* Linn	Madhura	Katu	Medhya
14.	Mashaparni	*Teramnus labialis* Spreng	Tikta, Madhura	Katu	-
15.	Mudgaparni	*Phaseolus trilobus* Ait	Tikta, Madhura	Katu	Chakushya, Grahi, Shukrala
16.	Odanapaki	*Barleria strigosa* Willd.	Tikta, Madhura, Kashaya	Katu	-
17.	Punarnava	*Boerhavia diffusa* Linn Syn *B. repens* Linn	Katu, Kashaya	Katu	Grahi
18.	Rajakshavka	*Euphorbia hirta* Linn	Madhura, Tikta	Katu	Hridya, Shukrala
19.	Samharsha	*Loranthus longiflorus* Desr *(Dendrophthoe falcata* (Linn.f) Etting	Tikta, Kashaya, Madhura	Katu	Vrishya, Rasayana
20.	Shatapushpa	*Peucedanum graveolens* Linn *Foeniculum vulgare* Mill	Katu	Katu	Deepana
21.	Shravani	*Sphaeranthus indicus* Linn	Madhura	Katu	Medhya
22.	Tamalaki	*Phyllanthus niruri* Linn. *P.urinaria* Linn	Tikta, Kashaya, Madhura	Katu	-
23.	Urubuka	*Ricinus communis* Linn	Madhura	Katu/ Oil-Madhura	-
24.	Vira[2]	*Lasia spinosa* Thwaites	Tikta	Katu	-
25.	Vrischira	*Trianthema portulacastrum* Linn	Katu, Kashaya	Katu	Chakshushya, Balya, Varnya, Shukrala, Keshya, Svarya

Ck- Ayurveda-dipika commentary, Ys- Charakopaskara commentary, Gr- Jalpakalpataru commentary, Bh. Ni- Bhavaprakashanighantu, R. Ni- Rajanighantu, K, Ni- Kaiyadevanighantu

Certain ferns are used by tribal for rejuvenating effect and among the list of Madhuraskandha drugs Hansapadi (*Adiantum lunulatum* Burn) is included which has exhibited antioxidant and immunomodulatory activity[3]. Mahasaha has been interpreted as Mudgaparni[4] and as Rakta kurubaka[5] by Chakrapani and Yogindranath Sen, commentators of Charakasamhita respectively. Since Mudgaparni is also included in this group, therefore it is more appropriate to accept Rakta kurubaka (*Barleria cristata*) for Mahasaha. Among the above drugs Kakanasika appears to be controversial. Veera is known as 'Jalandhar shaka' according to Chakrapani. Thakur Balawant Singh commented as it is hydrophytic plant with spines like *Lasia spinosa* Thwaites. It is a thick rhizome used as medicine and its thick spinous leaves used by tribal people in vegetables as 'Kantasaru' and 'Bamalashaka'[6]. It is also proven for their anti-oxidant activity. Therefore, it can be taken as source of Veera. There are total 25 drugs having Rasa other than Madhura, but included in Madhuraskandha. These drugs possess Katu, Tikta, Kashaya rasa and Katu Vipaka, but exhibit actions similar to that of Madhurarasa and Madhuravipaka like Shukrala, Rasayana, Chakshushya, Medhya, Vrishya etc. According to Ayurvedic pharmacology, these drugs exercise their activity by Prabhava (Achintya shakti) which is inexplicable. In

modern pharmacology, the anti-oxidant agent decreases the cell destruction activity of free radical and promotes cell longevity which falls under the spectrum of Rasayana activity. Therefore, to evaluate Rasayana activity on the scientific parameter, anti-oxidant activity is preferred. Phytochemicals are structurally diverse, based on their biosynthetic origins; they can be classified into basically four classes whose members may exert positive effects on human health; the terpenoids, phenolic and poly-phenolic and nitrogen-containing alkaloids and sulphur-containing compounds[7], alkaloids, saponins, anthraquinone, cardiac glycosides, coumarine, phlobatannins, flavonoids, tannins are the major phytoconstituents for producing anti-oxidant activity[8]. Drugs of Madhuraskandha having Madhuraprabhava are listed below with their reported antioxidant activity.

Aparajita (*Clitoria ternatea* Linn)
Ethanol extract of *Clitoria ternatea* shows presence of terpenoid, flavonoid, tannin and steroid which act as antioxidant principle. Recent study showed that malonylated flavonoid, glycosides were isolated from the petals of *Clitoria ternatea* with different petal colors using LC/MS/MS. It was also reported that five new anthocyanin, ternatins A_3, B_3, B_4, B_2 and D_2 were isolated from *Clitoria ternatea* flowers[9].

Ashwagandha (*Withania somnifera* Dunal)
Chemical analysis of Ashwagandha shows its main constituents as alkaloids and steroidal lactones. Among the various alkaloids, Withanine is the main constituent. Certain withanolide constituents have been demonstrated to possess significant anti-oxidant and immunomodulatory activity, some of the simple withanolides have immunosuppressive activity and some glycowithanolides displayed immune-stimulation[10].

Brihati (*Solanum indicum* Linn)
Red berries showed a higher content of carotenoids compared to green and yellow ones. Regarding polyphenols, several phenolic acids and flavonoids were found in all berries. The content of caffeoylquinic acids, caffeic acid, flavonol glycosides and naringenin was higher in red berries, while the content of p-coumaric acid and feruloylquinic acids was similar among the three colors. The results show the important role of the ripening stage in increasing the antioxidant content of *Solanum indicum* berries[11].

Kantakari (*Solanum xanthocarpum* Schrad and Wendle)
The amount of total phenolic and total flavonoid content of methanolic, ethanolic and aqueous extracts of *Solanum xanthocarpum* berries was evaluated. Ethanolic extract revealed the highest total phenolic content and total flavonoids contents at 9.02 mg GAE/L and 36.16 mg QE/L respectively. The literature survey showed that total phenolic and total flavonoid content may contribute directly to antioxidant action[12].

Dvarda (*Tectona grandis* Linn. f)
The treatment of alloxan induced diabetic rats with the methanolic extract of bark of *Tectona grandis* (TGM) and significantly ($p < 0.05$) decreased the LDH and glucose - 6 - phosphatase levels on diabetic group. Experimental results also reflect that the *Tectona grandis* is capable of reducing the oxidative stress associated with diabetes. The reduction of thiobarbituric acid levels in tissues in the TGM treated diabetic group ensures the antioxidant potential of the *Tectona grandis*. A new compound (Abeograndinoic acid) and 21 known terpenoids were isolated from the bark of *Tectona grandis*. The enriched secondary metabolites may be responsible for the anti-diabetic and anti-oxidant activity of *Tectona grandis*[13].

Hansapadi (*Adiantum lunulatum* Burn)
A new triterpenoid, 22, 29xi-epoxy-30-norhopane-13beta-ol (1) was isolated together with six known compounds viz., fern-9(11)-en-6alpha-ol. Fern-9(11)-ene, fern-9(11)-en-25-oic acid, fern-9(11)-en-28-ol, filicenol-B, adiantone and oxidation product of fern-9(11)-en-6alpha-ol obtained as 6-oxofern-9(11)-ene from the whole plant of *Adiantum lunulatum*; these triterpenoids can perform anti-oxidant activity[14].

Kakanasika (*Pentatropis microphylla* W and A)
P. microphylla was analyzed by various *in vitro* assays like total antioxidant, free radical scavenging, reducing power and metal ion chelating activities. Ascorbic acid and BHT were used as standards. The total antioxidant activity was higher in the methanolic leaf extract (1632. 6 ± 143.6). The DPPH (2, 2-diphenyl-1-picrylhydrazyl) free radical scavenging activity was well established (IC_{50} at 129 µg/ml). Reducing power activity was higher (0.441 ± 0.13) in the higher concentration of the extract, 700 µg/ml. Similarly, the metal ion chelating activity was also higher (51.74 ± 1.63) in the higher concentration of the extract, 300 µg/ml with the IC_{50} value, 245 µg/ml[15].

Kapotavalli (*Elettaria cardamomum* Maton)
The methanolic extract of the fruit of the *Elettaria cardamomum* was evaluated for their free radical scavenging property keeping ascorbic acid as standard drug. Free radical scavenging activity was evaluated by DPPH method. It showed weak free radical scavenging activity with the DPPH method. But its IC_{50} [half maximal inhibitory concentration] value is higher[16].

Karkatashrngi (*Pistacia integerrima* Stew. ex. Brandis)
Pistacia integerrima (Anacardiaceae) showed presence of phenolics, flavonoids, carbohydrates and volatile oils in preliminary phytochemical screening. The Co-TLC of methanol extract and ethyl acetate fraction of methanol extract confirmed presence of Gallic acid, and Quercetin which are known to possess antioxidant activity[17].

Kataka (*Strychnos potatorum* Linn)
In the preliminary pharmacognostical and phytochemical evaluation of seed powder of *Strychnos potatorum* (SPP) and extract of *Strychnos potatorum* (SPE) in previous study revealed the presence of phenolic, steroids, triterpenes/volatile oils, saponins, alkaloids and volatile oils. HPTLC fingerprinting of specified fractions like alkaloids, steroids/triterpenes and polysaccharide fractions were also reported earlier. The highest antioxidant activity of SPE may be due to the presence of

antioxidant phytochemicals like polyphenols, steroids and triterpenes[18].

Kshudrasaha (*Aloe vera* Tourn. ex Linn)
The polysaccharide and flavonoid concentrations of two-, three-, and four-year-old *Aloe vera* were determined, and their antioxidant activity was evaluated. The results showed that three-year-old *Aloe vera* contained significantly higher levels of polysaccharides and flavonoids than two- and four-year-old *Aloe vera*, and no significant differences in flavonoid levels were found between three- and four-year-old *Aloe vera*. All the aloe extracts showed significant antioxidant activity[19].

Mahasaha (*Barleria cristata* Linn.)
Phytochemical screening yielded alkaloids, flavonoids, glycosides, saponins, phenols and tannins in the ethanol and aqueous extracts of *Barleria cristata*. Study yielded a new flavonoid compound, 6-O-α-L-rhamnopyranoside-3, 7, 3'-O-trimethylated-8- hydroxyquercetin, together with known flavonoids 6- O-α-L-rhamnopyranoside 3-methoxy quercetin, quercetagetin, tamarixetin, gossypetin and quercetin. The 50 % ethanol extract of leaves showed significant antioxidant activity probably from the occurrence of secondary metabolites[20].

Mashaparni (*Teramnus labialis* Spreng)
Plant has been reported to contain dalbergioidin, kievitone, phaseollidin and flavonoid glycosides viz. Quercitin, kaempferol, vitexin, isovitexin have been reported. The fruit of this plant is found to contain proteins, minerals and vitamin K, vitamin C. Plant is extensively used by tribal people of Nandurbar district of Maharashtra, India in the treatment of jaundice and other liver disorders. The plant also contains friedelin, epifriedelin, stigmasterol and tannins. Total flavonoid content present in the root powder of the plant was found to be 92 mg/g. These phytochemical compounds are known to support bioactive activities in medicinal plants and thus responsible for the antioxidant activities of this plant extract used in this study[21].

Mudgaparni (*Phaseolus trilobus* Ait)
The methanolic extractives of *Phaseolus trilobus* led to the isolation and characterization of vitexin, bergenin, daidzin and 3-O-methyl-D- chiro -inositol as active constituents. Vitexin exhibited a dose-dependent inhibitory activity on 5-lipoxygenase enzyme. The isolated constituents were also screened for their antioxidant activity by nitro blue tetrazolium (NBT) riboflavin photo reduction method. Vitexin exhibited moderate antioxidant activity[22].

Odanapaki (*Barleria strigosa* Willd.)
Allied species like *Barleria cristata* is evaluated for their antioxidant activity.

Punarnava (*Boerhavia diffusa* Linn)
Phytochemical constituents like flavonoids, alkaloids, glycosides and sterols have been reported to be present in the alcoholic root extracts of *Boerhavia diffusa*. The anti-stress activity of *Boerhaavia diffusa* is mainly attributed to these constituents with established antioxidant activity[23].

Vrischira (*Trianthema portulacastrum* Linn)
The methanolic extract was screened for the presence of various phytoconstituents like steroids, alkaloids, terpenoids, glycosides, flavonoids and carbohydrates. Plants produce a variety of antioxidants against molecular damage from reactive oxygen species produced by arterial wall macrophages and phenolic compounds are the major class of plant derived antioxidants. Among the various phenolic compounds, the flavonoids are perhaps the most important group. In the present study, the *in vitro* antioxidant or free radical scavenging activity of methanolic extract of the plant might be due to the presence of phenolic compounds in the methanolic extract[24].

Rajakshavaka (*Euphorbia hirta* Linn)
Alcohol, acetone, ethyl acetate, hexane, petroleum ether, chloroform and aqueous extracts of *Euphorbia hirta* are screened through thin layer chromatography. From this analysis four compounds such as steroid, flavonoid, alkaloid and phenols were found in the leaves. The leaves of *Euphorbia hirta* have a high flavonoid and phenolic compounds than the steroid and alkaloid compounds. *In vitro* antioxidant activity of leaf of *Euphorbia hirta* which was achieved by using two different extracts such as alcohol and acetone. Total antioxidant activity of *Euphorbia hirta* is higher in acetone extract compared to alcoholic extract[25].

Samharsha (*Dendrophthoe falcata* (Linn.f)
The ethanolic extracts of leaf of *D. falcata* showed very potent free radical scavenging properties indicated by the presence of a yellowish spot on the reddish purple background of the TLC plate. The potent antioxidant activity observed with the extracts (IC_{50} 5.1 µg/ml) might be due to the major compound 1 (quercitrin), a standard antioxidant[26]. The same results were obtained, when the study was done on the extract of the stem of *D. falcata.* It also exhibit potent free radical scavenging and antioxidant activity. The overall antioxidant activity might be attributed to its polyphenolic content and other phytochemical constituents like quercetin[27].

Shatapushpa (*Foeniculum vulgare* Mill)
Foeniculum vulgare ripe fruit revealed the presence of sterols and triterpenes, flavonoids, coumarins and volatile oils. Phenolic compounds containing free hydrogen are largely responsible for antioxidant activity thus the phenolic compounds of *F. vulgare* can be referred to be responsible for the antioxidant activity[28].

Shravani (*Sphaeranthus indicus* Linn)
The total antioxidant capacity of ethanolic extract of root of *Sphaeranthus indicus* was calculated based on the formation of phosphomolybdenum complex which was measured spectrophotometrically at 695 nm. It was reported that flavonoids are products which have been shown to possess various biological properties related to antioxidant mechanisms. Thus, in the present study, the

antioxidant potential of *S. indicus* may be attributed to the presence of flavonoids[29].

Mahashravani (*S. africanus* Linn)
The methanolic extract of leaves of *Sphaeranthus africanus* shows the presence of total phenolic contents and showed dose-dependent DPPH radical scavenging activity[30].

Tamalaki (*Phyllanthus niruri* Linn., *P. urinaria* Linn)
These result suggested that over 95 % of the antioxidant capacity in *Phyllanthus* was due to the contribution of phenolic compounds. The other 5 % may be due to other non-phenolic compounds that exhibit antioxidant properties. Overall it can be observed that both the total phenolic content and antioxidant activity was consistently higher in the methanol extract when compared with the water extract, may be due to difference in polarity of solvents[31].

Urubooka (*Ricinus communis* Linn)
The methanolic extract of *Ricinus communis* leaves is found to contain flavonoids and tannins. A large number of flavonoids including these are known to possess strong antioxidant properties. Hence the antioxidant activity of *Ricinus communis* leaves is probably due the presence of flavonoids and tannins in the 50 % methanolic extract.[32] The DPPH (1, 1-diphenyl-2- picryl hydrazyl)-mediated in vitro study reveals that gallic acid, quercetin, gentisic acid, rutin, epicatechin and ellagic acid are the major phenolic compounds responsible for the antioxidant activity of the dry leaves of *Ricinus communis* Linn[33].

Vira (*Lasia spinosa* Thwaites)
The powdered leaves of *Lasia spinosa* were subjected to preliminary phyto-chemical screening for qualitative detection of phytoconstituents. The result represents the presence of the alkaloids, carbohydrates, saponins, glycosides, tannins, flavonoids etc. in the leaves of *L. spinosa*. The ethyl acetate extract contain only the flavonoids. Ethyl acetate soluble partitionate of the methanolic extract of the plant material showed significant antioxidant property using DPPH assay with IC_{50} value of 16.42 µg/ml[34].

DISCUSSION

According to the principles of Ayurvedic pharmacology, Madhurarasa containing drugs generally exhibit Rasayana activity (Rejuvenating effect). There is an exception to this rule which envisaged that drugs which are not possessing Madhurarasa and Madhuravipaka (Biotransformation of the drug which yields the Madhurarasa activity) also contribute for Rasayana activity. As the modus operandi of such drugs cannot be explained in rational way, Acharya of Ayurveda evolved the concept of Prabhava (an inexplicable attribute of the drug) which acts as a causative factor of certain specific action and beyond the comprehensive of the science. Some categorize it as empirical principle of drug action with the advent of phytochemistry. Several active drug molecules are isolated and their activity is being assessed objectively making the empirical principle (Prabhava) to explain in explicit manner. The Rasayana activity (antioxidant activity one of the indices of Rasayana Karma) is well explained in the light of presence of phenol compounds, triterpenoids, flavonoids, gallic acids etc. Drug which are not possessing either Madhurarasa or Madhuravipaka and exhibiting Rasayana activity (cell protector activity) can be explained by certain compounds present in them. Seers of Ayurveda referred the incomprehensible principle as Prabhava. But researches have made it comprehensive.

CONCLUSION

The nomenclature of Vipaka is coined based on Rasa and similarly the principle of Prabhava is referred by Rasa into six categories namely Madhuraprabhava, Amlaprabhava, Lavanaprabhava, Tiktaprabhava, Katuprabhava and Kashayaprabhava. Recent researches have scientifically validated Rasayana Karma which contributes for healthy longevity of cell in terms of anti-oxidant activity. But the drugs having Madhuraprabhava do possess Rasayana activity as all these drugs show anti-oxidant activity due to the presence of flavonoids, terpenoids, saponins, coumarins, alkaloids, phenols, tannins etc.

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