DOI : 10.58993/ijh/2023.80.1.18

Indian J. Hortic. 80(1), March 2023: 119-125

Turmeric press residue – a high-value by-product of turmeric juice powder

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ABSTRACT

Turmeric press residue is an industrial by-product obtained after the extraction of turmeric juice in making turmeric juice powder. In the present study, turmeric press residues from four varieties of turmeric viz. Chintapalli (1-year crop), Chintapalli (2-year crop), IISR-Pragathi and IISR-Prabha were studied for various quality parameters. The dry recovery of the press residue varied from 8.07 to 9.70% based on the initial mass of fresh turmeric, while it varied from 14.52 to 20.61% based on the mass of press residue obtained after juice extraction. The moisture content of dry turmeric press residue varied from 7.98 to 8.21%. The essential oil content of the turmeric press residues for varieties Chintapalli (1-year crop), Chintapalli (2-year crop), IISR-Pragathi and IISR-Prabha was 5.86, 6.30, 5.06 and 5.33%, respectively. The oleoresin content was 9.66, 11.92, 10.76 and 15.53%, respectively, and the corresponding curcumin content was 3.28, 3.26, 5.13 and 5.21%, respectively. GC-MS analysis revealed that the major volatile oil constituents in the essential oil extracted from turmeric press fibre were ar-turmerone, turmerone, curlone, β-sesquiphellandrene and zingiberene.

Keywords: *Curcuma longa,* Press residue, Essential oil, Curcumin, Oleoresin.

INTRODUCTION

Turmeric (*Curcuma longa)*, is valued for its brilliant yellow colour, aroma and is also an important commercial spice crop in India. It is used in different forms as a spice, colouring and flavouring agent and as a principal ingredient in curry powder preparation. As the demand for natural products is increasing, the demand for food additives like turmeric as natural food colour is also increasing (Sowbhagya *et al*., 20). Turmeric is known for centuries to be a safe household remedy for various illnesses like common cold, intestinal disorders *etc*. (Prasad and Aggarwal, 15). Bhowmik *et al*., (5) reported consumption of turmeric by mixing it with milk or in water to treat problems of throat and disorders of stomach.

Turmeric juice is an important value-added product obtained from fresh turmeric rhizomes. The residue left after the extraction of juice is called as 'turmeric press residue' is a valuable by-product which has a great potential for food application. Presently, a small quantity of the turmeric press residue finds its application in poultry and veterinary feeds. Generally, it is discarded or used as a fuel for the boiler. Reports indicate that the export of value-added turmeric juice powder from India is increasing year after year which is also an indication that the amount of the by-product generated is also increasing, causing problems in its disposal and environmental pollution. The effective utilization of this industrial by-product to a value added food product requires scientific investigation. Sowbhagya, (19) reported processing spent residues of spices into value-added food products, *viz.* in the preparation of bio-films, snacks and bakery products. The preliminary laboratory analysis revealed that the turmeric press residue was rich in curcumin and other nutritional constituents. However, reports on the quality aspects of turmeric press residue or its use for any edible purposes are either not available or scanty. Therefore, an investigation was undertaken to determine the various quality parameters and the potential use of turmeric press residue for culinary applications.

MATERIALS AND METHODS

Chintapalli local varieties of turmeric grown in the Vishakapatnam district of Andhra Pradesh is generally harvested once in two years, compared the turmeric grown in other regions of the country where turmeric is harvested at the end of seven or eight months. Further, the turmeric grown in this region is claimed to possess high nutraceutical properties and used by pharmaceutical industries. Hence, it was necessary to assess the quality of this variety in comparison to the improved varieties developed by the Institute.

The turmeric varieties used for the experiment *ie*. Chintapalli local (1 year crop), Chintapalli local (2 year crop) and IISR-Pragathi were procured from the farmer's field at Chintapalli district in Andhra Pradesh, India, while IISR-Prabha was procured from farmer's field at Koorachundu, Kozhikode, Kerala, India (Fig. 1 shows the cross sectional view of various

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turmeric varieties) during January 2019. IISR-Prabha and IISR- Pragathi were considered as control for comparing the various quality parameters.

The harvested clumps of turmeric were manually cleaned to remove the roots and mud adhering to it and it was broken to separate the finger and mother rhizomes. The separated rhizomes were washed thoroughly with water and the cleaned fresh rhizomes were fed into the feed hopper of the twin screw expeller (Global Kitchen make) of capacity 60 kg/h at the rate of 1 kg/min. The expeller was operated by a 2 hp motor to extract fresh turmeric juice. The work was carried out in the facility available at M/s. Biowin Agro Research Centre, Mananthawady, Wayanad, Kerala

The juice obtained after the extraction was used to produce turmeric juice powder by the industry. By-product obtained after extraction of juice, called as the turmeric press residue (or press cake), was dried at 55°C for about 8 h in a mechanical dryer (Labline make, India, Power - 2 kW) and stored in polypropylene covers (75 microns) (Fig. 2). The dried turmeric press residue at moisture content of about 6.50% was pulverized in a mixer grinder (Preethi Blue Leaf Platinum – MG 139 having a Universal 750 W high power motor) of jar capacity 1.2 litres to obtain fine powder (60 mesh size) and used for further quality analysis (Fig 3).

Moisture content of the turmeric press residue (in wet basis) was analysed at a temperature set to 110°C in a fully automatic moisture balance (Precisa, XM 60-HR) with the heating unit made up of ceramic infrared heating element. Dry recovery of turmeric press residue was calculated as the ratio of the final mass of the dried product to the initial mass of the fresh sample and expressed in percentage. Bulk density of sample was obtained by exactly filling the dried sample in a 1 litre volume measuring cylinder and mass of the sample contained in the cylinder was recorded (Gupta and Das, 8). Colour of the turmeric sample was determined using colour meter (Color flex EZ, Hunter Lab, 45/0 LAV) and the values were expressed as L*, a* and b*.

Turmeric press residue was analysed for its nutritional composition and constituents like total carbohydrates, fat, protein, and crude fibre. Total carbohydrate was determined by Anthrone method (Sadasivam and Manickam, 17), soluble protein was determined by Lowry's method (Lowry *et al*., 12), crude fibre content was estimated by ASTA method (2) and total fat content of the sample was determined

Chintapalli (1 year crop) Chintapalli (2 year crop) IISR-Pragathi IISR-Prabha

Fig. 1. Cross sectional view of fresh turmeric rhizome used for juice extraction

Chintapalli (1year crop) Chintapalli (2 year crop) IISR-Pragathi IISR-Prabha

Fig. 2. Press residues of different turmeric varieties after drying

Chintapalli (1 year crop) Chintapalli (2 year crop) IISR-Pragathi IISR-Prabha

Fig. 3. Press residue powder

by extracting it with petroleum ether for 4-5 h using Soxhlet apparatus (Sadasivam and Manickam, 17).

Essential oil content was estimated using modified Clevenger apparatus by hydro-distillation process (AOAC, 1), oleoresin content was determined using solvent acetone by ASTA method, (2) and curcumin content was estimated by refluxing powdered sample with acetone for 1 h and by reading the absorbance using UV visible spectrophotometer (Shimadzu, UV-1800) at 425 nm against acetone as blank (ASTA, 2). The total polyphenol content were determined by using Folin-Ciocalteu Spectrophotometric method (Sadasivam and Manickam, 17). The α-glucosidase inhibitory activity was determined based on the spectrophotometric assay using acarbose as the reference compound following the modified methods proposed by Matsui *et al*. (13) and Braunlich *et al*., (6).

A gas chromatograph with mass spectroscope (Shimadzu GC 2010 and Shimadzu spectroscope QP -2010) and capillary column (RTX-WAX, 30M× 0.25MM id × 0.25 um) was used to analyse the constituent of the essential oil by injecting 0.1 µl through the injection part. The column temperature was programmed as injection port temperature-250°C, flow rate-1 ml/min, carrier gas-helium with linear velocity of 48.1 cm/s, split ratio-50, and ionization energy-70 eV.

The quality parameters of turmeric press residue were analysed using SAS software version 9.3 (SAS Institute Inc., Cary North Carolina). The data were analysed by using PROC ANOVAs procedure and means were separated according to Fisher's least significant difference (LSD) test (p≤0.05).

RESULTS AND DISCUSSION

The dry recovery of the turmeric press residue obtained after the extraction of juice, varied from a minimum value of 14.52% for variety Chinthapalli local (1 year crop) to a maximum value of 20.61% for IISR-Pragathi. However, the dry recovery based on initial mass of turmeric taken for extraction of juice ranged from 8.07% for Chinthapalli local (1 year crop) to a maximum value of 9.70% for IISR-Pragathi with a mean value of 8.75% (Table 1). As this is the first report on the study of turmeric press residue, there are no cited earlier reports about this valuable byproduct. However, reports of the studies at ICAR-Indian Institute of Spices Research showed that the dry recovery of IISR-Prabha variety was 19.50% and IISR-Pragathi was 18% (Prasath, 16).

Significant variation in the moisture content of dried turmeric press residues was observed among the varieties and the values ranged from a minimum of 7.98±0.01% for Chinthapalli (2 year crop) to a maximum value of 8.21±0.01% for IISR-Pragathi with a mean value of 8.08±0.01% (Table 2). Chittrarasarayan *et al.,* (7) reported that the moisture content recommended for turmeric powder should not exceed 12% as per the standards of Food Safety and Standards Authority of India.

The bulk density which indicates the mass per unit volume, varied from 0.25±0.01 to 0.30±0.01 g/cc and corresponded to the varieties IISR-Prabha and Chintapalli (1 year crop). The analysis of variance indicated that the variation in bulk density was significantly influenced (p≤ 0.05) by the turmeric varieties. Barnwal *et al*., (4) reported that the bulk density of ambient ground turmeric varied from 348.30 kg/m^3 at 10% moisture content (w.b) to 586.70 kg/m^3 at moisture content of 4% wet basis.

The Hunter colour value L* which indicates the lightness of colour ranged from a minimum value of 36.48±0.24 for Chinthapalli (1 year crop) to a maximum value of 40.37±0.24 for IISR-Prabha. The Hunter colour value a* ranged from 14.73±0.06 for Chinthapalli (1year crop) to 20.20±0.17 for IISR-Prabha while colour value b* ranged from minimum value 28.86±0.15 for Chinthapalli (2 year crop) to maximum value 32.63±0.29 for IISR-Pragathi.

Table 1. Dry recovery of press residue of turmeric after juice extraction

Treatments	Initial mass of turmeric (A) (kg)	Mass of press residue after juice extraction (B), (kg)	Mass of juice extracted, (C), ((kg)	Mass of press residue after drying (D), (kg)	Dry recovery based on the mass of residue obtained (D/B), (%)	Dry recovery based on initial mass of turmeric, (D/A), (%)
Chintapalli (1 year crop)	15.10±0.42	8.40±0.25	6.70±0.15	1.22±0.05	14.52±0.75^{d}	8.07±0.35^{d}
Chintapalli (2 year crop)	18.00±0.78	9.22±0.30	8.78±0.17	1.51±0.06	16.37±0.68^{c}	8.38±0.41^{c}
IISR-Pragathi	20.60±0.65	9.70±0.18	10.90±0.19	2.00±0.05	20.61±0.85^{a}	9.70±0.62^{a}
IISR-Prabha	20.30±0.79	9.51±0.16	10.79±0.18	1.80±0.04	18.92±0.61^{b}	8.86±0.38^{b}
Mean	18.5±2.54	9.21±0.58	9.29±1.98	1.63±0.34	17.60±0.72	8.75±0.48
LSD at 5%	1.86	0.48	1.29	0.36	0.15	0.05

Table 2. Physical properties of press residue of turmeric

Treatments	Moisture content (%) (w.b)	Bulk density (g/cc)	Colour value		
			L*	a*	b*
Chintapalli (1 year crop)	8.08±0.01^{b}	0.30±0.01^{c}	36.48±0.24^{d}	14.73±0.06^{d}	29.90±0.10^{b}
Chintapalli (2 year crop)	7.98±0.01^{d}	0.28±0.01^{b}	36.79±0.24^{c}	16.76±0.12^{b}	28.86±0.15^{c}
IISR-Pragathi	8.21±0.01^{a}	0.27±0.02^{b}	39.36±0.21^{b}	15.53±0.16^{c}	32.63±0.29^{a}
IISR-Prabha	8.03±0.01^{c}	0.25±0.01^{c}	40.37±0.24^{a}	20.20±0.17^{a}	32.60±0.17^{a}
Mean	8.08±0.10	0.28±0.02	38.25±1.92	16.81±2.41	31.00±1.91
SED	0.01	0.01	0.18	0.09	0.16
LSD at 5%	0.025	0.019	0.42	0.21	0.36

Analysis of variance indicated that variation in turmeric varieties significantly affected (p≤0.05) the Hunter colour values of turmeric press residue.

The nutritional quality parameters of the turmeric press residue (Table 3) showed that maximum carbohydrate content of 42.46±0.25% was obtained for the variety Chintapalli (2 year crop), highest protein content of 7.40±0.20% was obtained for IISR-Pragathi, maximum fat content of 5.98±0.10% was obtained for Chintapalli (2 year crop) and The highest crude fibre content of 5.75±0.05% was obtained for the variety IISR-Prabha. The analysis of variance indicated that the total carbohydrates, proteins, fat, and crude fibre content of dried turmeric press residue was significantly influenced (p≤0.05) by the turmeric varieties. Natarajan and Lewis, (14) reported that turmeric rhizome contained 60–70% carbohydrates, 6–8% protein, fat content of about 5–10% and fibre content of 2–7%.

The secondary metabolites studied for the turmeric press residue is shown in Table 4. The essential oil content of press residues from various turmeric varieties studied showed that Chintapalli (2 year crop) had a maximum value of 6.30±0.26% while

Table 3. Nutritional analysis of turmeric press residue

Treatments	Total carbohydrates (%)	Protein (%)	Fat (%)	Crude fibre (%)
Chintapalli (1 year crop)	37.10±0.10^{d}	7.26±0.25^{a}	5.04±0.04^{d}	4.48±0.17^{c}
Chintapalli (2 year crop)	42.46±0.25^{a}	6.56±0.21^{b}	5.98±0.10^{a}	4.44±0.04^{c}
IISR-Pragathi	38.70±0.26^{c}	7.40±0.20^{a}	5.62±0.12^{c}	4.70±0.20^{b}
IISR-Prabha	40.20±0.26^{b}	6.40±0.20^{b}	5.79±0.06^{b}	5.75±0.05^{a}
Mean	39.61±1.94	5.91±1.39	5.61±0.036	4.84±0.083
SED	0.19	0.18	0.07	0.11
LSD at 5%	0.43	0.40	0.16	0.26

Table 4. Secondary metabolites, total phenol and alpha-glucosidase activity of turmeric press residue

Treatments	Essential oil, (%)	Oleoresin, (%)	Curcumin, (%)	Total phenol, (mg/ml)	α-glucosidase activity, IC_{50} value, (mg/ml)
Chintapalli (1 year crop)	5.86±0.23[b]	9.66±0.15[d]	3.28±0.12[b]	16.01±0.12[a]	3.63±0.05[a]
Chintapalli (2 year crop)	6.30±0.26[a]	11.92±0.93[b]	3.26±0.25[b]	17.57±0.11[b]	2.71±0.04[b]
IISR-Pragathi	5.06±0.23[d]	10.76±0.06[c]	5.13±0.06[a]	12.70±0.13[c]	2.17±0.03[b]
IISR-Prabha	5.33±0.23[c]	15.53±0.15[a]	5.21±0.15[a]	12.67±0.14[c]	3.24±0.04[a]
Mean	5.64±0.02	11.97±0.41	4.22±0.08	14.74±2.13	2.94±0.95
SED	0.19	0.39	0.13	0.74	0.64
LSD at 5%	0.45	0.91	0.30	1.70	0.24

IISR-Pragathi had the minimum value of 5.06±0.23%. Natarajan and Lewis, (14) reported that turmeric rhizome contained 3–7% of essential oil. Singh and Jain, (18) reported that average yield of volatile oil content in dried powder of *Curcuma longa* rhizome was 8.20 ±1.66 % v/w.

The oleoresin content obtained from the turmeric press residue varied from a minimum of 9.66±0.15% for Chintapalli (1 year crop) to a maximum of 15.53±0.15% for IISR-Prabha and the oleoresin content was significantly influenced by the varieties. Shashidhar *et al.,* (21) evaluated eighteen turmeric genotypes and reported the highest oleoresin content of 16.20 % was recorded in *var*. Pratibha which was on par with *var.* Alleppey (15.69%) while the lowest oleoresin content of 3.8% was observed in *var.* Krishna.

The curcumin content in the turmeric press residue varied from 3.26±0.25% for Chintapalli (2 year crop) to 5.21±0.15% for IISR-Prabha and the curcumin content was significantly influenced by the varieties. Krishnamurthy *et al.,* (10) reported that the curcumin content of turmeric rhizome was 1.8 to 5.4%. Barnwal *et al*., (3) investigated the quality profile of cryogenically ground turmeric powder in comparison to ambient ground and reported that at 10% moisture content the cryogenically ground turmeric powder contained 5.2±0.10% essential oil, 13.28±0.02% oleoresin and 5.17±0.02% curcumin content, while the corresponding values for ambient ground powder were 4.27±0.12, 10.12±0.63 and 4.17±0.02%.

The total phenol content varied from a minimum value of 12.67±0.14 mg/ml for IISR-Prabha to a maximum value of 17.57±0.11mg/ml for Chintapalli (2 year crop) and was significantly influenced ($p \leq 0.05$) by the turmeric varieties. Barnwal *et al.,* (3), reported that the total phenol content in alcohol extract, water extract and petroleum extract of cryogenically ground turmeric powder at 10% moisture content varied as 2.11±0.01%, 0.70±0.01% and 0.31±0.01%, respectively.

The anti-diabetic property, which is measured in terms of α- glucosidase activity and expressed as IC_{50} (mg/ml) were studied for all the four varieties and the minimum value 2.71±0.04 was obtained for the variety IISR-Pragathi which indicated that this variety possessed the higher anti-diabetic property. Analysis of variance indicated that the varieties significantly influenced the α-glucosidase activity of the turmeric press residues. Hasimun *et al*., (9) evaluated sixteen species of Zingiberaceae family for alpha-glucosidase inhibitions (AGIs) and reported that IC_{50} value against α-glucosidase varied from 28.4 µg/ml to 269.2 µg/ml and the highest inhibition against α-glucosidase, was reported for *Curcuma longa* with IC_{50} value of 28.4 µg/ml indicating that it is a potential alternative medicine for treating diabetes mellitus.

The major volatile constituents in essential oil were identified as zingiberene, β-sesquiphellandrene, turmerone, curlone and ar-turmerone (Table 5). The highest content of ar-turmerone was obtained for IISR-Pragathi (30.09±0.86%), curlone content of 24.62±0.86% was obtained for IISR-Prabha, β-sesquiphellandrene content of 3.84±0.06% was obtained for Chintapalli (2 year crop) and the highest zingiberene content of 2.94±0.11% was obtained for Chintapalli (2 year crop). While turmerone content varied from 31.76 ±0.11% for Chintapalli (2 year crop) to 21.28±0.76% for IISR-Pragathi. The analysis of variance indicated there was significant variation ($p \leq 0.05$) in the ar-turmerone, curlone, β-sesquiphellandrene, turmerone and zingiberene content in the turmeric press residue obtained from different varieties. Leela *et al.,* (11) identified forty seven constituents from the essential oil of turmeric rhizomes and reported that the major components were ar-turmerone (31.15%), turmerone (10.0%) and curlone (10.6%) and ar-curcumene (6.3%).

From the study it was concluded that turmeric press residue, an industrial by-product obtained after the extraction of turmeric juice is valuable in nutrients

Table 5. Major volatile constituents of essential oil from turmeric press residue

Treatments	Zingiberene (%)	β-sesquiphellandrene (%)	Turmerone (%)	Curlone (%)	ar- turmerone (%)
Chintapalli (1 year crop)	2.46±0.12^{b}	3.07±0.05^{b}	28.87±0.90^{b}	19.60±0.69^{c}	28.59±1.15^{b}
Chintapalli (2 year crop)	2.94±0.11^{a}	3.84±0.06^{a}	31.76±1.10^{a}	19.17±0.74^{d}	26.06±0.98^{d}
IISR-Pragathi	2.48±0.13^{b}	3.14±0.05^{b}	21.28±0.76^{d}	20.51±0.72^{b}	30.09±0.86^{a}
IISR-Prabha	1.44±0.12^{c}	1.85±0.04^{c}	24.84±0.81^{c}	24.62±0.70^{a}	27.68±0.78^{c}
Mean	2.33±0.63	2.98±082	26.69±4.59	20.98±2.49	28.11±1.68
SED	0.08	0.13	0.13	0.11	0.08
w	0.19	0.29	0.29	0.25	0.18

and other constituents like curcumin, essential oil and oleoresin. Among the four varieties evaluated, maximum retention of curcumin content (5.21%) and oleoresin content (15.53 %) was obtained in the press residue of IISR-Prabha while maximum essential oil content (6.30 %) was obtained in the press residue of Chintapalli (2 year crop). The major constituents of volatile essential oil extracted from turmeric press fibre were ar-turmerone, turmerone, curlone, β-sesquiphellandrene and zingiberene.

AUTHORS' CONTRIBUTION

Conceptualization of research (E. Jayashree); Contribution of experimental materials (E. Jayashree and Shakkira P. K.); Execution of lab / field experiments and data collection (Shakkira P. K. and Anees K.); Analysis of data and interpretation (E. Jayashree and Anees K); Preparation of the manuscript (E. Jayashree and Anees K.); Designing of the experiments (E. Jayashree)

DECLARATION

The authors declare that they have no conflict of interest.

ACKNOWLEDGEMENT

Authors are thankful to ICAR for the financial grant provided and Director, ICAR-IISR, Kozhikode for valuable guidance.

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Received : September, 2022; Revised : January, 2023;
Accepted : February, 2023