

Analysis of *Madhuraskandha's* Rasayana Drugs through Pharmacognostical, Physicochemical and Phytochemical Parameters

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Abstract

Acharya Charaka has classified drugs based upon the *Rasa*; as *Rasaskandha* in the context of *Asthapana Bastidravyas*. The drugs included in the *Skandha* are not only based upon their *Rasa* but also according to their *Vipaka* and *Prabhava*. *Madhurarasadravya* attributes actions like *Rasayana*, *Balya*, and *Jivaniya Karma*. Charaka had stated another therapeutic classification containing *dashemani* dravyas. In these groups of drugs, *Rasayana* karma may be attributed to *Jeevaniya*, *Balya*, *Brihmaniya*, *Vayasthapanadashemani* groups. In the present study, a list of ten *Rasayana* drugs was drawn by comparing *Vayasthapana gana* and *Madhuraskandha* drugs i.e. *Atibala*, *Vidari*, *Kantakari*, *Eranda*, *Gokshura*, *Guduchi*, *Shalaparni*, *Jivanti*, *Shatavari* and *Punarnava*. These drugs were evaluated by Pharmacognostical, Physicochemical and Phytochemical studies. The microscopical study of the powder showed the presence of starch grains and calcium oxalate crystals. Physicochemical parameters showed that water soluble extractive value is more than alcohol soluble extractive value. Majority of these drugs showed presence of Carbohydrates, Reducing sugar, Amino acids, Proteins, Tannin, Steroids, Triterpenoids, Anthraquinone, and Saponin. These can be used as standard parameters to generate purity and quality of the herbal drugs.

Keywords

Madhuraskandha, Pharmacognostical, Phytochemical, Starch, Carbohydrates



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INTRODUCTION

Acharya Charakahas classified drugs into 50 groups based upon pharmacological activity and rasa i.e., six *skandhas* were described. Among these *skandhas* maximum numbers of drugs were quoted in *Madhuraskandha* i.e., eighty five drugs. In these *skandha*, dravyas were arranged not only based upon their *Rasa* but also according to their *Vipaka* and *Prabhava*. It indicates that *Madhuraskandha* contains a drug which may have *Madhurarasa* or *Madhuravipaka* or *Madhuraprabhava*¹.

Madhurarasa drugs mainly have *Madhuravipaka* and *Sheetaveerya*. They have *Saptadhatuwardhan*, *Indriyaprasadana*, *Balavarnakara*, *Keshya*, *Kanthyas*, *Balya*, *Brihmaniya*, *Preenana*, *Tarpana*, and *Jeevaniya* activities².

Secondly, based upon pharmacological action, Charaka had described a group of drugs having *Rasayana* karma referred as '*Vayasthapana dashemani*'. Most of the drugs of this group are included under *Madhuraskandha*. *Vayasthapana dashemani* contains *Amruta*, *Abhaya*, *Dhatri*, *Mukta (Rasna)*, *Shweta (Aparajita)*, *Jivanti*, *Atirasa*, *Mandukaparni*, *Sthira (Shalaparni)*, *Punarnava*³. It is noted

that 6 drugs namely *Guduchi*, *Shatavari*, *Punarnava*, *Shalaparni*, *Jivanti*, *Shweta (Aparajita)* are common to both the groups (*Madhuraskandha* and *Vayasthapana dashemani*).

Bala, *Atibala*, *Shravani*, *Mahashravani*, *Rajadana*, *Ashwagandha*, *Vidari*, *Kshiravidari*, *Brihati*, *Kantakari*, *Eranda*, *Yashtimadhu*, *Mridvika*, *Kashmari*, *Sariva*, *Kharjura*, *Parushaka*, *Aatmagupta*, *Gokshura*, *Kakanasa* etc. are the drugs, having *Rasayana* property, which were not included in *Vayasthapana dashemani*.

A list is prepared by including five drugs from each group i.e. drugs uncommon and common between *Madhuraskandha* and *Vayasthapana dashemani*. In the present study, the following ten drugs i.e. *Atibala*, *Vidari*, *Kantakari*, *Eranda*, *Gokshura*, *Guduchi*, *Shalaparni*, *Jivanti*, *Shatavari*, *Punarnava* are selected to formulate a group having *Rasayana* activity.

The World Health Organization (WHO) has appreciated the importance of medicinal plants for public health care in developing nations and has evolved guidelines to support the member states in their efforts to formulate national policies on traditional medicine and to study their potential

usefulness including evaluation, safety, and efficacy. Keeping this in view, attempt has been made to evaluate the pharmacognostical, physicochemical and phytochemical analysis of these ten drugs, to document the qualitative information about the purity and quality.

MATERIALS AND METHODS

Collection of drugs

The drugs were collected in their respective season according to the part used. The details are mentioned in Table 1. All the collected drugs were washed, cleaned and dried in shade for several days.

Preparation of powder

The shade dried drugs were pulverized individually with help of grinder and passed through Mesh no.85 to obtain a fine powder⁴.

Preparation of extracts

About 5g of the test drug powders were macerated with methanol (100ml) in a closed flask for 24 hours with frequent shaking for first 6hrs and kept it for 18 hrs. After 24 hours it was filtered and alcoholic extracts were collected in semisolid form. The same procedure was followed to obtain aqueous extracts of the test drugs⁷.

Organoleptic characters

Organoleptic characters of 10 test drugs such as odor, taste, texture and color were observed.

Powder microscopy

The characteristic of test powder was found by taking pinch of powder on a glass slide. One drop of Chloral-hydrate solution was put on a slide and covered it with a cover slip, heated over a low flame for a short time⁵. The specimen is treated with Phloroglucinol + Conc. HCl (for Calcium oxalate crystal, lignified cell), Ruthenium red (for mucilage), FeCl₃ to (tannin) and Iodine (for starch grains)⁶. The sample was observed under compound microscope (QUASMO, India) at 10X followed by 40X magnification and photographs were taken by using Kodak Easy Share C140, 8.2 megapixel 3x Optical/5x Digital Zoom HD camera. The same procedure is followed for all the ten test samples.

Physicochemical parameters

Physico-chemical parameters like loss on drying, ash value, alcohol soluble extractive and water-soluble extractive values and pH were determined as per the API guidelines for the all the test samples⁷.

Phytochemical parameters

A preliminary phytochemical study of methanolic and aqueous extracts of ten test

drugs was carried out. Presence of various phyto-constituents viz., alkaloids, starch, proteins, amino acids, cardiac glycosides, flavonoids, phenols, saponins, steroids, tannins, phenolic compound and amino acids were evaluated^{8,9}.

Sample coding

All the ten samples are coded as follows: S1- *Abutilon indicum*, S2- *Pueraria tuberosa*, S3- *Solanum xanthocarpum*, S4- *Ricinus communis*, S5- *Tribulus terrestris*, S6- *Tinospora cordifolia*, S7- *Desmodium gangeticum*, S8- *Leptadenia reticulata*, S9- *Asparagus racemosus*, and S10- *Boerhavia diffusa*.

RESULTS

Organoleptic characters

Organoleptic characters of ten test samples i.e., taste, color, odor and texture are mentioned in Table 2. Majority of the drugs are of *Madhura* (Sweet), *Tikta* (Bitter) and *Kashaya* (Astringent) Rasa.

Powder Microscopy

Microscopic characteristics of all the test samples are described in Table 3 (Plate 2 & 3)

Physicochemical parameters

The physicochemical characters like loss on drying, ash value, water soluble extractive

value and alcohol soluble extractive value had been carried out by using crude drugs and pH was determined by using 5% aqueous solution. The results of physicochemical characters are as mentioned in Table 4.

Phytochemical parameters

Qualitative analysis was carried out by using methanolic and aqueous extracts of all test samples. The test samples were evaluated for carbohydrate, amino acids, proteins, starch, protein, alkaloid, tannin, steroid, flavonoids etc. their results are as quoted in Table 5.

DISCUSSION

Powder microscopy of all the test drugs were carried out to identify and authenticate the drugs. Among ten tests drugs, samples namely S1,S2, S4, S6, S7, S9, S10 have shown the presence of simple, compound, with or without hilum starch grains, starch grains with concentric lines; all the test drugs except S3 have revealed the presence of calcium oxalate crystals like prismatic, rosette, acicular and rhomboidal crystals.(Plate 2& 3)

Table 1 Protocol for collection of the *Rasayana* drugs of *Madhuraskandha* (Plate 1)

| No. | Individual drug | Botanical Source | Part Used | Time of collection | Place of collection |
|-----|-------------------|---|---------------|--------------------|-----------------------|
| 1. | <i>Atibala</i> | <i>Abutilon indicum</i> Linn. Sweet | Root | May 2014 | Periphery of Jamnagar |
| 2. | <i>Vidari</i> | <i>Pueraria tuberosa</i> DC. | Tuber | Nov 2014 | Junagadh |
| 3. | <i>Kantakari</i> | <i>Solanum xanthocarpum</i> S. &W | Whole plant | July 2014 | Periphery of Jamnagar |
| 4. | <i>Eranda</i> | <i>Ricinus communis</i> Linn | Root | May 2014 | Periphery of Jamnagar |
| 5. | <i>Gokshura</i> | <i>Tribulus terrestris</i> Linn | Fruit | Oct 2014 | Periphery of Jamnagar |
| 6. | <i>Guduchi</i> | <i>Tinospora cordifolia</i> (Willd.) Miers ex Hook. f. &Thoms | Stem | Sept 2014 | Periphery of Jamnagar |
| 7. | <i>Shalaparni</i> | <i>Desmodium gangeticum</i> DC. | Root | July 2014 | Junagadh |
| 8. | <i>Jivanti</i> | <i>Leptadenia reticulata</i> W. & A. | Leaves | July 2014 | Periphery of Jamnagar |
| 9. | <i>Shatavari</i> | <i>Asparagus racemosus</i> Willd. | Tuberous root | Jun 2014 | Periphery of Jamnagar |
| 10. | <i>Punarnava</i> | <i>Boerhavia diffusa</i> Linn | Root | July 2014 | Periphery of Jamnagar |

The loss on drying of any sample is directly related to its moisture content. If the moisture content is very high in any drug it may affect its preservation. The maximum loss on drying value was found in S5 (10.18 %w/w) followed by S3 (7.71% w/w) and S8 (5.38 %w/w). The ash value indicates the presence of inorganic and salt materials in the samples. The maximum ash value was

found in S3 (15.29%w/w) followed by S7 (15.15%w/w), S1 (13.12%w/w). Extract is a solid or semisolid preparation made by removing the soluble portion of a compound by using water or alcohol as the solvent and evaporating the solution or the active principle of a drug obtained by distillation or chemical processes¹⁰.

Table 2 Organoleptic characters of the *Rasayana* drugs of *Madhuraskandha*

| No | Sample | Botanical Source | Colour | Odour | Taste | Texture |
|-----|-------------------|---|--------------------|----------------------------|------------------------------|--------------------|
| S1 | <i>Atibala</i> | <i>Abutilon indicum</i> Linn. Sweet | Light yellow | Not specific | Sweet, Bitter | Fibrous, coarse |
| S2 | <i>Vidari</i> | <i>Pueraria tuberosa</i> DC. | Yellow | Sweet smell | Sweet | Fine |
| S3 | <i>Kantakari</i> | <i>Solanum xanthocarpum</i> S. &W | Brownish yellow | Sharp/ Pungent smell | Bitter, Pungent | Moderately fine |
| S4 | <i>Eranda</i> | <i>Ricinus communis</i> Linn | Light brown | Not specific | Bitter, Sweet | Fibrous, coarse |
| S5 | <i>Gokshura</i> | <i>Tribulus terrestris</i> Linn | Yellowish brown | Sharp smell | Sweet, Bitter | Moderately fine |
| S6 | <i>Guduchi</i> | <i>Tinospora cordifolia</i> (Willd.) Miers ex Hook. f. &Thoms | Yellowish brown | Bitter smell | Bitter | Moderately fine |
| S7 | <i>Shalaparni</i> | <i>Desmodium gangeticum</i> DC. | Brownish yellow | Woody smell | Astringent | Coarse |
| S8 | <i>Jivanti</i> | <i>Leptadenia reticulata</i> W. & A. | Dark green | Leafy smell | Bitter, Sweet, Astringent | Moderately fine |
| S9 | <i>Shatavari</i> | <i>Asparagus racemosus</i> Willd. | Yellowish brown | Sweet smell | Bitter, Sweet | Smooth |
| S10 | <i>Punarnava</i> | <i>Boerhavia diffusa</i> Linn | Brownish white | Woody smell | Astringent | Coarse |

Table 3 Microscopic characteristics powdered *Rasayana* drugs of *Madhuraskandha* (Plate 2 & 3)

| No | Botanical Source | Part Used | Microscopic characters |
|----|--------------------------------------|-----------|--|
| S1 | <i>Abutilon indicum</i> Linn. Sweet | Root | Simple and compound starch grains with hilum, Pitted, spiral vessels, Cluster crystal, Prismatic crystal, Rhomboidal crystal, Pitted parenchyma cells, lignified fibres, Yellowish content |
| S2 | <i>Pueraria tuberosa</i> DC. | Tuber | Simple starch grain with hilum, Compound starch grain with hilum, Annular vessel, Yellowish content, Fibre, Scaleriform vessel, Fragments of fibre, Acicular crystal, Prismatic crystal, Parenchyma cells filled with starch grain |
| S3 | <i>Solanum xanthocarpum</i> S. &W | Whole | Stellate, multi-branched and warty trichomes; Anisocyte stomata; Pitted, annular vessel, spiral vessels; Oil globule; |

| | | | |
|-----|---|---------------|---|
| | | plant | Septate fibre; Epicarp cells of fruit; Black debris; Cork cells |
| S4 | <i>Ricinus communis</i> Linn | Root | Bordered pitted vessels, Rosette, acicular, prismatic crystal, Septate fibre, fibre with wide lumen, Simple & compound starch grain with hilum, Cortex cell with rosette crystal, Brown content, Cork cell with tannin, Annular and spiral vessel |
| S5 | <i>Tribulus terrestris</i> Linn | Fruit | Trichome, Pluricellulartrichome, Rosette crystal, Epicarp of fruit, Group of fibres, Mesocarp, Spiral vessel, Sclerides, Brown content, Epidermal cell, Stratified fibre, Prismatic crystal, Parenchyma cell with tannin |
| S6 | <i>Tinospora cordifolia</i> (Willd.) Miers ex Hook. f. &Thoms | Stem | Simple and compound irregular shaped starch grain with or without hilum, Prismatic crystal Bordered pitted vessel , Yellow content; brown content, Collenchyma cells, Cork cells, Spiral vessels |
| S7 | <i>Desmodium gangeticum</i> DC. | Root | Cork cells, Prismatic crystal, Rhomboidal crystal, Brown content, Compound starch grain, Pitted vessel, Spiral vessel, Border pitted vessel, Epidermal cells with colouring matter, Group of simple starch grain without hilum, Oil globule, Crystal fibre, Pitted parenchyma |
| S8 | <i>Leptadenia reticulata</i> W. & A. | Leaf | Fragment of multicellular trichome, Epidermal cells with chlorophyll content, Fragments of Spiral vessel, Fragment of stomata along with epidermal cell, Fragment of multicellular warty trichomes, Paracytic stomata, Prismatic crystal, Brown content, Oil globule |
| S9 | <i>Asparagus racemosus</i> Willd. | Tuberous root | Parenchymatous cell; Septate fibre; Acicular, Rod shaped microcrystals; Pitted parenchyma cells; Starch grain with concentric lines; Raphides, Simple starch grain; Filiferous hair; Scleriform vessels, Lignified fibres |
| S10 | <i>Boerhavia diffusa</i> Linn | Root | Acicular crystal, Compound starch grain, Oil globule, Border pitted vessel, Brown content, Prismatic crystal, Cork cell in surface view, Parenchyma cells with starch grain, Bunch of Sclerides ,Stone cells |

Therefore, water soluble extract indicates the total water soluble contents of the drug and methanol soluble extract indicates the total alcohol soluble contents of the drug. In all the test sample water soluble extractive value is more as compared to alcohol soluble extractive value, except in S3 where alcohol soluble extractive value is more than water soluble extractive value. It can be considered that the above drugs can be used in water based dosage forms like decoction, cold infusions, hot infusions; juice etc. pH of the drug determines acidity or alkalinity of drug¹¹. Almost all the test drugs have pH below 7 indicating its acidic nature except S4 and S7 have pH value more than 7 which indicate their alkaline nature. All the test samples except S8 have shown the presence of Carbohydrates followed by reducing sugar, amino acids, proteins, tannin, steroids, triterpenoids, anthraquinone, and saponin.

CONCLUSION

Madhuraskandha's Rasayana drugs may show the presence of starch grains and calcium oxalate crystals. Physicochemical analysis showed that water soluble extractive values of the all the drugs is more than alcohol soluble extractive values, which indicates more water soluble contents like carbohydrates, starch etc. Phytochemically, these drugs show the presence of carbohydrates, reducing sugar, amino acids, proteins, tannin, steroids, triterpenoids, anthraquinone, and saponin, which may be useful for their *Rasayana* activity. Pharmacognostical, Physico-chemical characters and phytochemical parameters may be useful to generate standards for quality and purity of *Madhuraskandha's Rasayana* drugs.

Table 4 Physicochemical characteristics of the *Rasayana* drugs of *Madhuraskandha*

| No | Botanical Source | Part Used | Loss on drying | Ash value | Water soluble extractive value | Alcohol soluble extractive value | pH |
|----|--|-------------|----------------|------------|--------------------------------|----------------------------------|------|
| S1 | <i>Abutilon indicum</i> Linn. Sweet | Root | 4.9% w/w | 13.12% w/w | 6.858% w/w | 4.226% w/w | 6.40 |
| S2 | <i>Pueraria tuberosa</i> DC. | Tuber | 2.29 %w/w | 2.61% w/w | 11.52%w/w | 2.876% w/w | 4.61 |
| S3 | <i>Solanum xanthocarpum</i> S. &W | Whole plant | 7.71% w/w | 15.29% w/w | 5.992%w/w | 8.938% w/w | 6.93 |
| S4 | <i>Ricinus communis</i> Linn | Root | 4.13% w/w | 7.19% w/w | 5.185%w/w | 4.876% w/w | 7.25 |
| S5 | <i>Tribulus terrestris</i> Linn | Fruit | 10.18 %w/w | 8.68% w/w | 7.213%w/w | 6.284% w/w | 6.47 |
| S6 | <i>Tinospora cordifolia</i> | Stem | 4.79 %w/w | 7.61% w/w | 7.020%w/w | 6.232% w/w | 5.25 |

| | | | | | | | | | | | | |
|-----|--|--------------|-----------|------------|-------------|------------|------|--|--|--|--|--|
| | (Willd.) Miers ex Hook. f. &Thoms | | | | | | | | | | | |
| S7 | <i>Desmodium gangeticum</i> DC. | Root | 1.3 %w/w | 15.15% w/w | 10.103% w/w | 6.626% w/w | 7.12 | | | | | |
| S8 | <i>Leptadenia reticulata</i> W. & A. | Leaf | 5.38 %w/w | 12.46% w/w | 29.91% w/w | 10.15% w/w | 6.22 | | | | | |
| S9 | <i>Asparagus racemosus</i> Willd. | Tuberos root | 0.89 %w/w | 3.21% w/w | 36.52% w/w | 22.27% w/w | 4.73 | | | | | |
| S10 | <i>Boerhavia diffusa</i> Linn | Root | 0.47% w/w | 11.95% w/w | 10.58% w/w | 5.936% w/w | 5.13 | | | | | |

Table 5 Preliminary phytochemical characteristics of the *Rasayana* drugs of *Madhuraskandha*

| No | Phyto-constituents | Test performed | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 | S10 |
|-----|--------------------|---|----|----|----|----|----|----|----|----------|----|-----|
| 1. | Carbohydrate | Molish's test | + | + | + | + | + | + | + | - | + | + |
| 2. | Reducing Sugar | Fehling's test | - | + | - | - | - | + | - | - | ++ | + |
| 3. | Hexose sugar | Selwinoff's test | - | - | + | - | - | - | - | T | + | - |
| 4. | Amino acids | Ninhydrin test | - | + | - | - | + | + | + | + | + | + |
| 5. | Alkaloid | Dragondroff's test Hegar's test | - | - | - | - | - | - | - | - | - | - |
| 6. | Starch | Iodine test | - | - | - | - | - | - | - | + | - | - |
| 7. | Protein | Biuret's test Protein containing sulphur | - | - | - | + | + | + | - | - | - | - |
| 8. | Tannin | Lead acetate test FeCl₃ test | + | + | - | - | - | - | - | - | - | - |
| 9. | Steroid | Salkowski test | + | - | + | + | - | + | + | - | - | + |
| 10. | Flavonoids | Zinc HCl test Shinoda test VanilineHCl test Lead acetate | | | + | + | | | + | | | |
| 11. | Cardiac glycoside | Legal's test Baljet test | + | + | + | + | + | + | + | | | |

| | | | | | | | | | | | | |
|-----|---------------|---------------------------|---|---|---|---|---|---|---|---|---|---|
| 12. | Anthraquinone | Borntrreger's test | - | - | - | + | - | + | + | - | - | + |
| 13. | Saponin | Foam Test | - | - | - | - | + | - | - | - | + | - |

[T: Trace; +: Present; - : Absent]



Fig 1 *Abutilon indicum* Linn. Sweet



Fig 2 *Pueraria tuberosa* DC



Fig 3 *Solanum xanthocarpum* S. & W



Fig 4 *Ricinus communis* Linn



Fig 5 *Tribulus terrestris* Linn



Fig 6 *Tinospora cordifolia* (Willd.) Miers ex Hook. f. & Thoms



Fig 7 *Desmodium gangeticum* DC

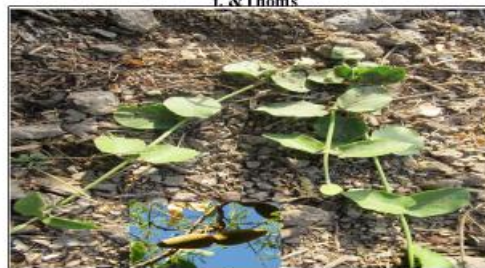


Fig 8 *Leptadenia reticulata* W. & A.



Fig 9 *Asparagus racemosus* Willd



Fig 10 *Boerhavia diffusa* Linn

Plate no.1 Madhuraskandha Rasayana drugs in their natural habitat



Fig 1 Powder of *A. indicum* root



Fig 2 compound starch grain



Fig 3 Prismatic crystal



Fig 4 Powder of *P.tuberosa* tuber

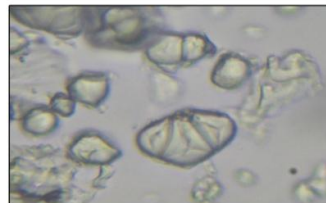


Fig 5 Compound starch grains

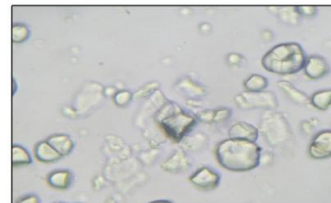


Fig 6 Prismatic crystal



Fig 7 Powder of *S.xanthocarpum* W.P.



Fig 8 Stelletate trichome



Fig 9 Lignified Pitted vessel

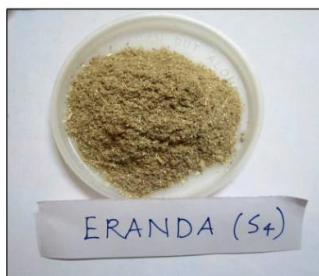


Fig 10 Powder of *R.communis* root



Fig 11 Simple starch with hilum



Fig 12 Acicular crystal



Fig 13 Powder of *T.terestrifruit*



Fig 14 Simple starch grain



Fig 15 Rosette crystal

Plate no.2 Powder microscopical characters of Madhuraskandha's Rasayana drugs (S1-S5)

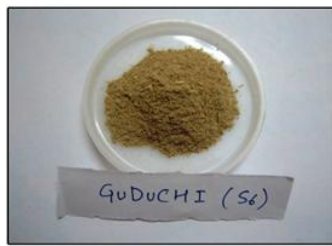


Fig 1 Powder of T.cordifolia stem



Fig 2 Simple starch grain

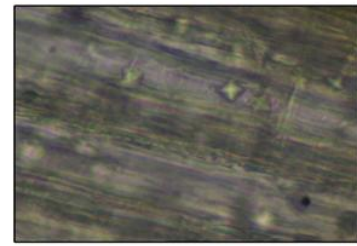


Fig 3 Crystal fibre



Fig 4 Powder of D.gangeticum root

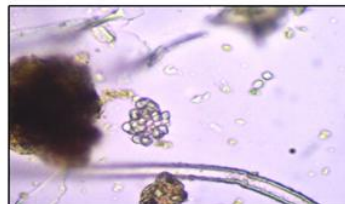


Fig 5 Simple starch grains

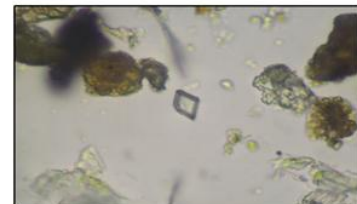


Fig 6 Diamond shaped Prismatic crystal



Fig 7 Powder of L.reticulata leaves

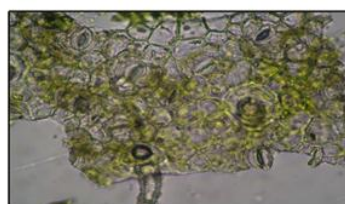


Fig 8 Anisocyste stomata

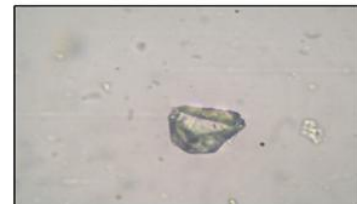


Fig 9 Prismatic crystal



Fig 10 Powder of A.racemosus root



Fig 11 Simple starch with hilum



Fig 12 Raphides



Fig 13 Powder of B.diffusa root

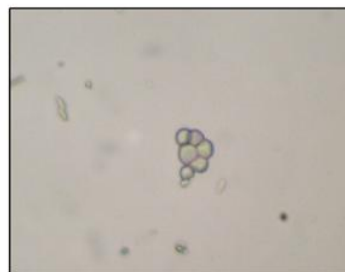


Fig 14 Simple starch grain



Fig 15 Acicular crystal

Plate no.3 Powder microscopical characters of Madhuraskandha's Rasayana drugs (S6-S10)

REFERENCES

- Health & FW, Dept. of ISM and H; 213-14
1. Yadavaji Trikamaji Acharya, editor, Cakrapanidatta, commentator (2009). Carakasamhita, Vimanasthana 8/138, 1st reprint edition, Varanasi: Chaukhambha Surbharati Prakashana; 283
 2. Yadavaji Trikamaji Acharya, editor, Cakrapanidatta, commentator (2009). Carakasamhita, Sutrasthana 26/42, 61, 1st reprint edition, Varanasi: Chaukhambha Surbharati Prakashana; 144, 146
 3. Anonymous (2003). Ayurvedic Formulary of India, Part I, Vol I, 2nd edition, New Delhi: Govt. of India publication, Ministry of Health & FW, Dept. of ISM and H; 302
 4. Yadavaji Trikamaji Acharya, editor, Cakrapanidatta, commentator (2009). Carakasamhita, Sutrasthana 4/18, 1st reprint edition, Varanasi: Chaukhambha Surbharati Prakashana; 34
 5. Anonymous (1999) The Ayurvedic Pharmacopoeia of India, Part I, Vol. I, Appendix 2, 1st edition, New Delhi, Govt. of India publication, Ministry of Health & FW, Dept. of ISM and H; 207
 6. Krishnamurthy K V (1988). Method in the Plant Histochemistry. Madras: Vishwanandan Pvt. Ltd; 1-77
 7. Anonymous (1999) The Ayurvedic Pharmacopoeia of India, Part-I, Vol. 1-4, New Delhi, Govt. of India, Ministry of
 8. Shukla V.J., Bhatt U.B. (2001). Methods of Qualitative Testing of some Ayurvedic Formulations. Jamnagar, Gujarat Ayurved University; 5-10.
 9. K. R. Khandelwal (2008). Practical Pharmacognosy-techniques and experiments, 19th Edition, Pune, Nirali Prakashan; 149-156
 10. Donald Venes, Editor, Clayton L. (Eds.) Thomas, Clayton L. Thomas, Editor (2005). Taber cyclopaedic medical dictionary, 20th edition, Philadelphia, PA, F. A. Davis Company; 762.
 11. Donald Venes (Editor), Clayton L. (Eds.) Thomas, Clayton L. Thomas, Editor (2005). Taber cyclopaedic medical dictionary, 20th edition, Philadelphia, PA, F. A. Davis Company; 1647.