ORIGINAL ARTICLE

Physicochemical optimization and nutritional assessment of *Balachaturbhadrika Sharkara* prepared using different sweetening agents

Nikita Sharma[1], Chinky Goyal[2], Amrit Malik[3], Sudhir Malik[4], Shivani Rawat[5], Amandeep Kaur[6], Jadhav Viraj Vilas[7]

[1]Department of Roga Nidan, Saraswati Ayurved Hospital and Medical College, Gharuan, Mohali, Punja, India, [2]Department of Rasa Shastra and Bhaishjya Kalpana, Saraswati Ayurved Hospital and Medical College, Gharuan, Mohali, [3]Department of Agad Tantra, Shri Dhanwantry Ayurvedic College and Hospital, Chandigarh, India, [4]Department of Bala Roga, Shri Krishna Government Ayurvedic College, Kurukshetra, Haryana, India, [5]Medical Officer, Dehradun, Uttarakhand, India, [6]Department of Samhita and Siddhanta, Saraswati Ayurved Hospital and Medical College, Gharuan, Mohali, Punjab, India, [7]Principal, Saraswati Ayurved Hospital and Medical College, Gharuan, Mohali, Punjab, India

Abstract

Introduction: *Baalchaturbhadra churna* is a customary utilized formulation in children described by A*charya Chakradatta* in *Jwaratisara* having four ingredients, namely, *Ghana* (Cyperusrotundus), *Krishna* (Piper longum), *Aruna* (Aconitum heterophyllum), and *Shringi* (Pistaciaintegerrima). It is very difficult to administer bitter drugs to children; hence, *Baalchaturbhadra Sharkara* was formulated. **Material and Methods:** After authentication of raw material using different analytical parameters including thin layer chromatography (TLC), four samples of *Balachaturbhadrika Sharkara* with divergent sweetening mediums, namely, Sugar (BCS1), Jaggery (BCS2), Honey (BCS3), and Stevia (BCS4) were prepared and analyzed on various physicochemical and phytochemical parameters as well as nutritional value. **Results:** Raw material analytical standards were found to be in accordance with pharmacopoeial standards and TLC identification also gave positive results for the respective drug. Respective values of all the four samples were found to be pH – 4.36, 4.16, 4.13, 4.57, viscosity – 11.59, 12.2, 11.08, 4.11, specific gravity – 1.27, 1.28, 1.28, 1.0411, refractive index – 1.45, 1.47, 1.45, 1.40, total solid content – 67.21, 67.12, 67.86, 6.92, total sugar content – 66.7%, 67%, 66.8%, nil, reducing Sugars – 59.81%, 65.11%, 63.01%, Nil, non-reducing sugars – 6.81%, 1.69%, 3.99%, nil. No alcohol content, heavy metals and aflatoxins were detected in any of the samples. Nutritive value showed % carbohydrate – 2.595, 2.688, 2.252, nil, % fat – 0.009, 0.011, 0.013, 0.008, % protein – 0.054, 0.0495, 0.66, 0.057, and energy – 10.67, 11.05, 9.4, 0.3 KCal. Total microbial load was also found to be in permissible limit. **Conclusion:** Physicochemical data of *Balachaturbhadrika Sharkara* were set in as a quality specification for the same and *Sharkara* prepared with stevia can also be useful in diabetes patients due to its low calorific value.

Key words: *Balachaturbhadrika Sharkara*, nutritional value, *Sharkara,* sweetening agents, syrup

INTRODUCTION

Sharkarakalpana (Syrup) came into existence in 20th century in context of *Banapshasharkara* in *Pittaja Jwara* by *Acharya Krishnaram Bhatt* and its reference is also found in *Dravyaguna Vigyaniyam Uttrardha* by *Acharya Yadavji Trikamji*.[1] It is a secondary formulation derived from the *Panchvidha Kashaya Kalpana* with the help of Sugar. Liquid dosage forms in comparison

Address for correspondence:
Dr. Chinky Goyal, Associate Professor and HOD, Department of Rasa Shastra and Bhaishjya Kalpana, Saraswati Ayurved Hospital and Medical College, Gharuan, Mohali, Punjab, India.
Mobile: +91-9815144152.
E-mail-chinkygoyal52@gmail.com

Received: 21-04-2023
Revised: 10-06-2023
Accepted: 17-06-2023

are easy to consume, are palatable, and are more acceptable by almost all the strata of patients including non-responsive ones. Concerning the potency, it is evinced that liquids act quicker than solids due to their brisk absorption.

Acharya Charaka connoted that the drugs to be administered in children should possess *Kashaya*and *Madhura Rasa*. Among modern dosage forms also, suspension and syrup can overcome nearly all the shortcomings of solid dosage forms especially for administration to children without much degressing from *Ayurvedic* postulates of pharmaceutics.[2]

Balachaturbhadra churna (BC) is a customary utilized formulation described by A*charyaChakradatta* in *Jwaratisara*. It is a kindred concoction of fine powders of *Ghana* (*Cyperusrotundus*), *Krishna* (*Piper longum*), *Aruna* (*Aconitum heterophyllum*), and *Shringi* (*Pistaciaintegerrima*).[3] Syrups are liquid preparations of drugs having ample aggregate of sucrose, either to safeguard them or to make their utilization easier.

MATERIALS AND METHODS

In the present study, the *Balachaturbhadrika Sharkara* formulated using four different sweeting agents, namely, sugar, honey, stevia, and jaggery were analyzed on various physicochemical parameters to develop some evidence-based data regarding the same.

Preparation of *Balachaturbhadrika Sharkara*

Balachaturbhadrika churna was prepared into *Sharkara* form by maintaining its sucrose percentage 66.7 g/100 mL as per the reference given by Indian Pharmacopoeia. The ratio of jaggery in the syrup has been taken from *vatikalpana*, use of double quantity of jaggery gives 66.7% sugar in the syrup. Keeping same object of sucrose concentration in concern honey was mixed four times than decoction. As stevia is non-caloric sweetener, its concentration is maintained according to the palatability and as per the sweetness concentration compared to sugar. Decoction was prepared after overnight soaking of drugs in required quantity of water which was further filtered with muslin cloth. Afterward, mentioned quantity of sweetening agents was added to the decoction and heating process was carried out on mild temperature (not more than 70°C) till the proportion of liquid is reduced to the initial quantity taken. Then, the solution was filtered through stainless steel strainers, the final product was measured and stored at room temperature in amber colored glass bottles.

Physicochemical Characterization

Analytical tests as specified in Table 1 were carried out at Interstellar Testing Centre, Panchkula (Haryana).

Total ash value

Incinerate about 2 g accurately weighed, of the pretext drug in a tared silica or platinum dish at not more than 4500 temperature until free from carbon, cool, and weigh. One more way to achieve carbon free ash is to exhaust the scorched mass with hot water, cumulate the residue on an ash less filter paper, carbonize the residue and filter paper, put in the filtrate, volatilize to dryness, and burn up at a temperature not more than 4500. Calculate the percentage of ash in accordance to the air-dried drug.

The percentage of total ash in the herbal drug was calculated as:
Weight of empty crucible= X g
Weight of empty crucible + sample =Y g
Weight of crucible + ash = Z g

$$\% \text{ of ash content} = \left(\frac{\text{Weight of ash / weight of sample}}{Z - X / Y - X} \right) \times 100$$

Acid-Insoluble Ash

Add 25 mL of dilute hydrochloric acid to the crucible with total ash. Cumulate the indissoluble matter on an ashless filter paper (Whatman 41) and wash with hot water until the filtrate is neutral. Shift the filter paper with in dissoluble matter to the primary crucible, dry it, and scorch to consistent weight. Let the residue to cool in a desiccator for ½ h and weigh immediately. Enumerate the content of acid-insoluble ash in accordance to the air-dried drug.

$$\text{Percentage ofacidinsoluble ash} = \left(\frac{Z - X}{Y - X} \right) \times 100$$

Where:
Z−X = Weight of acid insoluble ash, Y−X = Weight of herbal drug
X = Weight of silica crucible, Y = Weight of silica crucible + drug
Z = Weight of silica crucible + acid insoluble ash

Alcohol Soluble Extractive

Coarse powder of 5 g air dried drug was macerated with 100 mL of alcohol in a closed flask for 24 h, with consistent shaking during 6 h and allowing standing for 18 h. Filter swiftly, taking care of solvent damage, evaporate 25 mL of the filtrate to dryness in a tared flat dish, and dry at 1050, to consistent weight and weigh. Enumerate the percentage of alcohol-soluble extractive in accordance to the air-dried drug

Water Soluble Extractive

Same procedure as described for the enumeration of alcohol-soluble extractive, whereby chloroform-water is used instead of ethanol.

pH

The pH of the formulation was determined using Digital pH meter.[4]

Specific Gravity

The weight difference method was used for specific gravity determination. 10 mL of water (at 25°C) was taken into a clean, parchedpycnometer, and weighed. It was vacated, scorched and again; 10 mL of each sample was filled in the same pycnometer and weighed at same constant temperature. Specific gravity of the sample was determined by fractionating the weight of the sample by the equal weight of water (at 25°C).[5]

Refractive Index

The refractive index was conveniently measured using the Abbe refractometer at 25°C employing the wavelength of the D line of sodium (λ = 589.3 nm), after calibrating the apparatus against distilled water whose nD20 at 25ºC was 1.3225.[6]

Reducing Sugars

20 mL of sample was neutralized with sodium hydroxide and was then evaporated to half volume on water bath to remove alcohol. After cooling 10 mL of 21.9 g zinc acetate, 3 mL glacial acetic acid followed by 10.6 g potassium ferrocyanide was added and volume was made up to 100 mL with distilled water. To the fehling solution (10 mL), burette solution was added drop wise. It was boiled till blue color. Further two droplets of methylene blue were added and titration was carried out till the appearance of brick red color.[7]

Non-reducing Sugars

20 mL of sample was mixed with equal amount of distilled water and further boiled for 30 min. The solution was cooled and adjusted to pH 7. The volume was further made up to100 mL by addition of distilled water. To the fehling solution (10 mL), solution from burette was added drop wise. It was heated to boiling till blue color appeared, over the hot plate. Then, two droplets of methylene blue were added and the titration was carried out till the appearance of brick red color.[7]

Total Solid Content

It means the remnants acquired when desired amount of the drug is scorched to a consistent weight under controlled conditions. 50 ml of sample was accurately shifted in an evaporating dish and was evaporated to a thick extract using water bath. Extract the residue with 4 quantities, each of 10 mL, of dehydrated ethanol with stirring and filter it. Merge the filtrates to one more evaporating dish that have been scorched to consistent weight and volatilize nearly to scorches on water bath. Put in accurately 1 g of diatomite, agitate rigorously, and scorch at 105°C for 3 h. Cool it in a desiccator for ½ h and weigh instantly. Deduct the weight of diatomite added, the weight of residue is noted as total solid content of the sample.[8]

Heavy Metal Analysis

Heavy metals were determined by atomic absorption spectrophotometry-vapor generation analysis.[9]

Test for Aflatoxins

Aflatoxins content was determined by high-performance liquid chromatography (HPLC).[10]

Test for Specific Pathogens

Test for the presence of *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa,* and Salmonella species was conducted as per methods given in API.[11]

Microbial Load

Total fungal and bacterial count was estimated as per API.[12]

Nutritive Value

Enumeration of crude fat using soxhlet apparatus, proteins by Lane and Eynon's Method, carbohydrates by Kjeldahl Method, and energy by calculation method was done.[13]

OBSERVATIONS AND RESULTS

Tables 2-6.

DISCUSSION

Discussion is the main step in any research. It is the process of examining the facts through their merits and demerits to obtain proper knowledge about the facts, a theory can be accepted only after proper reasoning of observations. To reach up to the depth of the knowledge, the discussion is the

Table 1: Physicochemical parameters

Raw material analysis	Finished product analysis
Total ash value	pH
Acid insoluble ash	Viscosity
Alcohol soluble extractive	Refractive index
Water soluble extractive	Alcohol content
Identification (by TLC)	Total sugar content
	Reducing sugar
	Non-reducing sugar
	Total solid content
	Test for heavy metals viz. Pb, Cd, As, Hg
	Microbial count - Total fungal and bacterial count
	Test for specific pathogen viz. *Escherichia coli*, Salmonella spp. *Staphylococcus aureus*, *Pseudomonas aeruginosa*
	Test for aflatoxins
	Nutritional value

TLC: Thin layer chromatography

Table 2: Physicochemical analysis of Raw Material

Parameter	*Nagarmotha*	*Pippali*	*Ativisha*	*Karkatshringi*
Total ash	6.10% w/w	5.89% w/w	1.32% w/w	1.50% w/w
Water soluble extractive	13.35% w/w	9.10% w/w	26.65% w/w	34.3% w/w
Alcohol soluble extractive	6.69% w/w	7.75% w/w	8.20% w/w	31.0% w/w
Acid insoluble ash	1.01% w/w	0.07% w/w	0.09% w/w	0.13% w/w
Identification (by TLC)*	Positive	Positive	Positive	Positive

*Mobile Phase: Toluene ethyl acetate (Scanning at 254 nm and 3666 nm). TLC: Thin layer chromatography

Table 3: Organoleptic parameters of samples of *Balachaturbhadrika Sharkara*

Parameter	BCS1	BCS2	BCS3	BCS4
Rupa (Colour)	Dark brown	Dark brown	Dark brown	Light brown
Rasa (Taste)	*Madhura* (+++)	*Madhura* (+++)	*Madhura* (+++)	*Madhura* (+++)
Gandha (Odour)	Smell of *Shringi*	Smell of *Shringi*	Smell of *Shringi*	Smell of *Shringi*
Sparsha (Consistency)	Syrupy viscous	Syrupy viscous	Syrupy viscous	Dilute

Table 4: Physicochemical parameters of samples of *Balachaturbhadrika Sharkara*

Parameter	BCS1	BCS2	BCS3	BCS4
pH	4.36	4.16	4.13	4.57
Viscosity (cSt)	11.59	12.2	11.08	4.11
Specific gravity	1.27	1.28	1.28	1.0411
Refractive index	1.4476	1.4664	1.45567	1.4024
Alcohol content	Nil	Nil	Nil	Nil
Total sugar content % w/v	66.7	67	66.8	Nil
Reducing sugar % w/w	59.81	65.11	63.01	Nil
Non-reducing sugar % w/w	6.81	1.69	3.99	Nil
Total solid content	67.21	67.12	67.86	6.92

important step which helps in understanding the subject and guides to exclusive judgment. Analyzing of the final product will help to fix and confirm the quality of the finished product. There should not be much variation; otherwise, it shows the

Table 5: Total microbial load of samples of *Balachaturbhadrika Sharkara*

Test	BCS1	BCS2	BCS3	BCS4	Normal Limit
Total bacterial count (Cfu/ml)	172	177	150	165	1×10^5 cfu/mL
Total fungal count (Cfu/ml)	<1	<1	<1	<1	1×10^3 cfu/mL

Table 6: Nutritive value of samples of *Balachaturbhadrika Sharkara*

% value	BCS1	BCS2	BCS3	BCS4
Fat content	0.009	0.011	0.013	0.008
Protein content	0.054	0.0495	0.066	0.057
Carbohydrate content	2.595	2.688	2.252	NIL
Energy (Kcal)	10.677	11.0499	9.389	0.3

difference in the quality of the end product. Hence, analysis should be compulsory adopted. Physical and chemical standards help to evaluate the samples.

Raw material analytical standards were found to be in accordance with pharmacopoeial standards and thin layer chromatography identification also gave positive results for the respective drug as given in Table 2. Observation of organoleptic features from Table 3 also gave better ideas regarding the end product. All the samples of *BalachaturbhadrikaSharkara* were well identified by its color and consistency. *Sharkara* and jaggery-based syrups were dark brown in color simultaneously syrup prepared with the help of honey was light brown in color, stevia-based syrup was dilute in nature and taste of all the samples was sweet followed by pungent taste on the tongue as depicted in Table 4. The pH of all the samples with different sweetening agents was very similar to each other which shows that no other organic compound is performed. The pH of the stevia-based syrup was little higher than others but all the samples of were acidic in nature. The amalgamation of sweetening medium in decoction is expected to change their specific gravity. As the data show that the specific gravity of all the samples increased but the increase of specific gravity in stevia-based syrup is markedly less as compared to the other ones. The refractive index of any drug is the quotient of the velocity in the substance. From the analytical study, it was evaluated that the refractive index varies from 1.4024 to 1.4664, the range of refractive index is highest in Sample 2 and lowest in Sample 4. Specific gravity and refractive index are closely related because whenever the specific gravity increased, the thickness or viscosity increases there by increasing the refractive index. The standard value of the sugar % w/v in sugar, jaggery, and honey-based syrup in all the sample is 66.7% and the stevia-based syrup is sugar and carbohydrate free. The average reducing sugar percentage of all the syrup samples is 62.64. The *Sharkara* prepared with the help of honey shows highest range of reducing sugar percentage. The high reducing sugar content might be due to lesser or negligible conversion of sugar into alcohol. The non-reducing sugar percentage is highest in sugar-based syrup followed by honey and jaggery. Total solids indicate the amount of active constituents present in the sample, extractables in aqueous media as shown in Table 5. Heavy metals are not detected by Atomin Absorbance Spectrophotometer in any of the samples. The test of Aflatoxins by HPLC method showed complete absence of Aflatoxins in all the samples. No pathogens were detected in all the samples. As per microbial load results, every sample was having microbial content under the permissible limit as shown in Table 6. The *Sharkara* with jaggery shows more calories than sugar and honey and the calories are very low in the stevia based sample as specified from Table 6.

CONCLUSION

Physicochemical data of *Balachaturbhadrika Sharkara* were set in as a quality specification for the same and *Sharkara* prepared with stevia can also be useful in diabetes patients due to its low calorific value.

REFERENCES

1. Kapila A, Goyal C, Malik A, Rawat S. A review on Sharkara Kalpana W.S.R to syrups. Int J Green Herbal Chem 2021;10:311-8.
2. Goyal C, Sharma KC, Gupta AK. Stability testing of ayurvedic formulations: Exigency of today's world. Int J Green Pharm 2017;11:S338.
3. Goyal C, Bhatt P, Rawat S, Sharma VK, Ahuja MR. Estimation of shelf-life of *Balachaturbhadrika* syrup containing different sweetening agents. Res J Pharm Technol 2022;15:622-9.
4. Govt. of India, Ministry of Health and Family Welfare. Indian Pharmacopoeia, New Delhi: Controller of Publications; 1996. Appendix 8.11.
5. Ayurvedic Pharmacopoeia of India, PartII (Formulations). Vol. 1. New Delhi: Ministry of Health and Family Welfare, Government of India; 2008. Appendix 3.2.
6. Ayurvedic Pharmacopoeia of India, PartII (Formulations). Vol. 1. New Delhi: Ministry of Health and Family Welfare, Government of India; 2008. Appendix 3.1.
7. Govt. of India. Ayurvedic Pharmacopoeia of India. Part II. Vol. 2. New Delhi: Ministry of Health and Family Welfare, Government of India; 2008.
8. Ayurvedic Pharmacopoeia of India, PartII (Formulations). Vol. 1. New Delhi: Ministry of Health and Family Welfare, Government of India; 2008. Appendix 3.8.
9. Ayurvedic Pharmacopoeia of India, PartII (Formulations). Vol. 1. New Delhi: Ministry of Health and Family Welfare, Government of India; 2008. Appendix 2.3.7.
10. AOAC Official Method of Analysis. In: Official Methods of Analysis of AOAC International. 17th ed. Washington

DC: AOAC Official Method of Analysis; 2000. p. 990.
11. Ayurvedic Pharmacopoeia of India, Part II (Formulations). Vol. 1. New Delhi: Ministry of Health and Family Welfare, Government of India; 2008. Appendix 2.4.2.
12. Ayurvedic Pharmacopoeia of India, Part II (Formulations). Vol. 1. New Delhi: Ministry of Health and Family Welfare, Government of India; 2008. Appendix 2.4.1.
13. Goyal C, Joshi N, Sharma KC. Physico-chemical standardization and nutritional assessment of devdarvadyarishta. J Ayurveda 2022;16:126-3.

Source of Support: Nil. **Conflicts of Interest:** None declared.