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Effects of Cooking and Drying Methods on Curcumin Content of Turmeric (*Curcuma longa*)

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ABSTRACT

The curcumin content of both water cooked and 0.1% Na_2CO_3 solution cooked turmeric fingers dried by different methods as estimated in terms of %. The results indicate that water cooked fingers had higher curcumin contents compare to 0.1% Na_2CO_3 solution cooked fingers irrespective of drying methods. Sun dried fingers had a lower curcumin contents compared to the corresponding solar and mechanical dried samples. Significant differences in curcumin content were observed due to boiling and drying methods. It is concluded that boiling of turmeric fingers Cv. Mydakur in closed vessel followed by drying in tray drier is better for higher curcumin, oleoresin contents and % NVAE yield. However, boiling in closed vessel followed by drying in solar drier is preferable to obtain the fingers with higher per cent volatile oil, curcumin recovery per cent by acetone extraction. Among cooking methods, boiling with 0.1% Na_2CO_3 solution is found to give required orange yellow colour but the curcumin content is in lower range compared to the higher values obtained in boiling with water. Based on the study, it can be suggested that boiling of turmeric fingers in closed vessel with water and drying in tray drier yield high quality produce with better curcumin content, oleoresin and % NVAE. However closed vessel cooking followed by solar drying is preferable to obtain higher % volatile oil and curcumin recovery % by acetone extraction.

Keywords: *Turmeric, Curcumin, Natural dye, Cooking, Drying*

INTRODUCTION

India is world's largest producer and exporter of turmeric. During 2011-2012, India produced 11, 67,000 tonnes of turmeric and exported 1, 85,000 tonnes valued at Rs.1184.63 crores. The initial moisture contents of fresh turmeric fingers range from 80 to 88% (wb), which are too high for their processing and storage. Therefore reduction of moisture contents of turmeric to a level of 5-7% (wb) becomes necessary before their processing and storage.

In all the major turmeric producing states of India, drying is carried out during the winter months of December to March resulting in large quantitative and qualitative losses.

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Too slow rate of drying allows development of moulds and white spots appear due to uneven heating and cooling. Traditionally, turmeric rhizomes are sun dried on mud floors, road side, open top etc. An improved method is therefore essential to reduce these losses. With this objective a study was under taken to compare the efficacy of different drying methods of turmeric on quality parameter.

Desikachar *et. al.* (1959) have recommended the use of lime water or 0.05-0.1% solution of sodium bicarbonate or sodium carbonate to impart orange yellow tinge to the core of turmeric finger. Sampathu *et. al.* (1988) dried turmeric finger by sun drying and mechanical drying and reported that colour retention was better in mechanically dried uncooked slices than the conventionally cooked and sun dried fingers. Similarly Krishnamurthy *et. al.* (1975) reported that sun drying of slices gave a slightly surface bleached product compared to mechanically dried turmeric slices which was brighter in colour. Chandramouli and Murthy (1987) reported that sun drying of slices gave a slightly surface bleached product compared to mechanically dried turmeric slices which was brighter in colour. Chandramouli and Murthy (1987) have designed a solar cabinet dryer and conducted performance tests for drying of turmeric compared its performance with traditional sun drying and concluded that solar cabinet dryer took 29 hours to reach safe moisture level compared to 64 hours by traditional sun drying. Haribabu and Anand (1996) developed a try dryer, using agriculture waste as heating medium can dry cooked rhizomes of turmeric which takes 58 hours to reach safe moisture level compared to 169 hours in open yard sun drying.

MATERIALS AND METHODS

For conducting the experiments, fresh turmeric fingers of "Mydukur" variety were obtained from a farmer. The turmeric fingers were boiled in open vessel, closed vessel and autoclave with water and remaining half are boiled in open vessel and closed vessel with 0.1% sodium carbonate solution. About 6 liters of water 0.1% Na_2CO_3 solution used for boiling of 2 kg of turmeric fingers and boiling time was 45 minutes.

A stainless steel vessel of 10-litre capacity was used for cooking in open vessel; same vessel with lid was used for cooking in closed vessel. A horizontal autoclave, was used for boiling (Steaming) of turmeric fingers at a pressure of 1.5 kg/cm^2.

Drying

Three different drying methods were used namely open sun drying on cemented floor, solar drying (natural conventional type) and mechanical drying (Tray type). Water cooked and 0.1% sodium carbonate solution cooked turmeric fingers of "Mydukur" variety were used to drying methods. Turmeric fingers were cooked in closed vessel.

Both water cooked and 0.1% Na_2CO_3 solution cooked turmeric fingers of 2 kg each were taken for all the drying methods. The turmeric fingers with an initial moisture content of 88% (wb) were dried to the final moisture content of 5-7% (wb).

Sun drying

The turmeric fingers were allowed to dry in the sun by spreading in 5-7 cm thick layers on drying floor. Spreading single layer is avoided to minimize the bleaching effects of sun. The time of drying was from 9 am to 3 pm. During night, the turmeric fingers were packed in polythene bags (gauge 200) which were moisture proof. The temperature of the ambient was noted after every 2 h with the help of a thermo meter. The moisture contents of turmeric fingers were determined after every 6 h, till an optimum moisture content of 5-7% (wb) was obtained. All these experiments were replicated 3 times.

Solar drying

The solar dryer which was used for experimental study was designed and developed by SEED, Hyderabad. Both turmeric fingers cooked with water and with 0.1% Na_2CO_3 solution were spread on two different trays separately in a single layer in the solar cabinet dryer and allowed to dry. The essential environmental parameters like

temperature relative humidity inside and outside the solar dryer were measured after every 2 h along with total sunshine hours in a day. The moisture content of turmeric fingers were determined after every 6 h, till an optimum moisture content of 5-7% (wb) was obtained. Temperature gradient was also calculated. All these experiments replicated three times.

Mechanical drying

The mechanical dryer (try type), which was used for the experimental study was designed and developed by C.M. Equipment, Bangalore. Turmeric fingers cooked with water of 2 kg at the initial moisture content of 88% (wb) were spread uniformly on a tray and were dried with heated air at 60±2°C. The moisture contents of turmeric fingers were determined after every 5 h till it attained an optimum moisture content of 5-7% (wb). Similar trails were also undertaken with turmeric fingers (2 kg) cooked with 0.1% Na_2CO_3 solution and all the experiments were replicated 3 times.

Quality Test Procedure

The dried fingers (about 400g) obtained from each of the samples were powdered to pass through 30 mesh sieve and were analysed for total colour content (as curcumin) by ASTA (1968) methods and for oleoresin by cold percolation method. In this method 30 g powder was packed in a glass column of internal diameter 3.2 cm and extracted with acetone giving an initial contact time of 2 h and subsequently 1h.Totally, 5 extracts of 30 ml each were collected, pooled and analysed for non-volatile solids estimated according to the ASTA method for non-volatile ether extract. Curcumin in the pooled extract was estimated by evaporating 5 ml aliquots on a boiling water bath, suitably diluting the solids obtained with 95% ethyl alcohol and recording absorbance at 425 nm. The per cent recovery of curcumin by acetone extraction was calculated based on initial.

Statistical analysis

The experimental data were analysed statistically by the method of analysis of variance as outlined by Panse and Sukhatme (1978). Statistical significance was tested by F value at five per cent level of significance. Critical differences at five per cent were worked out, where "F" test was found significant. The results are presented in the form of tables wherever necessary.

RESULTS AND DISCUSSIONS

Curcumin content

The curcumin content of both water cooked and 0.1% Na_2CO_3 solution cooked turmeric fingers dried by different methods as estimated in terms of % and the results are presented in Table 1. The results indicate that water cooked fingers had higher curcumin contents compare to 0.1% Na_2CO_3 solution cooked fingers irrespective of drying methods. The samples autoclaved with 0.1% Na_2CO_3 solution and sun dried showed lowest curcumin content (1.073%). The drop in the curcumin content of 0.1% Na_2CO_3 solution cooked fingers can be attributed to the destruction of curcumin in the presence of hot alkali. The sensitivity of curcumin to alkaline solution is reported by Tonneson and Karlson (1985). The tray dried samples showed highest curcumin content, solar drying samples showed medium curcumin content and least curcumin content was observed in sun dried samples. Sun dried fingers had a lower curcumin contents compared to the corresponding solar and mechanical dried samples. The loss may be ascribed to the photosensitive nature of curcumin.

Oleoresin and NVAE yields

The oleoresin and NVAE yields of both water cooked and 0.1% Na_2CO_3 solution cooked turmeric fingers dried by different methods as estimated in terms of % and the results are presented in Table 1. the water cooked fingers had lower oleoresin % compare to 0.1% Na_2CO_3 solution cooked fingers irrespective of drying methods. However mechanical dried fingers had higher oleoresin % (4.743, 5.080%), followed by solar dried samples (4.490, 4.763%) and sun dried fingers had least oleoresin % (4.580, 4.763%). The

NVAE yield ranged from 2.490 to 3.240% and followed a trend similar to that of oleoresin.

Curcumin recovery % by acetone extraction

The results are presented in Table 1. the curcumin recovery % by acetone extraction was higher in case of turmeric fingers cooked with water compared to cooked with 0.1% Na_2CO_3 solution irrespective of drying methods. The curcumin recovery % by acetone extraction was slightly higher for sun dried samples (84.940, 80.900%) followed by solar dried samples (84.760, 80.230%) and least in mechanical dried turmeric fingers (84.400, 79.867%). The lower curcumin recovery in mechanical dried turmeric fingers may be due to the more gelatinisation of starch which hinders the release of colouring matter during extraction.

Irrespective of drying methods samples boiled with 0.1% Na_2CO_3 solution showed higher curcumin recovery % by acetone extraction compared to water boiled. Irrespective of boiling methods sun dried samples showed maximum curcumin recovery %, tray-dried samples showed least curcumin recovery % and solar dried samples showed medium curcumin recovery % by acetone extraction.

It may be concluded that turmeric fingers cooked in 0.1% Na_2CO_3 solution showed better effect in terms of higher oleoresin %, curcumin recovery % by acetone extraction and NVAE yield. The quality (curcumin content, oleoresin%, NVAE yield) of the mechanically dried fingers were superior, followed by solar drying and was poor in sun drying.

Table 1: Analysis of turmeric fingers subject to different drying methods.

Treatment	Drying method	NVAE Yield*	Oleoresin %*	Curcumin*	
				Content	Recovery %
Open vessel cooking with water	Sun drying	2.567	4.237	1.550	78.900
	Mechanical drying	3.180	4.730	1.903	78.767
	Solar drying	3.040	4.710	1.783	78.830
Open vessel cooking with 0.1% Na_2CO_3 solution	Sun drying	2.840	4.683	1.310	79.400
	Mechanical drying	3.400	4.840	1.783	76.700
	Solar drying	2.720	4.720	1.677	77.340
Closed vessel cooking with water	Sun drying	2.580	4.580	1.680	84.940
	Mechanical drying	3.130	4.743	2.023	84.400
	Solar drying	2.490	4.490	1.927	84.760
Closed vessel cooking with 0.1% Na_2CO_3 solution	Sun drying	2.990	4.660	1.550	80.900
	Mechanical drying	3.240	5.080	1.897	79.867
	Solar drying	2.600	4.763	1.780	80.230

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