ISSN: 2249- 5746
International Journal of Ayurvedic and Herbal Medicine 15:3 (2025) 4954-4964
Journal homepage: http://www.interscience.org.uk
DOI: 10.47191/ijahm/v15i3.05
Impact Factor: 8.254

Indigenous "green" synthesis methods of incinerated Gold nanoparticles (*Swarna Bhasma*): A review

Dr. Lekshmi C S
Assistant professor, Department of RSBK, Institute of Teaching and Research in Ayurveda, Jamnagar

ABSTRACT: The convergence of traditional Ayurvedic alchemy and modern nanotechnology opens new avenues for understanding and optimizing therapeutic formulations like Swarna Bhasma (incinerated gold). This review explores the indigenous process of Swarna Marana in Ayurveda and juxtaposes it with contemporary green synthesis methods for gold nanoparticles. Classical Ayurvedic texts were systematically reviewed to identify 19 plant-based media used in the traditional incineration of gold, while a thorough PubMed search revealed 45 plants currently explored in the green synthesis of gold nanoparticles. Notable overlaps and unexplored opportunities were observed, particularly in phytochemicals such as alkaloids and flavonoids that contribute to nanoparticle formation and stabilization. The review highlights that while green synthesis adopts a bottom-up approach using metal salts, Marana employs a top-down strategy starting from elemental gold, yet both converge toward producing bioactive and biocompatible nanogold. The findings support the hypothesis that classical methods are inherently aligned with green chemistry principles. A call for interdisciplinary collaboration is made to explore the therapeutic potential of classical plant media in modern nanoparticle synthesis, ensuring safer, cost-effective, and environmentally friendly alternatives for future biomedical applications.

INTRODUCTION

The emerging field of nanotechnology has opened ways for Ayurveda to expand the therapeutic applications of its formulations, especially the range of indigenous nanomedicines. *Bhasma* are formulations which are sought for their enhanced therapeutic efficacy delivered in low doses. Even though these formulations show significant therapeutic efficacy in clinical settings, their mode of action remain unexplored. The postulation of a core shell model for metallic *Bhasma*, especially in the context of *Lauha Bhasma* leads to an assumption of an organometallic complex being formed on the core, which is the metal nanoparticle.[1] The formation of a metal organic framework in such formulations cannot be neglected because of the complex pharmaceutical procedures and treatments with a variety of plant extracts.[2] Green synthesis of metal nanoparticles is a new perspective in nanotechnology, which makes use of the same principle of plant extracts. They differ from the indigenous method of preparation of *Bhasma* because of the fact that metal salts are reduced to metal nanoparticles in green synthesis.[3] The scientific community is in constant search for novel phytochemicals which can aid in the formation of stable metal and metal oxide nanoparticles. The classical *Rasashastra* literature has ample number of plant extracts enlisted for the preparation of *Bhasma*. Gold nanoparticles are at present highly sought for their wide range of applications in medicine viz., diagnostics, photothermal therapy, photodynamic therapy, and as effective drug carriers. Similar to the therapeutic possibilities enlisted in Ayurvedic classics for *Swarna Bhasma* in the field of immunology, gold nanoparticles are being studied and proved as a good therapeutic agent in boosting the non-specific immunity in humans.[4] The plant extracts

used for the synthesis of gold nanoparticles do have several phytochemical constituents like alkaloids and flavonoids which aid in the synthesis of the same.[5] Similar to this process, *Marana* (incineration) is a pharmaceutical process in which elemental gold is converted to nanoparticles. While green synthesis is a bottom up approach, the process of *Marana* can be thought of as a top down. Thus, this paper is an attempt to explore the current state of knowledge in the field of green synthesis of gold nanoparticles and to compare the same with the references the classical Ayurvedic textbooks.

MATERIALS AND METHODS

50 textbooks from Classical Ayurveda literature were searched thoroughly and reviewed to compile the different methods of *Marana* (incineration) adopted for the preparation of *Swarna Bhasma* using herbal extracts. The current state of knowledge and advancements on green synthesis of Gold nanoparticles were compiled through and thorough and systematic search of database with the help of PubMed. The search strategy included the following keywords combined with 'AND' as the Boolean operator. The keywords used were *Ayurved*, *Ayurveda*, *Swarna*, *Bhasma*, Gold nanoparticles and Green synthesis. Reviews and Original research published within the past 10 years were compiled and reviewed thoroughly.

RESULT

The search for the number of plant extracts explored for their application in green synthesis of gold nanoparticles yielded 45 plants with the part of the plant used for preparation of the extract. Classical literature mentions 19 plant extracts for the preparation of *Swarna Bhasma*. These plant extracts are specifically used for trituration, which is an important pharmaceutical process in the preparation of *Bhasma*. The details of the results obtained from PubMed are enlisted in Table 1, while the results of the classical literature search have been tabulated in Table 2.

DISCUSSION

On critically analysing the data obtained from the review, it was observed that majority of the plants selected for green synthesis belong to the following families, i.e., Fabaceae, Rutaceae and Malvaceae. The extract of leaves is used predominantly in the process. All three families have Alkaloids and Saponins in abundance as the major phytoconstituents. [6] This observation has been made in many a number of original researches done in the field of green synthesis of metal nanoparticles. Importance of the process of *Marana* and *Bhasma* can be elucidated in the light of studies which show the metal nanoparticles produced by plants are more stable and bioactive in comparison with those produced by extracts of specific phytoconstituents of plants.[7] Comparison of the plants enlisted in classics versus plants explored in the area of green synthesis leads us to a newer and broader understanding that many a number of plants remain unexplored for their potential in the synthesis of nanoparticles. While chemical synthesis methods still exist for synthesis of gold nanoparticles , the toxic by products that might get incorporated into the synthesised nanomaterial poses a major concern. Green synthesis methods not only help us to overcome this confounding toxic by product synthesis, but also helps in cost effective synthesis if safe and stable gold nanoparticles.[8] *Swarna Bhasma*, which can be termed as the incinerated gold nanoparticles, have been found cytocompatibility as well as compatible with all the blood components in previous studies indicating the absence of any toxic by products in the formulation. [9] This also supports the previous findings obtained from researches conducted using green synthesis method.

CONCLUSION

The world is turning towards green and safe methods for synthesis of materials which are to be used therapeutically in the human body. Development of green synthesis technology for production of metal

nanoparticles not only ensures its biological safety but also ensures an environment friendly synthesis technique. Ayurveda, especially the field of Rasashastra has a lot to offer in this regard with an abundant reservoir of knowledge in the form of classical scriptures. The plants mentioned in classics can be studied for their potential in the synthesis of such nanomaterials, especially for gold nanoparticles due to its wide range of applications in medicine. An interdisciplinary and collaborative research process with experts from both the fields can definitely give interesting outputs which shall benefit mankind.

Table 1: Plants explored in green synthesis of Gold nanoparticles

Sl. No.	Plant name	Family	Part
1	*Artemisia vulgaris*[10], *Coreopsis lanceolate*[11]	Asteraceae	Leaves
2	*Clitoria ternatea*[12], *Cassia auriculata*[13], *Cassia tora*[14]	Fabaceae	Leaves
3	*Murraya koenigii* [15]	Rutaceae	Leaves
4	*Artocarpus hirsutus*[16]	Moraceae	Leaves
5	*Justicia glauca*[17]	Acanthaceae	Leaves
6	*Terminalia arjuna*[18]	Combretaceae	Leaves
7	*Memecylon umbellatum*[19]	Melastomataceae	Leaves
8	*Mangifera indica* [20]	Anacardiaceae	Leaves
9	Olive[21]	Oleaceae	Leaves
10	*Lonicera Japonica*[22]	Caprifoliaceae	Flower
11	*Nyctanthes arbortristis*[23]	Oleaceae	Flower
12	*Guazuma ulmifolia*[24]	Malvaceae	Bark
13	*Salix* [25]	Salicaceae	Bark
14	*Acacia nilotica*[26]	Fabaceae	Bark
15	*Musa paradisiaca*[27]	Musaceae	Peel
16	*Lantana camara*[28]	Verbenaceae	Fruit
17	Citrus (Lemon, tangerine, orange)[29], *Citrus maxima*[30]	Rutaceae	Fruit
18	Pear[31]	Rosaceae	Fruit
19	*Sterculia acuminate* [32]	Malvaceae	Fruit
20	*Pistacia integerrima*[33]	Anacardiaceae	Galls
21	*Abelmoschus esculentus*[34], *Theobromo cacao*[35]	Malvaceae	Seed
22	*Hevea brasiliensis*[36]	Euphorbiaceae	Latex
23	*Zingiber officinale*[37], *Curcuma longa* [38]	Zingiberaceae	Rhizome
24	*Panax ginseng*[39]	Araliaceae	Rhizome
25	*Acorus calamus*[40]	Acoraceae	Rhizome
26	*Areca catechu*[41]	Arecaceae	Nut
27	*Momordica cochinchinensis*[42]	Cucurbitaceae	Biomass
28	*Macrotyloma uniflorum*[43]	Fabaceae	Whole plant
29	*Salvia officianalis*[44]	Lamiaceae	Leaves

30	*Dendrobium officianale*[45]	Orchidaceae	Powder
31	*Garcinia mangostana*[46]	Guttiferae	Pericarp
32	*Delphinium chitralense*[47]	Ranunculaceae	Tuber
33	*Cretaegus oxycantha*[48]	Rosaceae	Twigs
34	*Ligustrum vulgare*[49]	Oleaceae	Berry
35	*Tamarindus indica*[50]	Fabaceae	Seed
36	*Capsicum chinense*[51]	Solanaceae	Leaves
37	*Punica granatum*[52]	Lythraceae	Fruit
38	*Pelargonium graveolens*[53]	Geraniaceae	Leaves
39	*Lippia citriodora*[54]	Verbenaceae	Leaves

Table 2: Plants mentioned in classics for Swarna Marana;

Sl.No.	Media	Botanical name	Family name	Reference
1	*Arkakshira*	*Calotropis procera*	*Apocynaceae*	Ras. Sa. Sa.[55], Ra. Ta.[56], Bha. Pra[57], Aa.Ve.Pra[58], Sha. Sam. [59]
2	*Nimbu*	*Citrus limon*	*Rutaceae*	Ras. Sa. Sa [60], Aa.Ve.Pra [61], [62],Bhava Prakasha[63], Ras. Amr.[64], Yo.Rat[65], Sha. Sam.[66], Ras. Chu.[67], Ra. Rat[68], Ra Pra Su [69], Ras.Chu[70], Ra. Ta.[71], R.R.S[72],Ba. Ra.[73], A.K[74], Bha. Pra[75], Yo.Rat[76]
3	*Jambira Nimbu*	*Citrus medica*	*Rutaceae*	R.R.S [77] ,Ras. Pa.[78], Ras. Amr.[79], Ra. Pra.Su[80]
4	*Kanchanara*	*Bauhinia variegata*	*Fabaceae*	Ras. Pa.[81], Ras. Amr.[82],Aa. Ve. Pra[83], Bha. Pra[84], Aa. Ve. Pra[85], Sha. Sam. [86], Ras. Chu.[87], Aa. Ve. Pra[88], Ra. Ta.[89]
5	*Tulasi*	*Ocimum tenuiflorum*	*Lamiaceae*	Ras. Amr.[90], Bha. Vig.[91]
7	*Vajridugdha*	*Euphorbia neriifolia*	*Euphorbiaceae*	R.P.S [92], Bha. Vig.[93], A.K [94], Ras. Rat.[95], Ras. Chu.[96]
8	*Hingu*	*Ferula asafoetida*	*Umbelliferaae*	Aa. Ve. Pra[97], R.P.S[98], Bha. Vig.[99], Ras. Chu.[100]
9	*Langali*	*Gloriosa superba*	*Colchicaceae*	Bha. Pra.[101], Aa.Ve.Pra[102], Bha. Vig.[103]
10	*Gulabansi, Jangli Gulab pushpa*	*Rosa rubiginosa*	*Rosaceae*	Bha. Vig.[104]
	Nimba,	*Azadirachta indica*	*Meliaceae*	Bha. Vig.[105]
11	*Kataka*	*Strychnos potatorum*	*Loganiaceae*	Bha. Vig.[106]

12	*Nagavalli*	*Piper betle*	*Piperaceae*	Bha. Vig.[107]
13	*Jwalamukhi*	*Capsicum annum*	*Solanaceae*	Rasa Pra Su[108], Bha. Pra.[109], Aa.Ve.Pra[110], Bha. Vig.[111]
14	*Rajavriksha*	*Cassia fistula*	*Caesaalpinioideae*	Ras. Rat.[112], A.K[113]
15	*Bhallathaka,*	*Semecarpus anacardium*	*Anacardiaceae*	Ras. Rat.[114], A.K [115]
16	*Chincha*	*Tamarindus indica*	*Fabaceae*	A.K [116]
17	*Jala Pippali*	*Lippia nodiflora*	*Verbenaceae*	Bha. Vig.[117]
18	*Swarnakshiri*	*Argemone mexicana*	*Euphorbiaceae*	Bha. Vig.[118]
19	*Shleshmantaka*	*Cordia dichotoma*	*Boraginaceae*	Ras. Chu[119]

List of abbreviations

Rasendra Sara Samgraha: Ra. Sa. Sa.
Bhava Prakasha: Bha. Pra.
Rasa Tarangini: Ra. Ta.
Ayurveda Prakasha: Aa. Ve. Pra.
Sharangadhara Samhita: Sha. Sam.
Rasamritam: Ras. Amr.
Yoga Ratnakara: Yo. Rat.
Rasendra Chudamani: Ras. Chu.
Rasa Ratna Samuchchaya: R.R.S
Anandakanda: A.K
Basavarajeeyam: Ba. Ra.
Rasapadhathi: Ras. Pa.
Bhasma Vigyaneeya: Bha. Vig.
Rasa Prakasha Sudhakara: R.P.S
Rasa Sanketa Kalika: R.S.K
Rasa Ratnakara: Ras. Rat.

REFERENCES

[1] Krishnamachary, Balaji & Brindha, Pemaiah & Krishnaswamy, S. & Krishnan, U.M. & Sethuraman, Swaminathan & K.s, Rajan. (2012). Elucidation of a core shell model for Lauha bhasma through physio-chemical characterization. International Journal of Pharmacy and Pharmaceutical Sciences. 4. 644-649.

[2] Selvakesavan, Rajendran K., and Gregory Franklin. "Prospective Application of Nanoparticles Green Synthesized Using Medicinal Plant Extracts as Novel Nanomedicines." *Nanotechnology, Science and Applications*, vol. 14, no. 00, 30 Sept. 2021, pp. 179.

[3] Silva, L.P., Reis, I.G., Bonatto, C.C. (2015). Green Synthesis of Metal Nanoparticles by Plants: Current Trends and Challenges. In: Basiuk, V., Basiuk, E. (eds) Green Processes for Nanotechnology. Springer, Cham. https://doi.org/10.1007/978-3-319-15461-9_9

[4] Dykman LA, Khlebtsov NG. Gold nanoparticles in biology and medicine: recent advances and prospects. *Acta Naturae*. 2011;3(2):34-55.

[5] FIRDHOUSE, M. & p ramadas, Lalitha & Kesavan, Mookkandi & J.Webster, Thomas. (2022). Biogenic Green Synthesis of Gold Nanoparticles and Their Applications – a Review of Promising Properties. SSRN Electronic Journal. 10.2139/ssrn.4053471.

[6] Fedha, Stephen & Omondi, Seline. (2017). Phytochemical Analysis of Some Selected Plants and Families in the University Botanic Garden Of Maseno, Kenya.. IOSR Journal of Pharmacy and Biological Sciences. 12. 31-38. 10.9790/3008-1204023138.

[7] Bukhari A, Ijaz I, Gilani E, Nazir A, Zain H, Saeed R, Alarfaji SS, Hussain S, Aftab R, Naseer Y. Green Synthesis of Metal and Metal Oxide Nanoparticles Using Different Plants' Parts for Antimicrobial Activity and Anticancer Activity: A Review Article. *Coatings*. 2021; 11(11):1374. https://doi.org/10.3390/coatings11111374

[8] Lee KX, Shameli K, Yew YP, Teow SY, Jahangirian H, Rafiee-Moghaddam R, Webster TJ. Recent Developments in the Facile Bio-Synthesis of Gold Nanoparticles (AuNPs) and Their Biomedical Applications. Int J Nanomedicine. 2020;15:275-300

[9] Paul W, Sharma CP. Blood compatibility studies of Swarna bhasma (gold bhasma), an Ayurvedic drug. *Int J Ayurveda Res*. 2011;2(1):14-22.

[10] Sundararajan B., Ranjitha Kumari B.D. Novel synthesis of gold nanoparticles using *Artemisia vulgaris* L. leaf extract and their efficacy of larvicidal activity against dengue fever vector *Aedes aegypti* L. *J. Trace Elem. Med. Biol. Organ Soc. Miner. Trace Elem.* 2017;43:187–196.

[11] Abhijith K.S., Thakur M.S. Application of green synthesis of gold nanoparticles for sensitive detection of aflatoxin B1 based on metal enhanced fluorescence. *Anal. Methods.* 2012;4:4250–4256.

[12] Vanaraj S., Jabastin J., Sathiskumar S., Preethi K. Production and Characterization of Bio-AuNPs to Induce Synergistic Effect Against Multidrug Resistant Bacterial Biofilm. *J. Clust. Sci.* 2017;28:227–244.

[13] Kumar V.G., Gokavarapu S.D., Rajeswari A., Dhas T.S., Karthick V., Kapadia Z., Shrestha T., Barathy I.A., Roy A., Sinha S. Facile green synthesis of gold nanoparticles using leaf extract of antidiabetic potent Cassia auriculata. *Colloids Surf. B. Biointerfaces.* 2011;87:159–163.

[14] Ghosh N. S, Pandey E, Kaushik M, Kadian J. P, Chauhan B, Yadav A, Singh R. Green Synthesis of Gold Nanoparticles: A Novel, Environment- Friendly, Economic, Safe Approach. Biomed Pharmacol J 2021;14(4).

[15] Alam M.N., Das S., Batuta S., Roy N., Chatterjee A., Mandal D., Begum N.A. Murraya koenegii Spreng. Leaf Extract: An Efficient Green Multifunctional Agent for the Controlled Synthesis of Au Nanoparticles. *ACS Sustain. Chem. Eng.* 2014;2:652–664.

[16] Vijayashree I.S., Niranjana P., Prabhu G., Sureshbabu V.V., Manjanna J. Conjugation of Au Nanoparticles with Chlorambucil for Improved Anticancer Activity. *J. Clust. Sci.* 2017;28:133–148.

[17] Karuppiah C., Palanisamy S., Chen S.-M., Emmanuel R., Muthupandi K., Prakash P. Green synthesis of gold nanoparticles and its application for the trace level determination of painter's colic. *RSC Adv.* 2015;5:16284–16291.

[18] . Gopinath K., Venkatesh K.S., Ilangovan R., Sankaranarayanan K., Arumugam A. Green synthesis of gold nanoparticles from leaf extract of Terminalia arjuna, for the enhanced mitotic cell division and pollen germination activity. *Ind. Crops Prod.* 2013;50:737–742.

[19] Arunachalam K.D., Annamalai S.K., Hari S. One-step green synthesis and characterization of leaf extract-mediated biocompatible silver and gold nanoparticles from Memecylon umbellatum. *Int. J. Nanomed.* 2013;8:1307–1315.

[20] Philip D. Rapid green synthesis of spherical gold nanoparticles using Mangifera indica leaf. *Spectrochim. Acta Part. A Mol. Biomol. Spectrosc.* 2010;77:807–810.

[21] Khalil M.M.H., Ismail E.H., El-Magdoub F. Biosynthesis of Au nanoparticles using olive leaf extract: 1st Nano Updates. *Arab. J. Chem.* 2012;5:431–437.

[22] Nagajyothi P.C., Lee S.E., An M., Lee K.D. Green synthesis of silver and gold nanoparticles using Lonicera Japonica flower extract. *Bull. Korean Chem. Soc.* 2012;33:2609–2612.

[23] Das R.K., Gogoi N., Bora U. Green synthesis of gold nanoparticles using Nyctanthes arbortristis flower extract. *Bioprocess. Biosyst. Eng.* 2011;34:615–619.

[24] Karthika V., Arumugam A., Gopinath K., Kaleeswarran P., Govindarajan M., Alharbi N.S., Kadaikunnan S., Khaled J.M., Benelli G. Guazuma ulmifolia bark-synthesized Ag, Au and Ag/Au alloy nanoparticles: Photocatalytic potential, DNA/protein interactions, anticancer activity and toxicity against 14 species of microbial pathogens. *J. Photochem. Photobiol. B.* 2017;167:189–199.

[25] Bahram M., Mohammadzadeh E. Green synthesis of gold nanoparticles with willow tree bark extract: A sensitive colourimetric sensor for cysteine detection. *Anal. Methods.* 2014;6:6916–6924.

[26] Emmanuel R., Karuppiah C., Chen S.-M., Palanisamy S., Padmavathy S., Prakash P. Green synthesis of gold nanoparticles for trace level detection of a hazardous pollutant (nitrobenzene) causing Methemoglobinaemia. *J. Hazard. Mater.* 2014;279:117–124.

[27] Vijayakumar S., Vaseeharan B., Malaikozhundan B., Gopi N., Ekambaram P., Pachaiappan R., Velusamy P., Murugan K., Benelli G., Suresh Kumar R., et al. Therapeutic effects of gold nanoparticles synthesized using Musa paradisiaca peel extract against multiple antibiotic resistant Enterococcus faecalis biofilms and human lung cancer cells (A549) *Microb. Pathog.* 2017;102:173–183.

[28] Kumar B., Smita K., Cumbal L., Debut A. Extracellular biofabrication of gold nanoparticles by using Lantana camara berry extract. *Inorg. Nano-Metal. Chem.* 2017;47:138–142.

[29] Sujitha M.V., Kannan S. Green synthesis of gold nanoparticles using Citrus fruits (Citrus limon, Citrus reticulata and Citrus sinensis) aqueous extract and its characterization. *Spectrochim. Acta. A Mol. Biomol. Spectrosc.* 2013;102:15–23.

[30] Yu J., Xu D., Guan H.N., Wang C., Huang L.K., Chi D.F. Facile one-step green synthesis of gold nanoparticles using Citrus maxima aqueous extracts and its catalytic activity. *Mater. Lett.* 2016;166:110–112.

[31] Ghodake G., Lee D. Green synthesis of gold nanostructures using pear extract as effective reducing and coordinating agent. *Korean J. Chem. Eng.* 2011;28:2329–2335.

[32] . Rodríguez-León E., Rodríguez-Vázquez B.E., Martínez-Higuera A., Rodríguez-Beas C., Larios-Rodríguez E., Navarro R.E., López-Esparza R., Iñiguez-Palomares R.A. Synthesis of Gold Nanoparticles Using Mimosa tenuiflora Extract, Assessments of Cytotoxicity, Cellular Uptake, and Catalysis. *Nanoscale Res. Lett.* 2019;14:334.

[33]Islam N.U., Jalil K., Shahid M., Muhammad N., Rauf A. Pistacia integerrima gall extract mediated green synthesis of gold nanoparticles and their biological activities. *Arab. J. Chem.* 2019;12:2310–2319.

[34] Jayaseelan C., Ramkumar R., Rahuman A.A., Perumal P. Green synthesis of gold nanoparticles using seed aqueous extract of Abelmoschus esculentus and its antifungal activity. *Ind. Crops Prod.* 2013;45:423–429.

[35] Fazal S., Jayasree A., Sasidharan S., Koyakutty M., Nair S.V., Menon D. Green Synthesis of Anisotropic Gold Nanoparticles for Photothermal Therapy of Cancer. *ACS Appl. Mater. Interfaces.* 2014;6:8080–8089.

[36] Cabrera F.C., Mohan H., dos Santos R.J., Agostini D.L.S., Aroca R.F., Rodríguez-Pérez M.A., Job A.E. Green Synthesis of Gold Nanoparticles with Self-Sustained Natural Rubber Membranes. *J. Nanomater.* 2013;2013:710902.

[37] Velmurugan P., Anbalagan K., Manosathyadevan M., Lee K.-J., Cho M., Lee S.-M., Park J.-H., Oh S.-G., Bang K.-S., Oh B.-T. Green synthesis of silver and gold nanoparticles using Zingiber officinale root extract and antibacterial activity of silver nanoparticles against food pathogens. *Bioprocess. Biosyst. Eng.* 2014;37:1935–1943.

[38] Nadagouda M.N., Iyanna N., Lalley J., Han C., Dionysiou D.D., Varma R.S. Synthesis of Silver and Gold Nanoparticles Using Antioxidants from Blackberry, Blueberry, Pomegranate, and Turmeric Extracts. *ACS Sustain. Chem. Eng.* 2014;2:1717–1723.

[39] Leonard K., Ahmmad B., Okamura H., Kurawaki J. In situ green synthesis of biocompatible ginseng capped gold nanoparticles with remarkable stability. *Colloids Surf. B. Biointerfaces.* 2011;82:391–396.

[40] Ganesan R.M., Gurumallesh Prabu H. Synthesis of gold nanoparticles using herbal Acorus calamus rhizome extract and coating on cotton fabric for antibacterial and UV blocking applications. *Arab. J. Chem.* 2019;12:2166–2174.

[41]Sathiyanarayanan G., Vignesh V., Saibaba G., Vinothkanna A., Dineshkumar K., Viswanathan M.B., Selvin J. Synthesis of carbohydrate polymer encrusted gold nanoparticles using bacterial exopolysaccharide: A novel and greener approach. *RSC Adv.* 2014;4:22817–22827.

[42] . Paul B., Bhuyan B., Purkayastha D.D., Vadivel S., Dhar S.S. One-pot green synthesis of gold nanoparticles and studies of their anticoagulative and photocatalytic activities. *Mater. Lett.* 2016;185:143–147.

[43] Aromal S.A., Vidhu V.K., Philip D. Green synthesis of well-dispersed gold nanoparticles using Macrotyloma uniflorum. *Spectrochim. Acta Part. A Mol. Biomol. Spectrosc.* 2012;85:99–104. doi: 10.1016/j.saa.2011.09.035.
[44] Elia P, Zach R, Hazan S, Kolusheva S, Porat Z, Zeiri Y. Green synthesis of gold nanoparticles using plant extracts as reducing agents. *Int J Nanomedicine*. 2014;9(1):4007-4021 https://doi.org/10.2147/IJN.S57343
[45] Zhao W, Li J, Zhong C, Zhang X, Bao Y. Green synthesis of gold nanoparticles from *Dendrobium officinale* and its anticancer effect on liver cancer. *Drug Deliv*. 2021;28(1):985-994. doi:10.1080/10717544.2021.1921079

[46] Xin Lee, Kamyar Shameli, Mikio Miyake, Noriyuki Kuwano, Nurul Bahiyah Bt Ahmad Khairudin, Shaza Eva Bt Mohamad, Yen Pin Yew, "Green Synthesis of Gold Nanoparticles Using Aqueous Extract of Garcinia mangostana Fruit Peels", Journal of Nanomaterials, vol. 2016, Article ID 8489094, 7 pages, 2016. https://doi.org/10.1155/2016/8489094
[47] Ahmad S, Zainab, Ahmad H, et al. Green synthesis of gold nanaoparticles using Delphinium Chitralense tuber extracts, their characterization and enzyme inhibitory potential. *Braz J Biol*. 2022;82:e257622. Published 2022 Mar 14. doi:10.1590/1519-6984.257622
[48] Ali S, Bacha M, Shah MR, et al. Green synthesis of silver and gold nanoparticles using Crataegus oxyacantha extract and their urease inhibitory activities. *Biotechnol Appl Biochem*. 2021;68(5):992-1002. doi:10.1002/bab.2018
[49] Singh P, Mijakovic I. Green synthesis and antibacterial applications of gold and silver nanoparticles from Ligustrum vulgare berries. *Sci Rep*. 2022;12(1):7902. Published 2022 May 12. doi:10.1038/s41598-022-11811-7
[50] Ullah U, Rauf A, El-Sharkawy E, et al. Green synthesis, in vivo and in vitro pharmacological studies of Tamarindus indica based gold nanoparticles. *Bioprocess Biosyst Eng*. 2021;44(6):1185-1192. doi:10.1007/s00449-020-02500-8
[51] Zamudio-Ojeda A, Reyes-Maldonado OK, et al. Green Synthesis of Gold and Silver Nanoparticles Using Leaf Extract of *Capsicum chinense* Plant. *Molecules*. 2022;27(5):1692. Published 2022 Mar 4. doi:10.3390/molecules27051692
[52] Elia P, Zach R, Hazan S, Kolusheva S, Porat Z, Zeiri Y. Green synthesis of gold nanoparticles using plant extracts as reducing agents. *Int J Nanomedicine*. 2014;9(1):4007-4021 https://doi.org/10.2147/IJN.S57343
[53] Elia P, Zach R, Hazan S, Kolusheva S, Porat Z, Zeiri Y. Green synthesis of gold nanoparticles using plant extracts as reducing agents. *Int J Nanomedicine*. 2014;9(1):4007-4021 https://doi.org/10.2147/IJN.S57343
[54] Elia P, Zach R, Hazan S, Kolusheva S, Porat Z, Zeiri Y. Green synthesis of gold nanoparticles using plant extracts as reducing agents. *Int J Nanomedicine*. 2014;9(1):4007-4021 https://doi.org/10.2147/IJN.S57343
[55] Shri Ambika Dutta Shastri, Commentator. Rasendra Sara Samgraha of Shri Gopalakrishna, Ch. 1, Ver. 251.1st edition, Varanasi:Chaukhambha Sanskrit Series Office; 1664. p. 69.
[56]Kashinathasastri, Editor. Rasatarangini of Sadananda Sharma, Ch.15, Ver.53. 8th Reprint edition, Delhi: Motilal Banarasidas; 2014.p.383.
[57] Srikantha Murthy K R, Translator. Bhavaprakasa of Bhavamisra, Vol.1, Ch.7(3), Ver.16, Second edition, Varanasi: Krishnadas academy; 2001.p.521.
[58] Gulrajsharma Mishra, Editor. Ayurveda Prakasha of Acharya Sri Madhava, Ch. 3, Ver. 74, Reprint edition, Varanasi: Chaukhambha Bharati Academy; 2020.p. 359.
[59] Parashuram Shastri Vidyasagar, Editor. Adamalla, Kasiram, Commentator. Sarangadhara Samhita of Sarangadharacarya, Madhyama Khanda, Ch. 11, Ver. 14. Varanasi: Chaukhamba Surbharathi Prakashan; 2013.p.242.
[60] Shri Ambika Dutta Shastri, Commentator. Rasendra Sara Samgraha of Shri Gopalakrishna, Ch. 1, Ver. 253.1st edition, Varanasi:Chaukhambha Sanskrit Series Office; 1664. p. 70.
[61] Gulrajsharma Mishra, Editor. Ayurveda Prakasha of Acharya Sri Madhava, Ch. 3, Ver. 53, Reprint edition, Varanasi: Chaukhambha Bharati Academy; 2020.p. 358.
[62] Gulrajsharma Mishra, Editor. Ayurveda Prakasha of Acharya Sri Madhava, Ch. 3, Ver. 57, Reprint edition, Varanasi: Chaukhambha Bharati Academy; 2020.p. 356.
[63] Srikantha Murthy K R, Translator. Bhavaprakasa of Bhavamisra, Vol.1, Ch.7(3), Ver.8, Second edition, Varanasi: Krishnadas academy; 2001.p.520.
[64] Devnath Singh Gautham, Commentator. Rasamritam of Yadavji Trikamji, Ch. 2, Ver. 22, Reprint edition, Varanasi: Chaukhambha publishing house; 2014. p. 28.
[65] Bhisagrantha Brahmasankar Sastri, Editor. Yogaratnakara of Vaidya Laksmipati Sastri, Ver. 1. Reprint edition, Varanasi: Chaukhambha publishing house; 1997.p.128.

[66] Parashuram Shastri Vidyasagar, Editor. Adamalla, Kasiram, Commentator. Sarangadhara Samhita of Sarangadharacarya, Madhyama Khanda, Ch. 11, Ver. 7. Varanasi: Chaukhamba Surbharathi Prakashan; 2013.p.242.

[67] Siddhinandan Mishra, Translator. Rasendra Chudamani of Somadeva, Ch. 14, Ver. 16, First edition, Varanasi: Chaukhambha Orientalia; 1984.p.233.

[68] Indradrev Tripathy, Commentator. Rasakhandam first part of Rasaratnakara of Srinityanatha Siddha, Ch.8, Ver.16, Reprint edition, Varanasi: Chaukhambha Amarabharati Prakashan;2006. p. 58.

[69] Siddhinandan Mishra, Commentator. Rasaprakasha Sudhakara of Acharya Yashodara, Ch.4, Ver. 14, Third edition, Varanasi: Chaukhambha Orientalia; 2004. p. 69.

[70] Siddhinandan Mishra, Translator. Rasendra Chudamani of Somadeva, Ch. 14, Ver. 15, First edition, Varanasi: Chaukhambha Orientalia; 1984.p.233.

[71]Kashinathasastri, Editor. Rasatarangini of Sadananda Sharma, Ch.15, Ver.46. 8th Reprint edition, Delhi: Motilal Banarasidas; 2014.p.381.

[72] Duttatreya Ananda Kulkarni, Commentator. Rasa Ratna Samuchchaya of Vagbhatacharya, Volume one, Ch. 5, Ver. 15, Reprint edition, New Delhi:Meherchand laxmandas publications;2010. p. 95.

[73] Sreegovardhanasharma Changaani, Editor. Basavarajeeyam of Basavaraja, Ch.25, Reprint edition, Delhi:Chaukhambha Sanskrit Pratishtan; 2013. p.395.

[74] Siddhinandan Mishra, Translator. Anandakandah of Acharya Bhairava, Kriyakarana vishranthi, Ch. 2, Ver. 25, Reprint edition, Varanasi: Chaukhambha Orientalia; 2015. p.695.

[75] Srikantha Murthy K R, Translator. Bhavaprakasa of Bhavamisra, Vol.1, Ch.7(3), Ver.6, Second edition, Varanasi: Krishnadas academy; 2001.p.520.

[76] Bhisagrantha Brahmasankar Sastri, Editor. Yogaratnakara of Vaidya Laksmipati Sastri, Ver. 3. Reprint edition, Varanasi: Chaukhambha publishing house; 1997.p.129.

[77] Duttatreya Ananda Kulkarni, Commentator. Rasa Ratna Samuchchaya of Vagbhatacharya, Volume one, Ch. 5, Ver. 15, Reprint edition, New Delhi:Meherchand laxmandas publications;2010. p. 95.

[78] Siddhinandan Mishra, Commentator. Rasapaddhathi of Acharya Bindu, Ver.50, Second edition, Varanasi: Chaukhambha Orientalia; 2005. p. 62.

[79] Devnath Singh Gautham, Commentator. Rasamritam of Yadavji Trikamji, Ch. 3, Ver. 19, Reprint edition, Varanasi: Chaukhambha publishing house; 2014. p. 28.

[80] Siddhinandan Mishra, Commentator. Rasaprakasha Sudhakara of Acharya Yashodara, Ch.4, Ver. 17, Third edition, Varanasi: Chaukhambha Orientalia; 2004. p. 69.

[81] Siddhinandan Mishra, Commentator. Rasapaddhathi of Acharya Bindu, Ver.50, Second edition, Varanasi: Chaukhambha Orientalia; 2005. p. 62.

[82] Devnath Singh Gautham, Commentator. Rasamritam of Yadavji Trikamji, Ch. 3, Ver. 16, Reprint edition, Varanasi: Chaukhambha publishing house; 2014. p. 27.

[83] Gulrajsharma Mishra, Editor. Ayurveda Prakasha of Acharya Sri Madhava, Ch. 3, Ver. 55, Reprint edition, Varanasi: Chaukhambha Bharati Academy; 2020.p. 358.

[84] Srikantha Murthy K R, Translator. Bhavaprakasa of Bhavamisra, Vol.1, Ch.7(3), Ver.11, Second edition, Varanasi: Krishnadas academy; 2001.p.520.

[85] Gulrajsharma Mishra, Editor. Ayurveda Prakasha of Acharya Sri Madhava, Ch. 3, Ver. 69, Reprint edition, Varanasi: Chaukhambha Bharati Academy; 2020.p. 359.

[86] Parashuram Shastri Vidyasagar, Editor. Adamalla, Kasiram, Commentator. Sarangadhara Samhita of Sarangadharacarya, Madhyama Khanda, Ch. 11, Ver. 10. Varanasi: Chaukhamba Surbharathi Prakashan; 2013.p.242.

[87] Siddhinandan Mishra, Translator. Rasendra Chudamani of Somadeva, Ch. 14, Ver. 18, First edition, Varanasi: Chaukhambha Orientalia; 1984.p.233.

[88] Gulrajsharma Mishra, Editor. Ayurveda Prakasha of Acharya Sri Madhava, Ch. 3, Ver. 55, Reprint edition, Varanasi: Chaukhambha Bharati Academy; 2020.p. 358.

[89]Kashinathasastri, Editor. Rasatarangini of Sadananda Sharma, Ch.15, Ver.62. 8th Reprint edition, Delhi: Motilal Banarasidas; 2014.p.384.

[90] Devnath Singh Gautham, Commentator. Rasamritam of Yadavji Trikamji, Ch. 3, Ver. 16, Reprint edition, Varanasi: Chaukhambha publishing house; 2014. p. 27.
[91] Harisharananand, Commentator. Bhasma Vigyaneeyam of Harisharananand, Vol. 2, Chathurtha Pada, 1st edition, Amritsar: Ayurved Vigyan Granthamala Karyalaya; 1654. p. 337.
[92] Siddhinandan Mishra, Commentator. Rasaprakasha Sudhakara of Acharya Yashodara, Ch. 4, Ver. 16, Third edition, Varanasi: Chaukhambha Orientalia; 2004. p. 68.
[93] Harisharananand, Commentator. Bhasma Vigyaneeyam of Harisharananand, Vol. 2, Chathurtha Pada, 1st edition, Amritsar: Ayurved Vigyan Granthamala Karyalaya; 1654. p. 336.
[94] Siddhinandan Mishra, Translator. Anandakandah of Acharya Bhairava, Kriyakarana vishranthi, Ch. 2, Ver. 22, Reprint edition, Varanasi: Chaukhambha Orientalia; 2015. p.695.
[95] Indradrev Tripathy, Commentator. Rasakhandam first part of Rasaratnakara of Srinityanatha Siddha, Ch.8, Ver.13, Reprint edition, Varanasi: Chaukhambha Amarabharati Prakashan;2006. p. 58.
[96] Siddhinandan Mishra, Translator. Rasendra Chudamani of Somadeva, Ch. 14, Ver. 20, First edition, Varanasi: Chaukhambha Orientalia; 1984.p.234.
[97] Gulrajsharma Mishra, Editor. Ayurveda Prakasha of Acharya Sri Madhava, Ch. 3, Ver. 55, Reprint edition, Varanasi: Chaukhambha Bharati Academy; 2020.p. 358.
[98] Siddhinandan Mishra, Commentator. Rasaprakasha Sudhakara of Acharya Yashodara, Ch. 4, Ver. 16, Third edition, Varanasi: Chaukhambha Orientalia; 2004. p. 68.
[99] Harisharananand, Commentator. Bhasma Vigyaneeyam of Harisharananand, Vol. 2, Chathurtha Pada, 1st edition, Amritsar: Ayurved Vigyan Granthamala Karyalaya; 1654. p. 336.
[100] Siddhinandan Mishra, Translator. Rasendra Chudamani of Somadeva, Ch. 14, Ver. 20, First edition, Varanasi: Chaukhambha Orientalia; 1984.p.234.
[101] Srikantha Murthy K R, Translator. Bhavaprakasa of Bhavamisra, Vol.1, Ch.7(3), Ver.14, Second edition, Varanasi: Krishnadas academy; 2001.p.520.
[102] Gulrajsharma Mishra, Editor. Ayurveda Prakasha of Acharya Sri Madhava, Ch. 3, Ver. 73, Reprint edition, Varanasi: Chaukhambha Bharati Academy; 2020.p. 359.
[103] Harisharananand, Commentator. Bhasma Vigyaneeyam of Harisharananand, Vol. 2, Chathurtha Pada, 1st edition, Amritsar: Ayurved Vigyan Granthamala Karyalaya; 1654. p. 342.
[104] Harisharananand, Commentator. Bhasma Vigyaneeyam of Harisharananand, Vol. 2, Chathurtha Pada, 1st edition, Amritsar: Ayurved Vigyan Granthamala Karyalaya; 1654. p. 337.
[105] Harisharananand, Commentator. Bhasma Vigyaneeyam of Harisharananand, Vol. 2, Chathurtha Pada, 1st edition, Amritsar: Ayurved Vigyan Granthamala Karyalaya; 1654. p. 337.
[106] Harisharananand, Commentator. Bhasma Vigyaneeyam of Harisharananand, Vol. 2, Chathurtha Pada, 1st edition, Amritsar: Ayurved Vigyan Granthamala Karyalaya; 1654. p. 337.
[107] Harisharananand, Commentator. Bhasma Vigyaneeyam of Harisharananand, Vol. 2, Chathurtha Pada, 1st edition, Amritsar: Ayurved Vigyan Granthamala Karyalaya; 1654. p. 337.
[108] Siddhinandan Mishra, Commentator. Rasaprakasha Sudhakara of Acharya Yashodara, Ch.4, Ver. 12, Third edition, Varanasi: Chaukhambha Orientalia; 2004. p. 67.
[109] Srikantha Murthy K R, Translator. Bhavaprakasa of Bhavamisra, Vol.1, Ch.7(3), Ver.14, Second edition, Varanasi: Krishnadas academy; 2001.p.520.
[110] Gulrajsharma Mishra, Editor. Ayurveda Prakasha of Acharya Sri Madhava, Ch. 3, Ver. 73, Reprint edition, Varanasi: Chaukhambha Bharati Academy; 2020.p. 359.
[111] Harisharananand, Commentator. Bhasma Vigyaneeyam of Harisharananand, Vol. 2, Chathurtha Pada, 1st edition, Amritsar: Ayurved Vigyan Granthamala Karyalaya; 1654. p. 342.
[112] Indradrev Tripathy, Commentator. Rasakhandam first part of Rasaratnakara of Srinityanatha Siddha, Ch.8, Ver.27, Reprint edition, Varanasi: Chaukhambha Amarabharati Prakashan;2006. p. 61.
[113] Siddhinandan Mishra, Translator. Anandakandah of Acharya Bhairava, Kriyakarana vishranthi, Ch. 2, Ver. 40, Reprint edition, Varanasi: Chaukhambha Orientalia; 2015. p.697.

[114] Indradrev Tripathy, Commentator. Rasakhandam first part of Rasaratnakara of Srinityanatha Siddha, Ch.8, Ver.27, Reprint edition, Varanasi: Chaukhambha Amarabharati Prakashan;2006. p. 61.

[115] Siddhinandan Mishra, Translator. Anandakandah of Acharya Bhairava, Kriyakarana vishranthi, Ch. 2, Ver. 40, Reprint edition, Varanasi: Chaukhambha Orientalia; 2015. p.697.

[116] Siddhinandan Mishra, Translator. Anandakandah of Acharya Bhairava, Kriyakarana vishranthi, Ch. 2, Ver. 40, Reprint edition, Varanasi: Chaukhambha Orientalia; 2015. p.697.

[117] Harisharananand, Commentator. Bhasma Vigyaneeyam of Harisharananand, Vol. 2, Chathurtha Pada, 1st edition, Amritsar: Ayurved Vigyan Granthamala Karyalaya; 1st edition. p. 338.

[118] Harisharananand, Commentator. Bhasma Vigyaneeyam of Harisharananand, Vol. 2, Chathurtha Pada, 1st edition, Amritsar: Ayurved Vigyan Granthamala Karyalaya; 1654. p. 338.

[119] Siddhinandan Mishra, Translator. Rasendra Chudamani of Somadeva, Ch. 14, Ver. 18, First edition, Varanasi: Chaukhambha Orientalia; 1984.p.233.