

Process Optimization in Turmeric Heat Treatment by Design and Fabrication of Blancher

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Abstract. The manufacturing of Curcumin and Oleoresin in turmeric process treatment by traditional methods is studied and an introduction of new method of treatment by design, fabrication and evaluation is done in the process plant established in MAU campus. The process results in quality improvement in turmeric ingredients such as loss of color in curcumin reduced to 1% and also other factors such as time, overall labor cost and fuel was reduced.

Turmeric steam cooker is designed, fabricated and installed for the experiments to be conducted to study and evaluate the traditional method with the proposed one. It is observed that in the steam cooking process the material handling system is easy and comfortable, no trampling of cooked rhizomes, fuel required 87kg/batch of 300kg mass, which is less than half of the traditional method. The loss of color observed in curcumin, which is 1.5 to 2.5% in steam cooking whereas in boiling it is 1.6 to 3.5%. Thus the process of steam treatment is suggested to the turmeric business which is beneficial to farmers and turmeric process industries

Keywords: turmeric steam cooker, blancher, curcumin, oleoresin, heat treatment

1. Introduction

Turmeric is graded with its deep yellow color because of curcumin and aromatic flavor. Curcumin can be extracted by methanol, ethanol, acetone and dichloro ethylene and is used both as a spice and as a food coloring agent in pickles, chutneys, curries and other culinary preparations, as a drug and in cosmetics and in Ayurvedic system of medicine. The quality of turmeric depends upon curcumin content, organoleptic characters, general appearance, size and physical form of rhizome. India ranks first with 90% production of turmeric i.e. 701.16 lakh tones from 185.32-lakh ha. of area. (Varshney et al 2004). Maharashtra produces about 200 MT turmeric from 700 ha area under turmeric. (Vikas 2003). Because of increasing demand of turmeric in the market with good market returns and fluctuations in the market of other cash crops, turmeric is emerging as an assured cash crop in Marathwada and Vidarbha region of Maharashtra.

Traditional practice of using cow dung extract and lead chromate base for boiling has been found hazardous to the health. The other practice is to immerse the rhizomes in boiling water and take out after froth formation and typical odor when white fumes come out. But there are many drawbacks in this method such as

- Overcooking of rhizomes at the bottom of boiling pot and undercooking at the top of the heap.
- Loss of curcumin and oleoresin during taking out rhizomes from the vessel due to injuries occurred by rubbing, bruising etc.
- High labor requirement.

- Losses in handling, inefficient use of fuel, requires more time and increases cost of processing

This research was carried out to reduce the losses and difficulties of turmeric growers and processing industries because of traditional method of turmeric processing. In steam cooking, water vapor hardly escapes in the atmosphere, steam is uniformly distributed throughout the mass and uniform cooking is facilitated, loss of heat is prevented, easy handling and cost of processing is reduced. Because of faster rate of cooking, quality of turmeric will also be improved. The overall cost of processing will be reduced due to above reasons. By considering the advantages of steam cooking turmeric steam cooker was designed, fabricated and tested in the College of Agril. Engg. & Technology, M.A.U.,Parbhani.

2. Material and Methods

Turmeric steam cooker consists of foundation and platform, boiler, cooking vessels, steam conduit, pressure gauge, temperature gauge, water level indicator, water inlet valve, flush valve, safety valve and steam control valve. Turmeric steam cooker was designed by following the standard method. Design details are shown in the Table 1. Turmeric rhizomes of variety Salem were harvested, graded, washed with clean water and then boiled in traditional turmeric boiling pot and cooked in turmeric steam cooker for 15,20,25 and 30 minutes. Agricultural waste was used as a fuel. Three wheel trolley and gunny bags were used to handle and store the rhizomes. Turmeric cured by both the methods was dried in the open drying yard, solar dryer and in shade. Dried turmeric samples were polished; ground and were filled in the polyethylene bags. Then samples were analyzed to know the percentage of curcumin and oleoresin content by following American Spice Trade Association method.

Since 2005-06 the blancher was evaluated for three years and observations were tabulated. The fuel required per quintal of turmeric, drying time, labor required, losses during handling and processing, difficulties in processing, effect of time, method of steam cooking and boiling on quality parameters was noted.

Table 1. The assumptions made in the design of Turmeric Steam Blancher.

Sr. No.	Name of the Item	Specifications
1	Capacity	300kg /batch
2	Size	4.625 m x 1.65m x 2.45 m
3	IMC of turmeric rhizomes	72-75%
4	MC of blanched turmeric rhizomes	75-79 %
5	Ambient air temperature	25-40 °C
6	Steam pressure in boiler	1.05kg/cm ²
7	Steam pressure in vessel	0.75kg/cm ²
8	Type	Internally Fired Fire tube batch type
9	Loading and unloading time	10min.
10	Heat required for evaporation of 1kg water	2257kJ
11	Material of construction	Mild steel
12	Fuel	Wood/Agricultural waste
13	Calorific value of fuel	4500 kcal/kg.



Thermal Insulation by glass wool

TURMERIC-BLANCHER
*designed fabricated
and installed in MAU-
Campus.
introduced by
Prof.K.J.Kamble and
Computer aided design
testing by
Gopal U. Shinde
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Table 2.Components of Turmeric Steam Cooker.

Boiler	No. of tube	4
	Diameter of tube	0.15 m.
	Length of tube	1.2 m.
	Thickness of tube	0.002 m.
	Area of tube	0.565m ²
	Tube position	On top of the furnace
	Rate of evaporation	125 kg. / hr. (4.4 kg. / kg. of fuel)
Furnace	Size	1.05m. x 1.05m x 0.45m
	Thickness	0.003 m.
	Volume	0.496 m ³
	Feed gate size	0.15m x 0.15m x 0.30m
	Grate size	0.15m x 0.15m x 0.10m
	Diameter of M.S. bar	0.025m
	Fuel feed rate	100 kg/ hr.
Water Tank	Size	1.65m x 1.65m x 2.00m.
	Thickness	0.003m.
	Capacity	3500 liters
	Circulation of water	Natural circulation
Accessories	Safety valve	1
	Control valve	2
	Flush valve	1
	Water level indicator	1
Chimney	Size	22.5 cm. X 22.5 cm.
	Height	1m.
Vessel	Shape	Cylindrical (Trapezoid bottom)
	No. of Vessels	2
	Position	Vertical
	Height	1.15m.
	Diameter	0.68m.
	Capacity	3 qt. (1.5+1.5)
	Loading / unloading	Manually
	Inlet	Lid with push and lock type
	Outlet	Gear driven metal plate supported with MS bar from bottom side at three places
	Accessories	Pressure gauge, Steam distribution pipe, Steam regulating valves.
Area of heat conduction	Furnace area	2.606m ²
	Tube area	0.565m ²

	Total area	3.172m²
Working Conditions	Steam type	Saturated steam
	Pressure	0.75 kg./cm² (Atmospheric pressure)
	Temperature	100 + 10⁰C
Foundation	Length x Width x Height	6.625 m x 3.15 m x 1.20 m.
	Brickwork	25.04 m³
Trolley	Size	2.00m. x 1.50m. x 0.60m.
	Handle Diameter	0.025m
	Three metal wheels	D=0.20m

3. RESULTS AND DISCUSSION

It is observed that turmeric rhizomes steam cooked for 15,20,25 and 30min. minutes attains non-uniform yellow color with separate yellow core and outer layer, uniform yellow color with visible core, uniform yellow color with soft rhizomes and uniform yellow color with very soft rhizomes respectively. Although the rhizomes steam cooked for 25 and 30 minutes shows uniform color of core but are soft to handle which leads breakage and rubbing during handling before drying which may lead to great loss of Curcumin in drying See table 3.

From table 4 it is observed that turmeric rhizomes stem cooked and boiled for 15, 20, 25, and 30 minute retains curcumin content 4.28%, 4.27%, 4.09%, 4.01% and 4.25%, 4.21%, 3.91%, 2.29% respectively. Also the oleoresin content in the rhizomes steam cooked and boiled was 5.04%, 5.01%, 4.92%, 4.90% and 4.99%, 4.98%, 4.86% and 4.81% respectively. The loss of curcumin and oleoresin content in turmeric boiling is more as compared to steam cooking. The volatile oil content was analyzed by Clevenger method and total color content by (American Spice Trade Association) method. The cooking of rhizomes as well as their storage leads to reduction in essential oils.

From table 5 it is observed that the moisture content of steam cooked and boiled turmeric was 78.5% and 80.67% respectively. The moisture content in stem cooked turmeric rhizomes was less than the boiled rhizomes. The time of drying for steam cooked and boiled turmeric was 8,10, 12 days and 11, 15, 18, days when dried in solar cabinet dryer, open sunlight, shade respectively.

From table 6 it is observed that handling steam cooked turmeric rhizomes is easier than boiled rhizomes. Trampling take place in boiling whereas in steam cooking trolley is used to handle the steam cooked rhizomes to avoid the trampling of rhizomes. Labor required for steam cooking is half of the boiling process. The time required for optimum boiling is 30 to 35 minutes where as steam cooking is carried out in only 20 minutes. Also the fuel required for boiling 300kg turmeric rhizome is 165kg where as for steam cooking it is 96.66kg.

Table 3. Effect of steam cooking on turmeric rhizomes.

Time (Minutes)	Skin removal	Stick piercing	Color Uniformity
15	Difficult	Difficult	Non uniform yellow, Visible Core
20	Less easy	Less easy	Uniform yellow, Slightly visible Core
25	Easy	Easy	Uniform yellow
30	More easy	More easy	Uniform yellow, very soft rhizomes

Table 4. Effect of steam cooking and boiling time on curcumin and oleoresin.

Content %	Time in minutes							
	Steam cooking				Boiling			
	15	20	25	30	15	20	25	30
Curcumin	4.28	4.27	4.09	4.01	4.23	4.21	3.91	2.29
Oleoresin	5.04	5.01	4.92	4.90	4.99	4.98	4.86	4.81

Table 5. Effect of cooking method on turmeric drying.

Drying Method	Steam cooking			Boiling	
	IMC %	FMC %	Drying Time up to 6% m.c. (wb)	FMC %	Drying Time up to 6% m.c.(wb)(days)
Solar Cabinet Dryer	76	78.5	8	80.67	11
Sun Drying	76	78.5	10	80.67	15
Shade	76	78.5	12	80.67	18

Table 6:- Time, fuel and labor requirement for steam cooking and boiling of turmeric.

Sr.No.	Process	Steam Cooking	Boiling
1.	Handling	Easy	Difficult
2.	Tramplng	No tramplng	Takes place
3.	Labor required	2	4
4.	Time of curing	20min.	30-35min
5.	Fuel required	96.66kg	165kg

4. SUMMERY AND CONCLUSION

The improved method of turmeric boiling given by CFTRI is quite better than the traditional one but still there are losses of quality, labor and time. Hence study was undertaken to design and fabricate turmeric steam cooker and it was evaluated in 2006-07, 2007-08 and 2008-09. The results compared with the traditional method of turmeric boiling.

In the study it was observed that in steam cooking handling of turmeric is easy and labor required is half of boiling method, no tramplng of cooked rhizomes, fuel required 87kg in place of 185kg per batch of 300kg for boiling. The loss of important coloring matter curcumin, the main quality parameter is 1.5 to 2.5% in steam cooking whereas in boiling it is 1.6 to 3.5%. Time required for drying of steam-cooked turmeric is 8days where as for boiled turmeric 15days. By considering the advantages of reducing the losses of fuel, labor, time, quality and difficulties in turmeric processing, steam-cooking method is beneficial to the turmeric growers and processing industries.

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