

Post-harvest processing in medicinal turmeric

India is the major turmeric exporter and represents 80% of the global production with the net profit of 201.2 million USD during 2020. Turmeric has high potential and enormous demand at international market with the global market value of 4419 million USD in 2023. The small and marginal farmers of turmeric growers could earn more revenue by adopting a small and simple post-harvest processing technique like curing rather than simply selling the fresh turmeric rhizome in market. This will not only impact the socio-economic status of such group of farmers, but it will also make a strong bonding between the growers and the consumers or companies directly, and also eventually fasten the process to bring the product in foreign market without compromising the quality and quantity. So, curing is a very significant post-harvest step, which involves boiling of rhizomes and drying to maximize the profit to the growers.

TURMERIC, popularly known as *haldi* in India is well-recognized for its therapeutic potential and has been traditionally used as food preservative, spices and for colouring. Turmeric, *Curcuma longa* belongs to Zingiberaceae family and its economic part is an underground rhizome. Besides the normally consumed yellow turmeric (*Curcuma longa*), white (*Curcuma zedoaria*) and black turmeric (*Curcuma caesia*) are well known for its nutritional and ethnomedicinal utility in various aspects. The pungency of white turmeric has mango like smell, very popularly acknowledged as '*Amba Haldi*' and it has tough brown skin with orange flesh and bitter flavour. The black turmeric (*Kali haldi*) flesh is most notable for its colouring and concentric circles in rhizomes, appearing in shades of dark blue, light blue, cobalt blue, to blue-green. Moreover, camphor-like aroma with mildly spicy and bitter undertones pungency is released from *kali haldi*. The

above mentioned two turmeric species are not commonly consumed in day-to-day cuisine spices due to their hot, sharp, sour, and earthy taste which is rather preferred for use in medicinal as well as in ornamental purpose. However, in terms of bioactive constituents, higher curcumin content is found in black turmeric, followed by yellow and white turmeric along with others chemical compounds. In white turmeric, major constituents are curzerenone (22.3%) followed by 1,8-cineole (15.9%) and germacrone (9.0%). Collectively turmeric growing farmers have wide scope in terms of supplying materials to the pharmaceutical industries for making drugs, cosmetics and process industries for powder preparation.

Currently, India is a leading producer, consumer and exporter of turmeric in the world. In India, Telangana is leading state (330.26 MT) followed by Maharashtra (262.61) and Karnataka (130.97) (NHB, 2021-22). During



Cultivation



Harvesting

Table 1. Optimum boiling temperature, duration, types of rhizome and its impact on quality parameters

Type of materials	Optimum boiling time (mins)	Boiling temperature	Preferable quality parameters
Finger rhizome	15	98°C	Oleoresin, curcumin and essential oil content
Mother rhizome	30	80°C	Crude protein
Finger rhizome	60	100°C	Dry matter content
Mother rhizome	45	100°C	Curing %, curcumin and volatile oil content
Whole rhizome	15	Steam	Curcumin and oleoresin content
Whole rhizome	30	Steam	Better skin removal, uniform yellow, very soft rhizomes

Table 2. Impact of quality parameters based on boiling types

Boiling nature/type	Quality parameters
Steam pressure (15 mins hold at 20 psi)	Minimum drying time (53.33 h)
Steam pressure (5 mins hold at 15 psi)	Maximum dry recovery (21.32%)
Steam pressure (10 mins hold at 15 psi)	Highest curcumin content (4.13%)
Boiling (60 mins)	Maximum retention of carbohydrates (53.15%), proteins (3.16%), fat (2.72%) and starch (49.14%)
Boiling (45 mins)	Maximum retention of curcumin (5.91%), essential oil (3.6%) and oleoresin (13.3%) and dried in 11 days
Steam	Higher retention of curcumin and oleoresin
Boiling (30 mins)	18 h of drying time in cured turmeric but in non-cured turmeric took 108 h

2019-20, 1.36 lakh tonnes of turmeric have been exported with the value of ₹ 1216.40 crores (Spice Board, Cochin). The USA is the largest consumer of Indian turmeric, importing 22% of the total exported value, followed by Bangladesh (18%), Iran (6%), and UAE (5%) during 2019-20. Emerging trend of export value of turmeric can be increased exponentially by modifying into value-added products or introducing some new innovative value-addition rather than selling simply in raw/fresh forms. Dry or powder forms of turmeric are priced 4 to 5 times higher than fresh rhizome. Therefore, it can ensure that small and marginal turmeric growers will get higher profitability by adopting processing of turmeric into value-added dry or powder form.

Turmeric's main value-added product is powder, for which foremost step is curing of fresh turmeric rhizome for obtaining dry rhizome. The process of curing includes the boiling of fresh turmeric rhizome and drying. Curing is preferably done three to five days after harvest. Finger and mother rhizome should be separated carefully because mother rhizomes (bulb) are normally kept for sowing purpose and finger rhizome undergoes curing process. Curing process involves boiling of cleaned fresh rhizomes in water for approximately 45-60 min or till froth comes out and white fumes appear, giving out a characteristic odour as per recommendation by IISS, Calicut. By curing, rhizomes become soft and can easily break when pressing and turn into yellow colour indicating an accurate boiling period. In case of mother rhizome, it requires more boiling duration of around 90 mins. The initial level of water in boiling should be 5-7 cm above the rhizomes. Over and under-cooking affects quality, as it deteriorates main quality parameter like curcumin when rhizome is boiled for too long and more

brittle when less boiled. Therefore, judgment of optimum boiling period is an important step in turmeric curing process. However, curing time is completely dependent on the size of rhizome, type of rhizome, variety, age and method of boiling and its temperature and based on that quality parameters are also altered (Table 1, 2). Whenever curing is done, always mother and finger rhizome should be cured batch wise because it has different size and thickness. Even smaller size batch corresponds better dry turmeric quality than larger batch as per research findings. Boiling of turmeric rhizome in alkaline condition is also recommended by various scientist; addition of 0.05 to 1.0% sodium carbonate or lime (calcium carbonate) gives intense colour of final turmeric powder. Even CFTRI, Mysuru has also proposed to boil rhizomes in lime water (20 g Na₂CO₃ + 20 ml HCl per 50 kg rhizomes). There has been development of different techniques to boil the rhizome by State Agricultural Universities and other institutes working in this domain.

During boiling, starch gets gelatinized which reduces drying time significantly and also distributes colour uniformly throughout the rhizomes. It also facilitates the sterilization of materials keeping it free from insect infestation throughout the storage. Boiled rhizomes are sliced (4-5 mm thickness) into small pieces uniformly which reduces the drying time and is reported to improve the quality of final product. It is practiced by hand, using a knife or mechanically through specially designed vegetable cutter. A number of instruments are available in market and even CFTRI, Mysuru also developed slicer specially designed for turmeric slicing. Slicing can be done even before the boiling and then the sliced rhizome are boiled.

Ultimately drying is done, and it is a critically

Table 3. Impact of different drying techniques on quality parameters

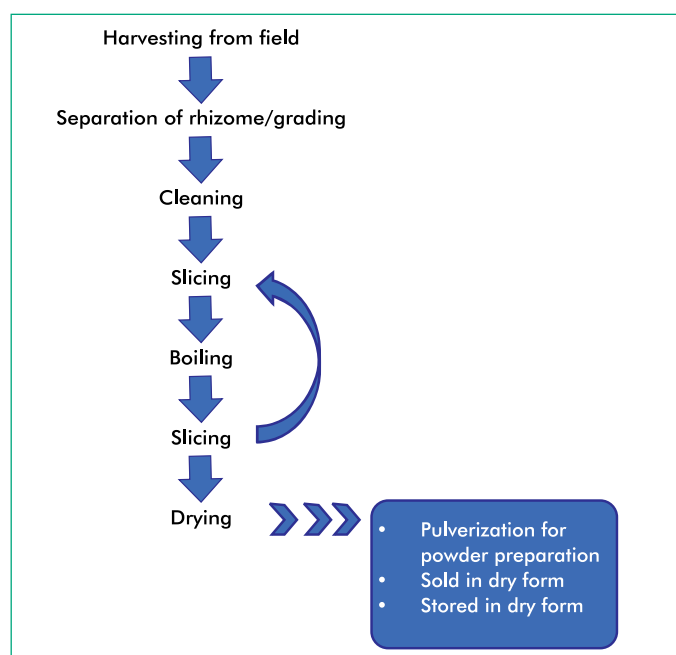
Type of dryer	Preferable quality parameters
Solar dryer	Degraded curcuminoids by 36.5% and the anti-oxidant capacity value decreased by 14%
Fluidized bed dryer (50-80°C)	Took lowest drying time without affecting curcuminoids and the antioxidant capacity
Hot-air dryer (70°C)	Higher curcumin (2.97%) with less drying time
Hot air dryer (60°C)	Low moisture level (4.23%) with less water activity (0.256%)
Solar tunnel dryer	Retains maximum curcumin content
Shade-net drying	Maximum retention of curcumin and dry recovery rate



Separation of mother and finger rhizomes



Dried rhizome



Turmeric processing

rhizomes are spread in 5-7 cm thick layers (avoid thin layer because it impairs quality). During the night time, it should be heaped or covered to prevent from the moisture absorption. The final quality parameters and duration of drying (Table 3) are the matter and various researchers revealed the pros and cons of each drying techniques. But, based on the availability, suitability and financial condition it is better to adopt the best dryer to get good quality and higher net return.

Eventually cured dried products can be used in powder preparation or sold in dried form or even can be stored for long period without any deterioration in terms of quality and quantity. Therefore, curing is a much necessary step in turmeric as a post-harvest event with an evidence that it increases the quality, shelf life and value. This small and simple post-harvest processing will offer huge scope for strengthening and development of entrepreneurship concept at micro, small or medium levels. More bridging between the growers and the consumers or the companies; will definitely help the farmers attain a better socio-economic status in a sustainable direction.

important step which reduces the moisture to different level at 10% for grinding or 5-6% for safe storage. There are different forms of drying techniques practiced including sun-drying. Other drying techniques include solar drying, hot air oven drying, tray drying, freeze drying, vacuum drying, microwave drying and osmotic drying has been used in turmeric drying in past and presently based on the condition. In sun-drying, sliced

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