International Food Research Journal 20(2): 745-749 (2013)
Journal homepage: *http://www.ifrj.upm.edu.my*

Effect of curing and drying methods on recovery, curcumin and essential oil content of different cultivars of turmeric (*Curcuma longa* L)

[1]Lokhande, S. M., [2]Kale, R. V., [1]Sahoo, A. K., and [3*]Ranveer, R. C.

[1]Department of Technology, Shivaji University, Kolhapur 416004 (MS), India
[2]MGM College of Food Technology, Aurangabad 431003 (MS), India
[3]Department of Food Science and Technology, Shivaji University, Kolhapur 416004 (MS), India

Article history

Received: 2June 2012
Received in revised form: 7September 2012
Accepted: 26 August 2012

Keywords

Turmeric
curcumin
volatile oil
curing
drying

Abstract

This investigation deals with the effect of curing and drying methods on the recovery, curcumin content and essential oil content in different turmeric cultivars. The Krishna cultivars were best among the three cultivars on the basis of physico-chemical analysis whereas, Salem and Tekurpeta had higher values for colour. The fingers cured with improved method loose moisture at faster rate than uncured and cured with traditional method. The fingers of Salem cultivar cured with improved method followed by shade-net drying had got higher recovery. The essential oil content of three cultivars was unaffected by the curing and drying methods.

Introduction

Turmeric is the dried rhizome of *Curcuma longa* L. of the ginger family. It is one of the extensively used spices and coloring agents in South and Southeast Asian cuisine, especially in the Indian subcontinent (Sarker and Nahar, 2007). Curcumin, demethoxycurcumin, bis-demethoxycurcumin, and ar-turmerone are four major active components of turmeric. It also contains high amounts of carotene, equivalent to 50 IU of vitamin A per 100 g (Chopra and Simon, 2000). Mostly it is used as a condiment and only a small quantity is used in pharmaceuticals and cosmetics (Chattopadhyay *et al*., 2004; Chirangini *et al*., 2004; Sarker and Nahar, 2007; Rouhani *et al*., 2009). Antioxidant activity and free radical scavenging potential are the most important characteristics (Nagarajan *et al*., 2010). The most valued constituent of turmeric is yellow pigment i.e. curcumin (Rakhunde *et al*., 1998) as it is an important factor in sensory and consumer acceptance of products (Wang *et al.*, 2009).

Turmeric contains on average 6% of curcuminoid pigments and 5% of essential oils (Bambirra *et al*., 2002). The common practice in India is to boil the rhizomes in water/alkaline water prior to dehydration. This along with drying conditions influences the level of curcuminoid pigments in the rhizomes (Sampathu *et al*., 1988). This investigation attempts to evaluate the effect of curing (Traditional and Improved) and drying methods (Mechanical, shade- net and sun) on physio-chemical characteristics, curcumin and essential oil contents of different cultivars of turmeric.

Materials and Method

Preparation of turmeric samples

Different Indian cultivars (i.e. Salem, Krishna and Tekurpetha) of turmeric were procured from local farmers of Sangli and Kolhapur districts of Maharashtra state (India). Freshly harvested turmeric rhizomes were sorted, cleaned to remove hairy roots and washed with potable water. The mother rhizomes and fingers were separated and fingers were divided into three lots. Out of these lots, one lot was kept as untreated (T1) and other two lots were, cured with traditional (T2) and improved (T3) methods respectively.

Curing of turmeric fingers

a) Traditional method

The cleaned fingers were cured by boiling for 40 - 50 min in water till it started frothing with white fumes, giving a typical odor. The water was then drained off using bamboo baskets. These were

*Corresponding author.
Email: *rahul.ranveer@gmail.com*

heaped on a drying yard and allowed to cool to room temperature, and then subjected to different drying methods (Govindrajan, 1980).

b) Improved methods

The cleaned fingers were taken in perforated galvanized mild steel drums and were immersed in a kettle containing alkaline solution (0.1% Sodium bicarbonate). The whole mass was boiled till the fingers became soft (Varshney *et al*., 2004) and then subjected to different drying methods.

Drying of turmeric fingers

Cured and uncured turmeric fingers of 5 cm thick were dried by three different drying methods i.e. sun, shade-net and mechanical. The completion of drying was indicated when fingers become hard, brittle and would break with metallic sound (Varshney *et al*., 2004).

a) Sun drying

Fingers were spread on the drying yard and exposed to the sun light for about 10 days and dried to about 10 % moisture content.

b) Shade net drying

The drying yard was coved with shade-net made-up of HDPE. Fingers were spread on the drying yard and exposed to sunlight for about 12 days and dried to about 10 % moisture content.

c) Mechanical drying

Fingers were spread on aluminum trays in a cross flow drier and dried at 60±2ºC for 48 hrs and dried to 10% moisture content (Singh *et al*., 2010).

Polishing and grinding

The dried turmeric fingers were subjected to a mechanical polisher and polished fingers were powdered with the help of a laboratory pulverizer.

Physical analysis

The length, breadth and weight of fingers were measured as per procedure suggested by Varshney *et al*. (2004), whereas the colour was recorded visually.

Chemical analysis

The powders obtained from shade-net dried fingers of three different cultivars were taken for analysis of moisture, protein, crude fat, crude fiber, ash, volatile oils, oleoresin content and curcumin content. The moisture, protein, crude fat and crude fiber contents were determined by standard procedure of AOAC (1990). The ash content, oleoresin and volatile oil content were determined by procedure suggested by Ranganna (1986). Total carbohydrate was estimated by Phenol – sulphuric acid method modified by Harold et al. (1999). Curcumin content was estimated by the procedure suggested by the ASTA (1968). Colour values were determined by using Lovibond tintometer (Model F).

Stastical analysis

The data obtained were subjected to analysis of variance (ANOVA) using complete randomized design according to Panse and Sukhatme (1961). The critical difference at $P<0.05$ was estimated and used to find significant difference if any.

Results and Discussion

Physical analysis

The results of physical parameters of fresh turmeric rhizomes of different cultivars are presented in table 1. The maximum number of fingers was recorded in Krishna cultivar (15) whereas minimum number in Tekurpetha cultivar (12). The visual observation of colour showed that Krishna rhizomes posses dark yellow colour, but Salem and Tekurpetha recorded reddish yellow colour. The results obtained are in agreement with the findings of Joseph and Nair (1983) and Subbarayedu *et al*. (1976).

Effect of curing and drying methods on recovery (%) of turmeric cultivars

The results of effect of curing and drying methods on recovery of turmeric cultivars are tabulated in table 2. The data reveals that there was no significant difference between cured and uncured samples for all the three cultivars. However, the samples dried in shade-net were having higher recovery than other drying methods for all the three cultivars. The data also shows that the recovery of Salem cultivar was higher than both Krishna and Tekurpeta cultivars. Pujari *et al*. (1987) had reported that Salem cultivar gives highest recovery compared to other cultivars.

Effect of curing and drying methods on curcumin content of turmeric cultivars

Effects of curing and drying methods on curcumin content of three turmeric cultivars were studied and the results obtained are given in table 3. The data revealed that the retention of curcumin was low in uncured samples than cured samples. Higher retention was observed in samples cured with improved method. According to Tonnesen and Karlsen (1985) in the improved curing method, the presence of alkali at higher temperature could favor the formation of ferulic acid and of feruloilmethane.

Table 1. Physical parameters of fresh turmeric rhizomes

Cultivar	Length of finger (cm)	Width of finger (cm)	Weight of rhizome (g)	No. of fingers / rhizome	Visual colour of Flesh
Krishna	10.24±0.10	2.9±0.51	178.4±0.10	15±0.58	Dark yellow
Salem	7.42±0.03	2.3±0.12	135.8±0.31	13±1.0	Reddish yellow
Tekurpetha	7.68±0.08	2.7±0.10	130.1±0.26	12±1.15	Reddish yellow

Results are mean ±SD of 20 determinations

Table 2. Effect of curing and drying methods on recovery (%) of different turmeric cultivars

Drying method	Salem			Krishna			Tekurpetha		
	T1	T2	T3	T1	T2	T3	T1	T2	T3
Sun drying	17.00	17.28	17.24	16.30	16.62	16.20	16.32	16.62	16.50
Shade-net Drying	19.04	19.10	19.44	16.49	16.84	16.80	16.74	16.90	16.82
Cabinet drying	17.00	17.10	17.12	16.35	16.45	16.60	16.50	16.45	16.58
SE	0.680	0.639	0.754	0.057	0.113	0.176	0.122	0.131	0.096
CD at 5%	2.924	2.747	3.243	0.245	0.485	0.758	0.523	0.564	0.413

T1 = untreated, T2 = Cured with traditional method and T3 = Cured with improved methods

Table 3. Effect of curing and drying methods on curcumin content (%) of turmeric cultivars

Drying method	Salem			Krishna			Tekurpetha		
	T1	T2	T3	T1	T2	T3	T1	T2	T3
Sun drying	4.98	5.02	5.15	2.55	2.60	2.70	2.74	2.80	2.86
Shade-net Drying	5.05	5.13	5.18	2.66	2.84	2.96	2.81	2.84	2.92
Cabinet drying	4.95	5.04	5.12	2.61	2.75	2.91	2.79	2.80	2.86
SE	0.030	0.034	0.017	0.032	0.070	0.080	0.021	0.013	0.020
CD at 5%	0.127	0.145	0.074	0.137	0.301	0.343	0.090	0.057	0.086

T1 = untreated, T2 = Cured with traditional method and T3 = Cured with improved methods

Table 4. Effect of curing and drying methods on essential oil contents (%) of turmeric cultivars

Drying method	Salem			Krishna			Tekurpetha		
	T1	T2	T3	T1	T2	T3	T1	T2	T3
Sun drying	2.86	2.83	2.84	2.14	2.18	2.10	2.39	2.23	2.37
Shade Drying	2.88	2.82	2.83	2.25	2.32	2.28	2.46	2.35	2.41
Cabinet drying	2.82	2.83	2.81	2.13	2.21	2.18	2.42	2.36	2.36
SE	0.018	0.003	0.009	0.038	0.043	0.052	0.020	0.042	0.015
CD at 5%	0.076	0.014	0.038	0.165	0.183	0.224	0.087	0.180	0.066

T1 = untreated, T2 = Cured with traditional method and T3 = Cured with improved methods

Part of the feruloilmethane formed during alkali degradation can participate in condensation reactions originating to compounds of yellow to yellow-brownish colour, which could affect the spectrophotometric determination of curcuminoid pigment. The retention of total curcumin content in Prabha and Prathibha cultivar was found higher when it was cured with improved method and dried under sun light (Kumar *et al*., 2010). The data showed that the shade-net drying was found to have higher retention of curcumin content than the mechanical and sun drying. But the colour of shade net dried samples was dull in appearance due to lower rate of moisture loss.

The higher value of curcumin content was recorded in Salem cultivar than other two cultivars. The amount of curcumin content of Salem varied in the range of 4.95 to 5.18% whereas, that of Krishna and Tekurpetha were in the range of 2.60 to 2.96%. Pujari *et al*. (1987) had reported similar findings for the curcumin content of these three turmeric cultivars. Krishnamurthy *et al*. (1975) had studied total colour value expressed in terms of curcumin content of 17 different turmeric cultivars and found that Nandyal cultivar was having highest value (4.1%) among them and Tekurpetha was having curcumin content of 1.85%.

Effect of curing and drying methods on essential oil content of turmeric cultivars

The essential oil content was estimated after curing and drying of different turmeric cultivars and is presented in table 4. It was observed that the Salem cultivar had higher value of essential oil, followed by Tekurpeta and Krishna (Rakhunde *et al*., 1998). There was no synergistic effect of curing and drying methods on essential oil content. The curing and drying methods (Sun drying and Mechanical drying) did not affect the essential oil content because the essential oil of turmeric had higher boiling point (Govindarajan, 1980).

Effect of curing on drying rates of salem cultivar

The results of effects of curing and drying methods on curcumin content showed that the Salem cultivar was having higher values among three cultivars. Hence, it was selected for drying rate study. The results of drying rates of the samples dried under sun, shade-net and mechanical drying are shown in figure 1, 2 and 3, respectively. It is observed that moisture loss of all cured and uncured samples with respect to drying time was linear with respect to time for all three types of dying. However, this linear trend of loss of moisture was for 6h of drying for mechanical drying method and 24 h of drying for sun and shade-net drying. Samples dried in mechanical drying were found to lose moisture rapidly during the initial stage and slowly at a later stage. This can be attributed to the fact that the moisture from surface is easily evaporated where as it takes time for moisture to be removed from the interior.

It can be summarized from all the three figures that the rate of drying was faster for mechanical drying method, which was 36 h for about 90% moisture loss as compared to sun and shade-net drying, where the time was 8 days and 10 days respectively to lose about 90% moisture.

Cured samples lost their moisture at faster rate than those uncured samples for all the three types of drying. However, between the two curing methods

Table 5. Chemical parameters of turmeric powder

Parameters (%)	Cultivars		
	Salem	Krishna	Tekurpetha
Moisture	9.08 ± 0.072	8.93 ±0.081	8.62 ±0.025
Protein	8.66 ± 0.058	7.62 ± 0.123	7.92 ± 0.065
Fat	7.86 ± 0.037	8.44 ±0.165	7.22 ± 0.055
Carbohydrates	67.9 ± 0.624	68.2 ± 0.568	69.9 ± 0.399
Crude fibre	7.83 ± 0.066	7.19 ± 0.073	8.06 ± 0.090
Ash	6.50 ± 0.100	6.81 ± 0.151	6.27 ± 0.110
Volatile oil	4.32 ± 0.158	4.82 ± 0.137	3.58 ± 0.106
Oleoresins	8.13 ± 0.095	9.56 ± 0.105	5.85 ± 0.090

Results are mean ±SD of three determinations

Table 6. Colour value of cured sun dried turmeric powder

Colour value	Variety		
	Salem	Krishna	Tekurpetha
Red	4.0±0.15	4.2±0.10	4.2±0.12
Yellow	26±1.00	24±1.53	24.5±1.73
Blue	0.1±0.03	0.1±0.02	0.1±0.03

Results are mean ± SD of three determinations

there was no significant difference in rate of drying. Govindrajan (1980) and Krishnamurthy *et al*. (1975) had reported that boiled or steamed rhizomes of turmeric reduce the drying time and gives better appearance to the product.

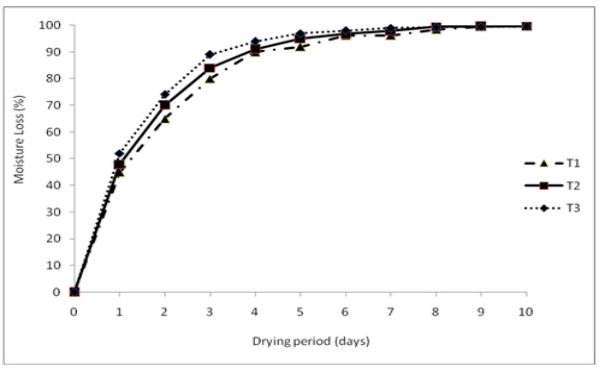
Physico-chemical analysis of turmeric powder

Since the turmeric fingers cured with improved method and dehydrated under shade-net were having higher values of curcumin content and essential oil, hence these samples were analyzed for chemical constituents. The obtained results are recorded in table 5. The data showed that carbohydrate content of all cultivars was in the range of 67.9 to 69.9%. The Salem (67.9%) recorded minimum carbohydrate content while maximum was in Tekurpetha (69.9%). There was no significant difference in the moisture content, protein, ash and crude fibers of different cultivars. Viasan *et al*. (1989) has reported similar findings for 11 cultivars of turmeric which did not include these three.

It was observed from table 5 that the volatile oil content of powders of all three cultivars varied from 3.58 to 4.82%. Maximum volatile oil content was found in case of Krishna and minimum was for Tekurpetha. Similar trends were reported by Rakhunde *et al*. (1998) for volatile oil content of fingers. It was also revealed from the data that there was significant difference in oleoresin contents of the three cultivars. Tekurpetha had lowest amount of oleoresins and Krishna had the highest amount.

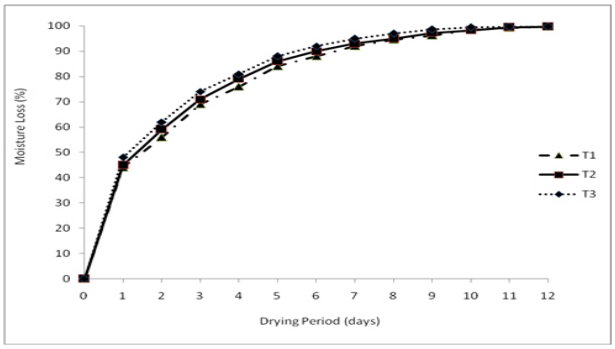
Colour

Samples of turmeric powders, cured with



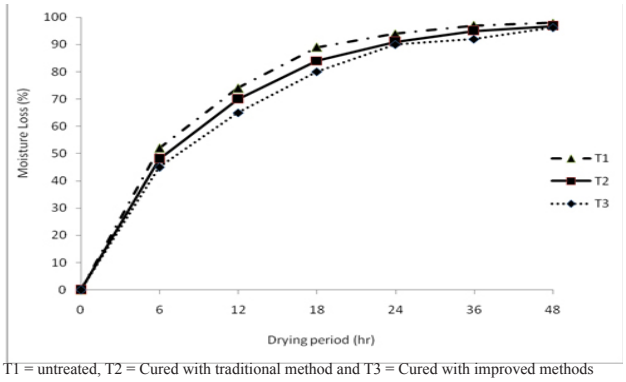
T1 = untreated, T2 = Cured with traditional method and T3 = Cured with improved methods

Figure 1. Effect of curing on drying rates of sun dried Salem cultivar



T1 = untreated, T2 = Cured with traditional method and T3 = Cured with improved methods

Figure 2. Effect of curing on drying rates of shade-net dried Salem cultivar of turmeric



T1 = untreated, T2 = Cured with traditional method and T3 = Cured with improved methods

Figure 3. Effect of curing on drying rates of mechanical dried Salem cultivar of turmeric

improved method and dried in shade-net were subjected to determination of colour values by using Lovibond tintometer (Model F) and obtained results are presented in table 6. Maximum yellow colour value was observed in Salem than Krishna and Tekurpetha cultivars. All the three cultivars were having similar colour values with respect to red and blue colour. Viasan *et al*. (1989) had reported that yellow colour of turmeric is due to pigments, curcumin, demethoxycurcumin and bis- demethoxycurcumin present in it.

Conclusion

The variety Krishna was found superior over

Salem and Tekurpetha in growth characteristics such as length, width, number of fingers per plant and weight whereas, Salem and Tekurpetha showed higher intensity of reddish yellow colour. The samples cured with improved method loose moisture faster than uncured samples and samples cured with traditional method. Recovery was highest in Salem by the improved curing method than Tekurpetha and Krishna. The shade-net drying was found superior over cabinet and sun drying for retention of curcumin content. The essential oil content was not affected by different curing and drying methods.

References

AOAC. 1990. Official methods of analysis. 15th Ed. Association of Official Analytical Chemist., Washington, D.C.

ASTA. 1958. Official analytical methods, color power of turmeric, methods, Englehwood, Chiffs, Nj. 18.0.

Bambirra, M.L.A., Junqueira, R.G. and Gloria, M.B.A. 2002. Influence of post harvest processing conditions on yield and quality of ground Turmeric (*Curcuma longa* L.). Brazilian Archives of Biology and Technology 45 (4): 423 – 429.

Chattopadhyay, I., Biswas, K., Bandyopadhyay, U. and Banerjee, R.K. 2004. Turmeric and curcumin: Biological action and medicinal applications. Current Science 87 (1): 44-53.

Chirangini, P., Sharma, G.J. and Sinha, S.K. 2004. Sulfur free radical reactivity with curcumin as reference for evaluating antioxidant properties of medicinal Zingiberales. Journal of Environnemental Pathology, Toxicology and Oncology 23: 227-236.

Chopra, D. and Simon, D. 2000. The Chopra Centre Handbook, Rider, London p. 112.

Govindrajan, V.A. 1980. Turmeric chemistry, Technology and quality. CRC Critical Review in Food Science and Nutrition 12 (3):199-301.

Harold, E., Ronald, S. and Ronald, S. 1999. Pearson's chemical analysis of foods. Addison Wesley Longman Ltd England, 51.

Joseph, P. and Nair, P.C.S. 1983. Morphological and yield characters of turmeric types. Indian Cocoa, Areca nut and Spices Journal 6: 61-67.

Krishnamurthy, M.N., Padmabai, R., Natarajan, C.P. and Kuppuswamy, S. 1975. Colour content of turmeric varieties and studies on its processing. Journal of Food Science and Technology 12: 12-14.

Kumar, V.K., Vadiraj, B.A., Sivadasan, C.R. and Potty, S.N. 2000. Post-harvest management of turmeric for higher recovery of curcumin. In proceeding of conference on Spices and aromatic plants: challenges and opportunities in the new century. Centennial conference on spices and aromatic plants, Calicut, Kerala, India 281-283.

Nagarajan, S., Kuber I. R. and Rao, L. J. 2010. Separation of Curcuminoids Enriched Fraction from Spent Turmeric Oleoresin and Its Antioxidant Potential. Journal of Food Science 75 (6) : H158–H162.

Panse, V.G. and Sukhatme, P.V. 1989. Statistical methods for agricultural Workers. Publication and Information division, Indian Council of Agricultural Research (ICAR), New Delhi.

Pujari, P.P., Patil, R.B. and Sakpal, R.T. 1987. Studies on growth, yield and quality components in different turmeric varieties. Indian Cocoa, Areca nut and Spices Journal 11: 15-17.

Rakhunde, S.D., Munjal, S.V. and Patil, S.R. 1998. Curcumin and essential oil contents of some commonly grown turmeric (*Curcuma longa* L.) cultivars in Maharashtra. Journal Food Science and Technology 35: 352-354.

Ranganna, S. 1986. Handbook of analysis and quality control for fruit and vegetable products, 2nd Edn. Tata Mc Graw Hill Publ. Co. Ltd., New Delhi. pp: 7-8.

Rouhani, S., Alizadeh, N., Salimi, S. and Haji-Ghasemi, T. 2009. Ultrasonic assisted extraction of natural pigments from rhizomes of Curcuma Longa L. Progress Colour colorents and coating, 2, 103-113.

Sampathu, S.R., Krishnamurthy, N., Sowbagya, H.B. and Shankarana-Rayanan, M.L. 1988. Studies on quality of (*Curcuma longa*) in relation to curing methods. Journal of Food Science and Technology 25 (3):152-155.

Sarker, S.D. and Nahar, L. 2007. Bioactivity of Turmeric in Turmeric: The Genus Curcuma. Taylor and Francis Group, LLC 258 -285.

Singh, G., Arora, S. and Kumar, S. 2010. Effect of mechanical drying air conditions on quality of turmeric powder. Journal of Food Science and Technology 47 (3) : 347-350.

Subbarayedu, M., Redey, R.K. and Rao, M.R. 1976. Studies on varietal performance of turmeric. Andhra Agriculture Journal 23:195-198.

Tonnesen, H.H. and Karlsen, J. 1985. Studies on curcumin and curcuminoids. VI. Kinectics of curcumin degradation in aqueous solution. Zournal Lebensmittel Forschung 180: 402 – 408.

Varshney, A.K., Garala, S.N. and Akbari, S.H. 2004. Status of post harvest technology of turmeric. Agriculture Engineering Today 28: 13-39.

Viasan, A.C., Menon, A.N., Rao, J.M., Nayaranan, C.S. and Mathew, A.G. 1989. Chemical analysis of some cultivars of *Curcuma longa* L. Journal of Food Science and Technology 26: 293-295.

Wang, Y., Lu, Z., Lv, F. and Xiaomei B. 2009. Study on microencapsulation of curcumin pigments by spray drying. European Food Research and Technology 229:391–396.