

# A Comparative Review on the Standard Quality Parameters of Turmeric

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## ABSTRACT

The world economy of the international trade of herbs and related products has been witnessing an increase of 15% annually. In the aftermath of the COVID-19 outbreak, there are reports highlighting an instant rise in the demand for medicinal plants especially the immunity booster plants. Due to the anti-oxidant, anti-inflammatory, anti-viral, anti-bacterial and anti-fungal properties of *Curcuma longa* L. popularly known as Turmeric and Haldi in India, herbal scientists are exploring this potential herb in managing the COVID-19 pandemic. It is widely believed that an increase in the demand for herbal products may increase the chances of species adulteration leading to adverse consequences. In such cases, it is important to devise a comprehensive intuitive document highlighting various standard quality parameters of Turmeric that are reported in different standard texts benefitting the concerned stakeholders. In the present review, classical texts such as API (Ayurvedic Pharmacopoeia of India), WHO (World Health Organization), FSSAI (Food Safety and Standards Authority of India) and other literature are explored to highlight standard quality parameters of Turmeric.

**Key words:** Agmark, ASTA, Ayurvedic Pharmacopoeia of India, COVID-19, *Curcuma longa*, ESA, FSSAI, Haldi, ICMR, Immunity-boosting, Quality parameters, Spices, Standard tests, WHO.



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## INTRODUCTION

The human dependence on medicinal plants is probably the oldest method to cure a vast array of ailments.<sup>[1]</sup> The traditional healing system such as Ayurveda, Unani, Siddha, Homeopathy, TCM (Traditional Chinese Medicine) and folk medicines are still practiced in the primary and secondary healthcare systems.<sup>[2]</sup> A tremendous upsurge and continuous growth in the herbs and related products has resulted in high demand for medicinal plant resources both collected wildly and cultivated worldwide.<sup>[3-5]</sup> According to the report of the National Medicinal Plant Board (NMPB), the total commercial demand for herbal raw drugs has been estimated at 5,12,000 (Dry wt. in MT) for the year 2014-15 in India.

<sup>[6]</sup> The resurgence of life-style related disorders, increased awareness about the health and belief of consumers on herbals being 'safe' are also major driving forces for the commercial success of herbal products.<sup>[7]</sup>

*Curcuma longa* L. belongs to the ginger family (Zingiberaceae). The rhizomes of the plant are used for thousands of years in traditional as well as a folk medicine to cure a wide array of ailments such as infectious diseases, inflammation, gastric, blood and hepatic disorders.

<sup>[8]</sup> An important polyphenolic compound i.e. curcumin present in the plant is reported to be responsible for possessing anti-oxidant, anti-viral and anti-bacterial properties.<sup>[9]</sup> In India, estimated consumption of turmeric by domestic herbal industry is reported around 1316.51 MT.<sup>[6]</sup> In the aftermath of the COVID-19 outbreak, the Ministry of AYUSH, Government of India, has recommended golden milk (a half spoon of turmeric in 150 ml of warm milk, once or twice a day) and

the use of turmeric in cooking, besides other herbs as an immunity-boosting measure for self-care during COVID-19 pandemic (<https://www.ayush.gov.in/docs/123.pdf>).<sup>[10]</sup> Subsequently, there are other reports recommending consumption of decoction of herbs such as *Curcuma longa*, *Glycyrrhiza glabra*, *Ocimum sanctum*, etc. to the exposed asymptomatic patients (quarantined) due to their protease inhibition activity and broad-spectrum anti-viral properties.<sup>[11,12]</sup> These recommendations for the consumers may have further resulted in a sharp increase in the demand for immunity boosting herbs, especially in India ([https://www.business-standard.com/article/companies/dabur-himalaya-witness-spike-in-sales-of-ayurvedic-products-amid-COVID-19-120042901042\\_1.html](https://www.business-standard.com/article/companies/dabur-himalaya-witness-spike-in-sales-of-ayurvedic-products-amid-COVID-19-120042901042_1.html)).

It is widely understood that this increasing trend in the demand for immunity boosting herbs especially turmeric might increase the chances of species adulteration leading to adverse pharmacological effects.<sup>[13]</sup> Furthermore, lack of adoption of (GACP) Good Agricultural and Collection Practices, lack of availability of quality planting material, irrational use of chemical pesticides and insecticides and vulnerability to heavy metal contamination are some of the major constraints in maintaining the quality of the herbs and competing in the global market.<sup>[14]</sup> Various quality parameters for turmeric are well described in different standard texts such as API, Indian Herbal Pharmacopoeia, WHO, FSSAI besides other reported literature. In this review, the authors have devised an intuitive document highlighting quality parameter ranges of turmeric described in the different texts for the concerned stakeholders to enable them to maintain the quality of the herbs.

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## Quality parameters for turmeric: Regulatory and textual perspectives

Reference texts for medicinal plants are the standard documents that are referred by the herbal scientists to check the quality of the herbal samples. It comprises of vast number of quality parameters with the appropriate ranges for an individual plant.<sup>[15]</sup> In the case of India, API is the most preferred book by the scientists comprising of medicinal plant standards describing the quality, purity and strength of an individual plant that is manufactured, sold and distributed by the licensed producer. It is divided into two parts: i) monographs of medicinal substance from natural origin ii) parameters for compound herbal formulations obtained from the schedule I- books under Drugs and Cosmetics Act, 1940. The API comprising of mono-monograph of medicinal plants was first published in the year 1989 followed by other volumes. Likewise, the first segment of the Ayurvedic Formulary of India was published in the year 1978.<sup>[16]</sup> The Indian Drug Manufacturers' Association, Mumbai 400018 and Regional Research Laboratory, CSIR, Jammu Tawi has published the Indian Herbal Pharmacopoeia in the year 1998 comprising of medicinal plants monographs.<sup>[17]</sup> Similarly, the ICMR (Indian Council of Medical Research), New Delhi has developed monographs of medicinal plants that are published in the different volumes of the Medicinal plants of India.<sup>[18-23]</sup> Apart from this, the FSSAI has described some essential quality limits for turmeric. The Spice Board of India has also highlighted mandatory tests that are required for the export of turmeric to different countries (<http://www.indianspices.com/trade/trade-notifications/mandatory-sampling-testing-certification-spice-export-consignments.html>).

Besides this, the ASTA (American Spice Trade Association, Inc.), ESA (European Spice Association), Agmark have different standards for the quality evaluation of turmeric during the trade.<sup>[24]</sup> The WHO has also described some critical quality control parameters such as the limit of pesticide residues, heavy metals, etc. in the medicinal plant materials with

the appropriate ranges.<sup>[25,26]</sup> These documents comprises of organoleptic, microscopic, physico-chemical, quantitative, toxicity indicators, etc. ranges for determining the quality of medicinal plants.

## Organoleptic and macroscopic evaluation parameters

Organoleptic properties refer to the general appearance such as fracture, flavor/taste, texture, the aroma of the medicinal plant. Organoleptic evaluation is the first step towards the authentication of turmeric and other medicinal plants. The evaluation is carried out by observing the part of the plant through the naked eye or magnifying lens by an expert.<sup>[27]</sup> Similarly, macroscopic characterization of turmeric involves different tools or methods related to botanical anatomy to measure the parts of the plant. Table 1 represents the ranges of different organoleptic and macroscopic parameters of turmeric mentioned in API and other standard reported literature.

## Microscopic evaluation

It is the next step after macroscopic analysis of the herb. It involves evaluating the specific microscopic characteristics of herb both through transverse/longitudinal sections and powder microscopy. Different staining techniques are followed to stain the specific organelle of the herb. The transverse section of the drug is examined using glycerol solution and staining with phloroglucinol, concentrated hydrochloric acid, safranin for examining starch, inulin, lignified elements, fixed oils, etc.<sup>[19,28]</sup> Similarly, in powder microscopy, the herb is grounded and the powdered drug is put on the slides in chloral hydrate solution for determining different descriptors using a microscope.<sup>[30]</sup> Some of the specific microscopic characters of transverse/longitudinal sections and powdered turmeric are mentioned in Table 2.

## Physico-chemical parameters

A set of physico-chemical evaluation of herbs estimates the strength of the medicinal plant. It highlights the appropriate percent of moisture

**Table 1: Important organoleptic and macroscopic parameters of Turmeric with range of values.**

Organoleptic analysis	API <sup>[28]</sup>	Other standard reported literature
Shape	Ovate, oblong, pyriform, cylindrical	Primary rhizomes: Ovate-oblong, conical, pear shaped. Secondary rhizomes: Known as fingers are cylindrical curved, tapering bluntly at both ends, occasionally branched. <sup>[19]</sup>
Size	2-5 cm long and 1-1.8 cm thick	Primary rhizome: 3 to 7 cm long, 2 to 3 cm wide Secondary rhizome: 4 to 10 cm in length 1 to 1.5 cm in diameter. <sup>[19]</sup>
Color	Externally yellowish to yellowish brown. Fractured surface orange to reddish brown.	Yellowish orange, internally uniformly dull yellowish. <sup>[19]</sup>
Odor	Characteristic	Aromatic and somewhat pungent. <sup>[19,29]</sup>
Taste	Characteristic	Bitter. <sup>[19]</sup>
Macroscopic analysis		
Primary rhizomes	Rhizomes are half as broad as long. Roots have scars and leaf bases bear annulations. Horny fractured surface and central cylinder twice as broad as cortex.	Primary rhizomes are condensed swollen. Longitudinally wrinkled and marked with rows of circular. 3 to 5 large depressions scars. Rhizomes are hard, heavy with short fracture. <sup>[19,29]</sup>
Secondary rhizomes	Short branched, Roots have scars and leaf bases bear annulations. Horny fractured surface and central cylinder twice as broad as cortex.	Longitudinally wrinkled exhibiting encircling leaf scars. Rhizomes are hard, heavy with short fracture. <sup>[19,29]</sup>

level and foreign matter present in the plant. The ash value determines the physiological, non-physiological ash and the silica present in the plant part. The water and alcohol extractives generally determine the number of chemical constituents present in the plant part.<sup>[30]</sup> Table 3 describes the essential physico-chemical parameters that are considered by FSSAI, industries and trade.

### Chromatographic profiling of turmeric using (TLC/HPTLC/HPLC)

TLC based chromatographic profiling is essential for the qualitative estimation of the major active constituent present in the plant. Curcumin is the major active constituent present in turmeric.<sup>[9]</sup> Chromatographic profiling of turmeric is followed by a quantitative estimation of curcumin using HPLC or HPTLC. It determines the quality of turmeric

observing the amount of curcumin present in it. This is an essential step to determine the adulteration of turmeric with inferior species or exhausted rhizomes. Table 4 represents the  $R_f$  value, quantitative range of curcumin along with the method mentioned in different standard texts.

### Toxicity indicators in turmeric

Toxicity indicators refer to the plant parameters that are not just critical to the quality of medicinal plants but can adversely affect the physiology of the human body when consumed. Toxicity indicators include the presence of heavy metal, pesticide residues and aflatoxin levels in turmeric. The hazardous sites can attract molds such as *Aspergillus flavus* which grows on the soil to produce Aflatoxins that are carcinogens.<sup>[37]</sup> Similarly, unknown history of soils and unreliable sources of irrigation water can increase the pesticide and heavy metal contents in the crop which is a limiting factor in the herbal industry and trade. Excessive

**Table 2: Important microscopic characters of Turmeric mentioned in standard texts.**

Type of microscopy	API <sup>[28]</sup>	Other standard reported literature
Transverse section	Epidermis: Thick-walled, cubical cells of different dimensions. Cortex: Thin wall rounded parenchyma cells, collateral vascular bundles. Scattered oleo-resin with brownish content, thin walled cork cells, ground tissue containing starch grains of 4-5 $\mu$ in diameter, oil cells containing orange- yellow globules of volatile oils. Presence of spirally thickened vessels.	Presence of cork, cortex, cortical vascular bundle, endodermis, oleoresin cells, stellar vascular bundle. Inner region with endodermis consist all the above mentioned descriptors including pericycle, phloem, starch grains, stellar vascular bundle, xylem. <sup>[19,31]</sup>
Powder	Not mentioned	Presence of cortical parenchyma cells with starch grains and oleoresin cells. Cork in the surface view, group of spiral and annular vessels, fragment of reticulate vessel and presence of starch grains. <sup>[19,31]</sup>

**Table 3: Physico-chemical ranges in different texts, general methods and their requirement in different commerce.**

Physico-chemical parameters	API <sup>[28]</sup>	Other reported literature	General methods of experimentation <sup>[19,28]</sup>	Essential parameters considered by:		
				FSSAI	Industry	Trade
Foreign matter	n.m.t. 2 %	n.m.t. 1% by weight. <sup>[32]</sup>	Inspect under unaided eye or at 6x lens for removal of foreign matter.	√	√	√
Total ash	n.m.t. 9 %	n.m.t. 9-12 %. <sup>[19,29,32]</sup>	Using gooch crucible/ tarred platinum or silica dish and incineration at 450°C.	√	√	-
Acid insoluble ash	n.m.t. 1 %	n.m.t. 1.5-1.8 %. <sup>[19,29,32]</sup>	Using 2 M hydrochloric acid for total ash determination	√	√	-
Alcohol soluble extractive	n.l.t. 8 %	n.l.t. 10 %. <sup>[19,29]</sup>	Maceration of drug using ethanol for 24 hr and finding weight variation with reference to air dried drug	-	√	-
Water soluble extractive	n.l.t. 12 %	n.l.t. 11 %. <sup>[19,29]</sup>	Maceration of drug using chloroform water for 24 hr and finding weight variation with reference to air dried drug.	-	√	-
Volatile oil	n.l.t. 4 %	--	Distilling the drug with water and glycerin and measuring the volume of oil.	-	√	-
Moisture	--	n.m.t. 12 % by weight. <sup>[32]</sup>	--	√	-	√
Total starch	--	n.m.t. 60% by weight. <sup>[32]</sup>	--	√	-	√

n.l.t: not less than; n.m.t: not more than

**Table 4: Qualitative and quantitative estimation of Turmeric.**

Major active constituent	API <sup>[28]</sup>	Other reported literature	General method of experimentation
Curcumin	--	$R_f$ at 0.54 (Reddish brown color). Percentage of curcumin range from 2.85 to 6.5 %. <sup>[19,24,29,33-36]</sup>	Solvent for extraction using Soxhlet apparatus: Ethanol Solvent system: Toluene: Ethyl acetate: Formic acid (5:1.5:0.5) Visualization: Under UV light at 254 nm. <sup>[19]</sup>

**Table 5: Ranges of toxicity indicators in Turmeric.**

Toxicity indicators	API	Other standard literature	Essential parameters considered by	
			FSSAI	Trade
Aflatoxin	--	Aflatoxin B1: 5 ppb Aflatoxin Total: 10 ppb. <sup>[24]</sup>	-	√
Pesticide residues	--	Iprobenfos: < 0.01 ppm Profenofos: < 0.05 ppm Triazophos: < 0.01 ppm Ethion: < 0.30 ppm Phorate: < 0.10 ppm Parathoin: < 0.60 ppm Chlorpyrifos: < 1.00 ppm Methyl parathion: < 3.00 ppm. <sup>[24,39]</sup>	√	√
Metal contamination	--	Lead: n.m.t. 10.0 ppm by weight Copper: n.m.t. 5 ppm by weight Arsenic: n.m.t. 0.1 ppm by weight Zinc: n.m.t. 25 ppm by weight Tin: Nil Cadmium: n.m.t. 0.1 ppm by weight Lead chromate: Nil <sup>[32]</sup>	√	√

n.m.t.: not more than; ppb: parts per billion, ppm: parts per million

**Table 6: Comparative analysis of the Turmeric standards in ASTA, ESA and Agmark.**

ASTA cleanliness specification of turmeric. <sup>[24]</sup>	Whole insect, dead: 3 by count Excreta, Mammalian: 11.1 mg/kg Excreta, Other: 11.1 mg/kg Mold: 3% by weight Insect Defiled/Infested: 2.5% by weight Extraneous Foreign Matter: 0.5% by weight
ESA (European Spice Association) quality minima for turmeric- <sup>[24]</sup>	<b>Whole turmeric</b> Total ash (% w/w) max: 8 Acid insoluble ash (% w/w) max: 2 Moisture (% w/w) max: 12 Volatile oil (v/w): 2.5 <b>Ground turmeric</b> Total ash (% w/w) max: 9 Acid insoluble ash (% w/w) max: 10 Moisture (% w/w) max: 10 Volatile oil (v/w): 1.5
Agmark standards for Turmeric powder. <sup>[24]</sup>	<b>Powder (passed 300 micron sieve)</b> Moisture (% w/w) max: 10 Total ash (% w/w) max: 7 Acid insoluble ash (% w/w) max: 1.5 Lead max (ppm): 2.5 Starch max (% w/w): 60 Chromate test: Negative <b>Coarse ground powder (passed 500 micron sieve)</b> Moisture (% w/w) max: 10 Total ash (% w/w) max: 9 Acid insoluble ash (% w/w) max: 1.5 Lead max (ppm): 2.5 Starch max (% w/w): 60 Chromate test: Negative

%w/w: per cent weight by weight; %w/v: per cent weight by volume; ppm: parts per million

**Table 7: Agmark specifications of different grades of Turmeric.**<sup>[24]</sup>

Parameters	Limits of Alleppey fingers (Good grade)	Limits of Alleppey fingers (Fair grade)	Fingers other than Alleppey (Special grade)	Fingers other than Alleppey (Good grade)	Fingers other than Alleppey (Fair grade)	Rajapore fingers (Special grade)	Rajapore fingers (Good grade)	Rajapore fingers (Fair grade)	Bulbs (Special grade)	Bulbs (Good grade)	Bulbs (Fair grade)
~Flexibility:	Hard to touch	Hard	Hard to touch, metallic twang on break	Hard to touch, metallic twang on break	Hard	Hard to touch, metallic twang on break	Hard to touch, metallic twang on break	Hard	-	-	-
~Broken pieces, fingers < 15 mm (not more than % by weight):	5	7	2	3	5	3	5	7	-	-	-
~Foreign matter (not more than % by weight)	1	1.5	1	1.5	2	1	1.5	2	1	1.5	2
~Defectives (not more than % by weight)	3	5	0.5	1	1.5	3	5	7	1	3	5
~Percentage of bulbs by weight, max.	4	5	2	3	5	2	3	5	-	-	-
~Flexibility:	Hard to touch	Hard	Hard to touch, metallic twang on break	Hard to touch, metallic twang on break	Hard	Hard to touch, metallic twang on break	Hard to touch, metallic twang on break	Hard	-	-	-

presence of heavy metals, pesticide residue and aflatoxin content in the turmeric leads to rejection of the lot.<sup>[38]</sup> Table 5 represents the range of toxicity indicators present in the different standard texts.

### Comparative analysis of ASTA, ESA and Agmark standards for turmeric

During export of turmeric to the USA, the customs notify the FDA (Food and Drug Administration) that carries the inspection of the produce for the quality estimation. If the batch is found to be adulterated or inferior quality, the batch is either destroyed or sent back to the exporting countries.<sup>[24]</sup> The ASTA (American Spice Trade Association, Inc.) has developed cleanliness specifications for spices that meet or exceed the food defect action levels of the FDA (<http://www.astaspice.com>). In the case of Europe, they have their quality parameters for the produce drafted by the European Spice Association (ESA). In general, the quality specifications are imposed by the importing country that mostly pertains to the cleanliness of turmeric. The rhizomes are graded into splits, bulbs and fingers. In the case of India, Agmark specifications (Agricultural Directorate of Marketing) are followed for checking and maintaining the quality standards of the turmeric.<sup>[24]</sup> A comparative analysis of quality parameters described in ASTA, ESA and Agmark are mentioned in Table 6. Similarly, different grades for Alleppey fingers, Rajapore fingers and bulbs of turmeric that are assigned by the Agmark are mentioned in Table 7.

## CONCLUSION AND FUTURE PROSPECTS

With the increase in the demand for medicinal plants, it is important to focus on the need for quality monitoring of medicinal plants. But unfortunately, little attention is paid towards the regulatory aspects and quality parameters of herbs and related formulations as compared to conventional medicine. In the present work, the authors have explored and compiled the quality parameters of turmeric that are mentioned in the API, ICMR, WHO, FSSAI, ASTA, ESA, Agmark to devise an intuitive review for the concerned stakeholders to compete in the fast-growing market. The implementation of these quality parameters would avoid hazardous contaminants that cause danger to the health of an individual consuming herbal formulation. This review imparts knowledge regarding the quality parameters that are essential for trade, FSSAI and industry. This review can act as a baseline study for compiling standard quality parameters for other medicinal plants and spices.

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

## Contribution details

All the authors have significantly contributed.

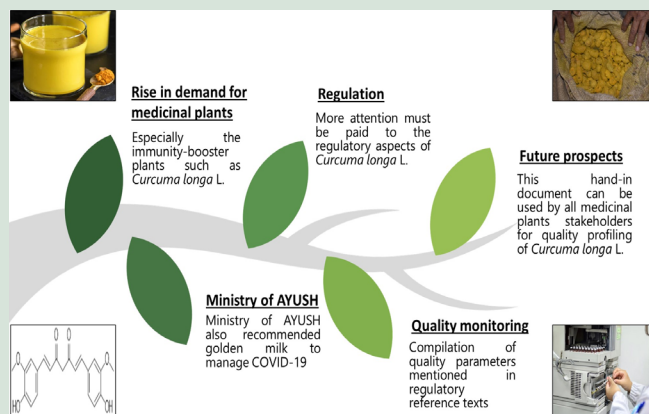
## ABBREVIATIONS

**%w/v**: per cent weight by volume; **%w/w**: per cent weight by weight; **n.l.t**: not less than; **n.m.t**: not more than; **API**: Ayurvedic Pharmacopoeia of India; **ASTA**: American Spice Trade Association, Inc; **AYUSH**: Ayurveda, Yoga, Unani, Siddha & Homeopathy; **cm**: centimeter; **COVID-19**: Coronavirus Disease; **CSIR**: Council of Scientific & Industrial Research; **ESA**: European Spice Association; **FDA**: Food and Drug Administration; **FSSAI**: Food Safety and Standards Authority of India; **GACP**: Good Agricultural and Collection Practices; **HPLC**: High Pressure Liquid Chromatography; **HPTLC**: High-Performance Thin Layer Chromatography; **ICMR**: Indian Council of Medical Research; **max.**: maximum; **mm**: millimetre; **MT**: Metric ton; **NMPB**: National Medicinal Plants Board; **ppm**: parts per million; **ppb**: parts per billion; **Rf**: Retention factor; **TCM**: Traditional Chinese Medicine; **TLC**: Thin Layer Chromatography; **UV**: Ultraviolet; **WHO**: World Health Organization.

## REFERENCES

- Jamshidi-Kia F, Zahra L, Amini-Khoei H. Medicinal plants: Past history and future perspective. *J Herbmed Pharmacol*. 2018;7(1):1-7.
- Payyappallimana U. Role of traditional medicine in primary health care: An overview of perspectives and challenging. *Yokohama J Social Sci*. 2010;14(6):57-77.
- WHO. WHO Guidelines on Good Agricultural and Collection Practices (GACP) for Medicinal Plants, Geneva, Switzerland: World Health Organization. 2003.
- Picking D. The global regulatory framework for medicinal plants. In: *Pharmacognosy: Fundamentals, Applications and Strategies*. Academic Press. 2017;663-75.
- Jiofack T, Fokunang C, Guedje N, Kemeuze V, Fongnzossie E, Nkongmeneck BA, et al. Ethnobotanical uses of medicinal plants of two ethnoecological regions of Cameroon. *Int J Med Medical Sci*. 2010;2(3):60-79.
- Goraya GS, Ved DK. Medicinal Plants in India: An Assessment of their Demand and Supply. National Medicinal Plants Board, Ministry of AYUSH, Government of India, New Delhi and Indian Council of Forestry Research and Education Dehradun. 2017.
- Mukherjee PW. Quality Control of Herbal Drugs: An Approach to Evaluation of Botanicals. New Delhi, India: Business Horizons Publishers. 2002.
- Gupta SC, Sung B, Kim JH, Prasad S, Li S, Aggarwal BB. Multitargeting by turmeric, the golden spice: from kitchen to clinic. *Mol Nutr Food Res*. 2013;57(9):1510-28.
- Labban L. Medicinal and pharmacological properties of turmeric (*Curcuma longa*): A review. *Int J Pharm Biomed Sci*. 2014;5(1):17-23.
- Nandan A, Tiwari S, Sharma V. Exploring alternative medicine options for the prevention or treatment of coronavirus disease 2019 (COVID-19): A systematic scoping review. *medRxiv* 2020;1-40. doi: <https://doi.org/10.1101/2020.05.14.20101352>
- Singh PA, Bajwa N, Baldi A. Possible role of traditional systems of medicine to manage COVID-19: A review. *Israel J Plant Sci*. 2020;5(4):205-9.
- Gupta H, Gupta M, Bhargava S. Potential use of turmeric in COVID-19. *Clin Exp Dermatol*. 2020;45(7):891-921.
- Urumarudappa SKJ, Gogna N, Newmaster SG, Venkatarangaiah K, Subramanyam R, Saroja SG, et al. DNA barcoding and NMR spectroscopy-based assessment of species adulteration in the raw herbal trade of *Saraca asoca* (Roxb.) Willd, an important medicinal plant. *Int J Legal Med*. 2016;130(6):1457-70.
- Singh PA, Baldi A. Good agricultural practices: A prerequisite approach for enhancing the quality of Indian herbal medicines. *Biomed J Sci and Tech Res*. 2018;5(5):1-4.
- Verma S, Singh SP. Current and future status of herbal medicines. *Vet World*. 2008;1(11):347-50.
- Joshi VK, Joshi A, Dhiman KS. The Ayurvedic Pharmacopoeia of India, development and perspectives. *J Ethnopharmacol*. 2017;197:32-8.
- Yadav NP, Dixit VK. Recent approaches in herbal drug standardization. *Int J Integr Biol*. 2008;2(3):195-203.
- Tandon N. Quality Standards of Indian Medicinal Plants. Indian Council of Medical Research, New Delhi. 2011;
- Tandon N, Sharma M. Quality Standards of Indian Medicinal Plants. Vol. 8. Indian Council of Medical Research, New Delhi. 2010.
- Tandon N, Sharma P. Quality Standards of Indian Medicinal Plants. Vol. 10. Indian Council of Medical Research, New Delhi. 2012.
- Tandon N, Sharma P. Quality Standards of Indian Medicinal Plants. Vol. 12. Indian Council of Medical Research, New Delhi. 2014.
- Tandon N, Sharma P. Quality Standards of Indian Medicinal Plants. Vol. 13. Indian Council of Medical Research, New Delhi. 2015.
- Tandon N, Sharma P. Quality Standards of Indian Medicinal Plants. Vol. 11. Indian Council of Medical Research, New Delhi. 2013.
- Plotto A. turmeric: Post-production management. Food and Agriculture Organization of the United Nations (FAO), AGST. 2004.
- World Health Organization. Quality control methods for medicinal plant materials. 1998.
- World Health Organization. Quality control methods for herbal materials. 2011.
- DeMedeiros PM, Pinto BLS, DoNascimento VT. Can organoleptic properties explain the differential use of medicinal plants? Evidence from Northeastern Brazil *J Ethnopharmacol*. 2015;159:43-8.
- The Ayurvedic Pharmacopoeia of India. Part-I, Government of India, Ministry of Health and Family Welfare, Department of AYUSH, New-Delhi, 1989;1:60-1.
- Indian Herbal Pharmacopoeia, Indian Drug Manufacturers Association and Jammu Tawi: Regional Research Laboratory (CSIR).1998;1.
- Singh PA, Bajwa N, Naman S, Baldi A. A review on robust computational approaches based identification and authentication of herbal raw drugs. *Lett Drug Des Discov*. 2020;17(1): 1066-1083.
- Wallis TE. Text Book of Pharmacognosy. 5<sup>th</sup> edition. CBS publishers and distributors; 2004.
- FSSAI. Ministry of Health and Family Welfare. Notification: F.No. 2-15015/30/2010; 2011.
- Chaudhary M, Kumar N, Baldi A, Chandra R, Babu MA, Madan J. 4-Bromo-4'-chloro pyrazoline analog of curcumin augmented anticancer activity against human cervical cancer, HeLa cells: *In silico*-guided analysis, synthesis and *in vitro* cytotoxicity. *J Biomol Struct Dyn* 2020;38(5):1335-53.
- Chaudhary M, Kumar N, Baldi A, Chandra R, ArockiaBabu M, Madan J. Chloro and bromo-pyrazole curcumin Knoevenagel condensates augmented anticancer activity against human cervical cancer cells: Design, synthesis, *in silico* docking and *in vitro* cytotoxicity analysis. *J Biomol Struct Dyn*. 2020;38(1):200-18.
- Kumar S, Baldi A, Sharma DK. Phytosomes: A modernistic approach for novel herbal drug delivery-enhancing bioavailability and revealing endless frontier of phytopharmaceuticals. *J Develop Drugs*. 2009;8(1):1-8.
- Baldi A, Chaudhary M, Sethi S, Chandra R, Madan J. Armamentarium of nanoscaled lipid drug delivery systems customized for oral administration: *In silico* docking patronage, absorption phenomenon, preclinical status, clinical status and future prospects. *Colloid Surface B* 2018;170:637-47.
- Kaaya NA, Warren HL. Review of past and present research on Aflatoxin in Uganda. *Afr J Food Agri Nutri Develop*. 2005;5(1):1-18.
- DeFreitas AMG, Bauab TM. Microbial quality of medicinal plant materials. *Latent Res Qual Cont*. 2012;67-81.
- FAO and WHO. Pesticide residues in food 2018 - Report 2018 - Joint FAO/WHO Meeting on Pesticide Residues. FAO Plant Production and Protection Rome. 2019;234

## GRAPHICAL ABSTRACT



## SUMMARY

- There rise in the demand for medicinal plants especially the immunity-booster plants.
- Golden milk (*Curcuma longa* L. milk) is recommended by the Ministry of AYUSH to manage COVID-19.
- Quality standard parameters for *Curcuma longa* L. are described to prevent adulteration and compete in growing market.

## ABOUT AUTHORS



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