J. Farm Sci., 31(3): (315-319) 2018

RESEARCH PAPER

Effect of pre-drying treatments and drying methods on drying time, moisture content and dry recovery of turmeric (*Curcuma longa* L.)

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(Received: July, 2018 ; Accepted: September, 2018)

Abstract: This investigation deals with the effect of pre-drying treatments and drying methods on drying time, moisture content and dry recovery of turmeric. The experiment includes five pre-drying treatments namely, slicing, peeling, steaming, blanching with polythene sheet and boiling, and three drying methods namely, solar drying, microwave drying and open sun drying. Among pre-drying treatments, steaming recorded the lowest drying time, the lowest final moisture content and blanching with polythene sheet recorded the highest dry recovery. Whereas among the drying methods, microwave drying recorded the least drying time and the highest dry recovery and solar drying recorded the lowest final moisture content.

Key words: Drying methods, Dry recovery, Drying time, Turmeric

Introduction

Turmeric (*Curcuma longa* L.) is one of the important commercial spice crops of India. Besides the taste and aroma, it is also being used for medicinal value since ancient times. Because of its unique flavour, medicinal properties, significance in religious ceremonies and auspicious occasions, it is popular since vedic times (Jacob, 1995). India is the home of turmeric and contributes to largest share in production, consumption and export in the world. Because of high curcumin content, Indian turmeric is considered to be the best in the world market. India has 1.93 lakh hectare area under turmeric cultivation with a total production of 10.51 lakh tonnes during 2016-17 (Anon., 2017). During 2016-17, India exported 1.16 lakh tonnes with the export value of ₹1,241.9 crores. The important turmeric growing states in India are Telangana, Maharashtra, Tamil Nadu, Andhra Pradesh, Karnataka and Gujarat. In Karnataka, 0.14 lakh hectare area is under turmeric with production of 0.76 lakh tonnes (Anon., 2017).

The processing of turmeric is the most expensive and labour intensive operation in turmeric cultivation. It involves boiling, drying, polishing and colouring. Boiling is the first post harvest operation to be performed at the farm level which involves cooking of fresh rhizomes in water. Boiling avoids the raw odour, kills the vitality of rhizome, reduces the drying time and yields uniformly coloured product. The cooked fingers are dried in the sun by spreading on the drying floor. It may take 10-15 days for the rhizome to become completely dry. Dried turmeric has poor appearance and rough dull outer surface with scales and root bits. The appearance is improved by smoothening and polishing the outer surface by manual or mechanical rubbing. The colour of the processed turmeric influences the price of the produce. Hence, to obtain attractive product, turmeric powder is sprinkled during the last phase of polishing.

Boiling the turmeric rhizomes prior to drying reduces drying time. However, it results in leaching loss of pigments and nutrients. Due to prolonged drying, open sun drying results in loss of volatile oil, destruction of light sensitive pigments and poor quality (Pruthi, 1976; Jose and Joy, 2005). Hence, a study was conducted to know the effect of different pre-drying treatments and drying methods on drying time, moisture content and dry recovery of turmeric.

Material and methods

The present investigation was carried out during 2017-18 at the Department of Horticulture, College of Agriculture, UAS, Dharwad. The fresh turmeric rhizomes of variety 'Salem' was collected from Spice Unit, UAS, Dharwad. Rhizomes were washed thoroughly in water to remove the adhering soil, hairs and extraneous matter. The undesirable portions were removed manually and subjected to pre-drying treatments *viz.,* slicing, peeling, steaming, blanching with polythene sheet and boiling followed by drying methods *viz.,* solar drying, microwave drying and open sun drying.

Turmeric rhizomes were cut into slices of 1cm thickness using vegetable dicer. Peeling was done using vegetable peeler. Steaming was done by subjecting the turmeric rhizomes to hot steam at a pressure of 15 lb/sq inch for 45 minutes using autoclave. Blanching with polythene sheet was done by placing rhizomes on transparent polythene sheet and covering with the same so that sweating was observed. This was done for two hours during the hottest part of the day. Rhizomes were boiled with plain water in aluminium vessel of 50 kg capacity for about one hour (check).

Solar drying was done using solar tunnel dryer (3.75 × 21.0 m) developed by College of Agricultural Engineering, UAS, Raichur. For Microwave drying, a microwave oven (model IFB 17 PM1) was used. In case of open sun drying the turmeric samples were spread on the cement floor in open yard and dried under sun during day time. It was covered in the night (check).

Observations regarding drying time (hr), moisture content (%) and dry recovery (%) were recorded. The experimental data were analysed statistically by the method of analysis of variance according to Panse and Sukhatme (1995).

Results and discussion

The data pertaining to the drying time required by turmeric rhizomes as influenced by pre-drying treatments and drying methods are presented in Table 1. Among pre-drying treatments, steaming recorded the minimum drying time (53.48 hr) whereas blanching with polythene sheet recorded the maximum drying time (128.50 hr). Among drying methods, microwave drying recorded the lowest drying time (0.43 hr) whereas open sun drying recorded the highest drying time (131 hr). Among interaction effects between pre-drying treatments and drying methods (P × D), the maximum drying time (205 hr) was recorded in blanching with polythene sheet followed by open sun drying and least (0.28 hr) in slicing followed by microwave drying.

During steaming, water vapour hardly escapes into the atmosphere. The steam distributes itself uniformly throughout the mass. This softens the tissue and thereby reduces drying time. Similar results were obtained by Viswanathan *et al.* (2002) who studied farm level steam boiling in turmeric. Blanching with polythene sheet is a recent approach followed in case of arecanut, black pepper, etc. Sweating caused during blanching results in faster drying rate. However, in the present

Table 1. Drying time required by turmeric rhizomes as influenced by pre-drying treatments and drying methods

Pre-drying treatments	Drying time (hr)			
	Drying methods			
	Solar drying	Microwave drying	Open sun drying	Mean
Slicing	90.00	0.28 (16.8)	110.00	66.76
Peeling	130.00	0.44 (26.4)	150.00	93.48
Steaming	70.00	0.45 (27.0)	90.00	53.48
Blanching with polythene sheet	180.00	0.51 (30.6)	205.00	128.50
Boiling	80.00	0.46 (27.6)	100.00	60.15
Mean	110.00	0.43 (25.8)	131.00	80.48

For comparing means of	S. Em±	C. D. at 1%
Pre-drying treatments (P)	0.75	3.11
Drying methods (D)	0.58	2.41
Interaction (P× D)	1.29	5.38

Figures in parantheses of drying time in microwave drying are drying time expressed in minutes

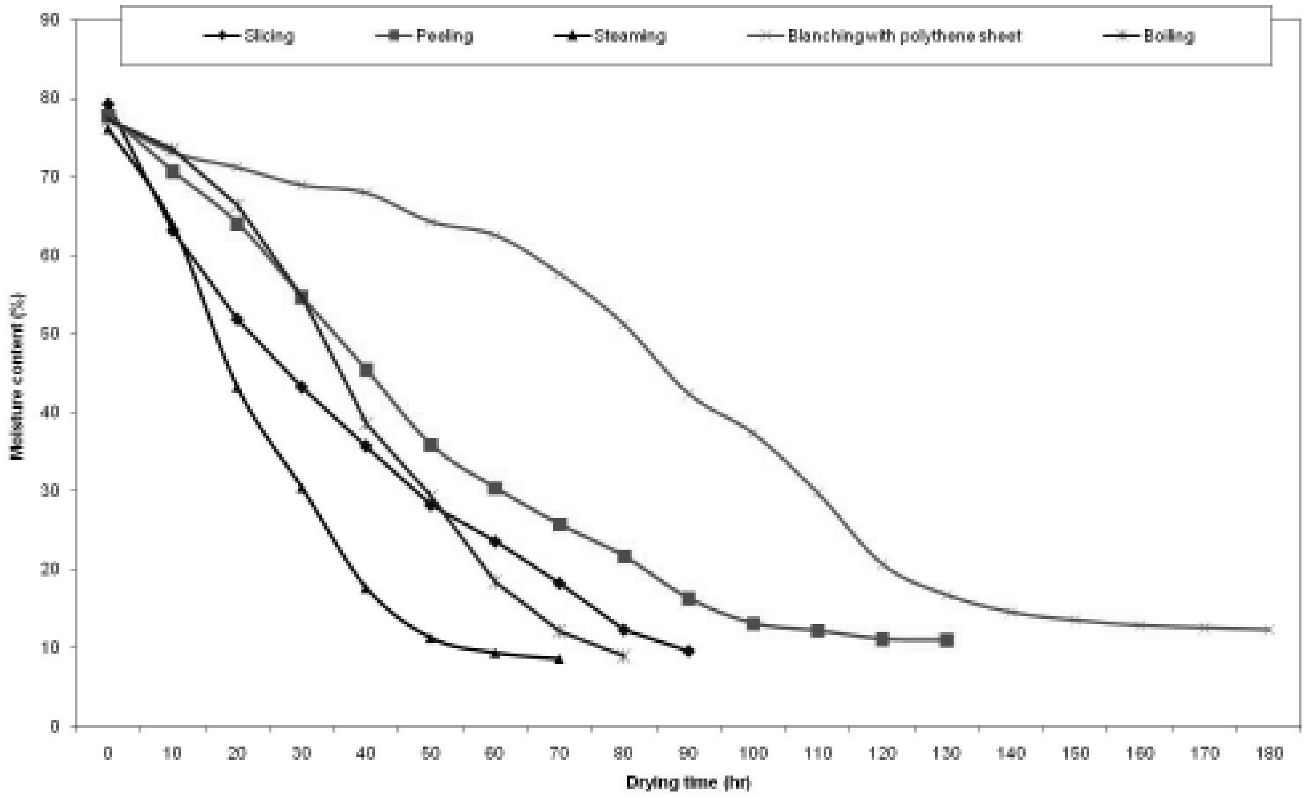

Fig. 1: Variation in moisture content of turmeric samples dried in solar drier after subjecting to pre-drying treatments

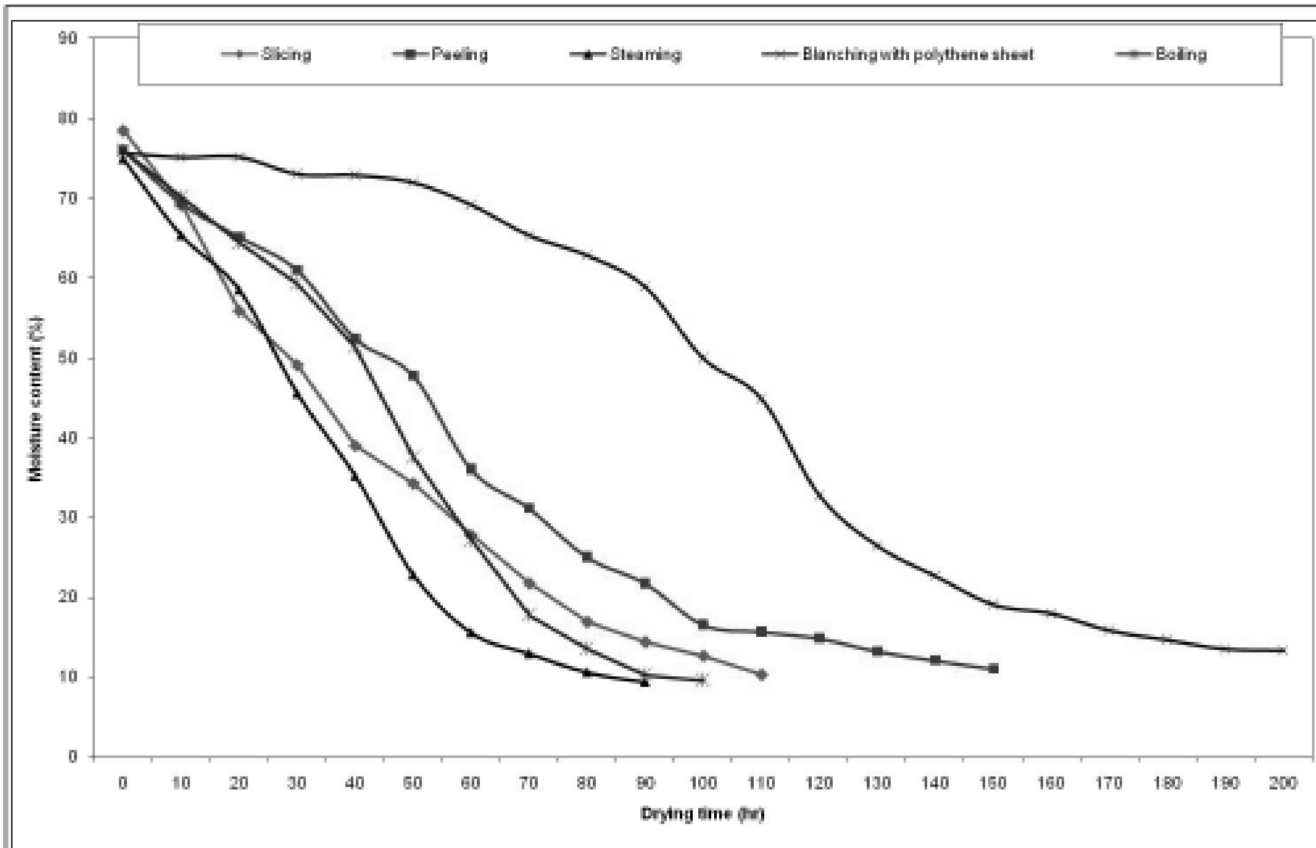

Fig. 2: Variation in moisture content of turmeric samples dried under open sun after subjecting to pre-drying treatments

investigation, this treatment was found ineffective in reducing drying time.

In the present investigation, microwave drying recorded the least drying time. In microwave drying, material to be dried absorbs microwave directly and internally and converts it into heat due to dipole moment and interactions of ions which leads to rapid heating rate (Chandrasekaran *et al.,* 2013). This could be the reason for least drying time in microwave drying. Similar results were obtained by Baby *et al.* (2017).

The variation in the moisture content of turmeric samples subjected to pre-drying treatments with drying time in solar drying and open sun drying is presented in Fig. 1 and Fig. 2. From the Fig. 1, it is seen that steaming has attained the lowest final moisture (8.61 %) among the pre-drying treatments in solar drying. Further, the highest final moisture content (12.34 %) was found in blanching with polythene sheet (Table 2). Samples subjected to blanching with polythene sheet took 80 hours in solar drier and 110 hours in open sun drying to reduce into 50 per cent moisture content compared to other pre-drying treatments, which took less than 40 hours in solar drier and less than 60 hours in case of open sun drying. In case of open sun drying, the lowest moisture content of 9.38 per cent was found in steaming while the highest final moisture content (13.36 %) was observed in blanching with polythene sheet (Table 2).

Moisture content is the chief factor which influences the storage life of any product. It is advisable to reduce final moisture content of turmeric to 6 to 12 per cent. In the present investigation, turmeric rhizomes subjected to steaming reached safer moisture level quickly after subjecting to drying. It was also noticed that low initial moisture content was present in steamed turmeric samples compared to other samples. Thus, it can be inferred from the observations that there was less absorption of moisture during steaming which in turn resulted in quicker drying rate. The turmeric samples subjected to blanching with polythene sheet took more time to reduce to 50 per cent moisture initially compared to other pre-drying treatments. It is always desirable to reduce moisture content quickly as it influences the storage life of product.

The solar drying achieved desired safe level of moisture at faster rate compared to open sun drying. This may due to the high temperature and low humidity prevailing inside solar drier compared to ambient condition. Similar results were reported by Gunasekar *et al.* (2006), Hossain and Bala (2007), Shinde *et al.* (2011) and Sanchavat *et al.* (2012).

The data pertaining to dry recovery of turmeric rhizomes as influenced by pre-drying treatments and drying methods are presented in Table 3. The results reveals that there was a significant difference among pre-drying treatments, drying methods and their interactions with respect to dry recovery. Among pre-drying treatments, blanching with polythene sheet recorded the highest dry recovery (22.76 %) and least (19.85 %) in peeling. With respect to drying methods, microwave drying recorded the highest dry recovery (23.79 %) and least (19.73 %)

Table 2. Initial and final moisture content (%) of turmeric samples as influenced by pre-drying treatments and drying methods

Pre-drying treatments	Initial moisture content (%)			Final moisture content (%)		
	Drying methods			Drying methods		
	Solar drying	Microwave drying	Open sun drying	Solar drying	Microwave drying	Open sun drying
Slicing	79.26	79.34	78.46	9.60	8.56	10.30
Peeling	77.82	77.56	76.00	10.99	9.34	11.03
Steaming	76.11	76.45	76.92	8.61	8.89	9.38
Blanching with polythene sheet	77.17	76.86	75.68	12.34	10.34	13.36
Boiling	77.28	76.67	76.01	8.95	9.08	9.61

Table 3. Dry recovery of turmeric rhizomes as influenced by different pre-drying treatments and drying methods

Pre-drying treatments	Dry recovery (%)			
	Drying methods			
	Solar drying	Microwave drying	Open sun drying	Mean
Slicing	18.20	22.40	20.00	20.20
Peeling	18.00	23.55	18.00	19.85
Steaming	20.32	24.19	21.63	22.05
Blanching with polythene sheet	21.37	24.51	22.40	22.76
Boiling	20.76	24.31	21.55	22.21
Mean	19.73	23.79	20.72	21.41
For comparing means of	S. Em±		C. D. at 1%	
Pre-drying treatments (P)	0.10		0.41	
Drying methods (D)	0.08		0.32	
Interaction (P× D)	0.17		0.72	

was in solar drying. Among interaction effect between pre-drying treatments and drying methods, blanching with polythene sheet followed by microwave drying recorded the highest dry recovery (24.51 %) and the least (18.00 %) was in peeling followed by open sun drying.

Dry recovery indicates how much quantity of spice is obtained after drying. In case of turmeric it varies from 18 to 25 per cent. It depends on stage of harvesting, variety, curing and processing practices. Since the raw material used for experiment is same, the processing methods might have affected dry recovery of turmeric. In the present investigation, turmeric samples subjected to peeling had the lowest dry recovery whereas highest was obtained in blanching with polythene sheet. Removal of rhizome skin during peeling caused loss of material. This in turn reduced dry recovery in case of peeling. Further, the dry recovery can be correlated with final moisture content. Turmeric samples subjected to blanching with polythene sheet had high final moisture content. This may be the reason for highest dry recovery in case of blanching with polythene sheet. However, retention of high moisture content in the sample is not desirable as it affects the storage life of product.

Microwave drying recorded highest dry recovery compared to other methods. This may be due to minimum damage to dry matter content in case of microwave dried samples. Similar results were reported by Baysal *et al.* (2003) who studied effect of microwave and infrared drying on quality of carrot and garlic. Whereas, samples dried in solar drier had low moisture content due to efficient drying which in turn resulted in low dry recovery. Similar results were reported by Joy *et al.* (2002) in case of black pepper.

Thus, from the above observations it could be concluded that steaming among the pre-drying treatments is the best with respect to drying time and quick moisture reduction. Microwave drying is the best which recorded the least drying time and the highest dry recovery among the drying methods.

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