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## Evaluation of turmeric accessions for quality\*

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**Abstract.** One hundred and eighty four accessions of *Curcuma* were analysed for curing percentage (dry recovery), essential oil, oleoresin and curcumin contents. Curing percentage varied from 13.5 to 32.4. The cultivar 'Konni' had the maximum percentage of oleoresin (19.2). The volatile oil content was more in *C. aromatica* than in *C. domestica*. Curcumin content varied from 2.3% in cultivar 'Hahim' to 10.9% in cultivar 'Edapalayam'. However, curcumin content was comparatively lower in six exotic types as well as in 14 related species. The importance of quality aspects with respect to breeding is discussed.

## Introduction

Turmeric of commerce is the dried rhizome of *Curcuma domestica* Val. (Syn. *C. longa* Linn.) belonging to the family Zingiberaceae, though *C. aromatica* Salisb. is also cultivated as a spice in certain parts of India. More than 50 commercial cultivars of turmeric are distinguished in *C. domestica* and *C. aromatica* in India by the name of the localities where they are extensively cultivated. However, majority of the cultivars belong to the species *C. domestica*.

Collection, conservation, cataloguing and classification of germplasm in turmeric are one of the priority research programmes undertaken at the Central Plantation Crops Research Institute (CPCRI) at Kasaragod, Kerala starting from 1976. Collection of different accessions of *C. domestica* and related species from within the country was undertaken by the Institute in collaboration with the National Bureau of Plant Genetic Resources during 1976-77. Based on this survey, 184 accessions of turmeric (120 accessions of *C. domestica*, 44 accessions of *C. aromatica*, six accessions obtained from Solomon Islands and 14 types from related species) were established at CPCRI Regional Station, Calicut. Systematic cataloguing, classification and evaluation of these accessions were initiated in 1978.

While yield is the preliminary consideration of the grower, in trade grading is based on the appearance, weight and also the quality parameters. The

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yellow color of the rhizome, by far the most important quality parameter, is due to an orange yellow pigment called 'curcumin' and normally turmeric rhizomes contain 2.5% to 6.0% curcumin [16]. Turmeric also contains 3% to 5% volatile oil obtainable from steam distillation. This oil is not highly valued in industry and much of turmeric oil is left unutilized. Turmeric oleoresin is obtainable by solvent extraction of the ground spice and curcumin forms about one third of good quality oleoresin. Turmeric oleoresin is usually mixed with a solubilizer [4].

The quality parameters viz., curing percentage, oleoresin, oil and curcumin percentage for all the available accessions of turmeric, maintained in the live herbarium of the Institute, were determined and are reported in this paper.

### Materials and methods

One hundred and twenty *C. domestica*, 44 *C. aromatica*, 6 unidentified types from Solomon Islands and 14 types from related species of *Curcuma* including *C. angustifolia* Roxb., *C. xanthorrhiza* Roxb., *C. zedoaria* (Berg.) Roxb., were utilized in the present study.

### Curing percentage

One kilogram of fresh rhizomes were boiled in water for 45 minutes uniformly and kept in a hot air oven at 58–60°C for 4–5 days. Curing percentage was calculated by noting the difference between fresh and dry weight.

### Oleoresin extraction

Oven dried turmeric fingers were ground to pass through 30/40 mesh. Twenty grams of sieved material was loaded in glass columns blocked with non-absorbent cotton. 150 ml of acetone was percolated down into the glass column and kept it in contact for overnight. Soluble extraction was then drained in a preweighed 250 ml beaker ( $W_1$ ). Twenty ml of acetone was percolated to make it approximately to 150 ml which was then evaporated to near dryness and final weight recorded ( $W_2$ ) [5].

$$\% \text{ Oleoresin (air dry)} = \frac{W_2 - W_1}{20} \times 100.$$

### Essential oil extraction

Fifty gram of dried turmeric powder was transferred quantitatively in a 1000 ml flask. 500 ml of distilled water along with few glass beads were added. The flask was fitted with an essential oil extraction apparatus fitted with lighter than water type extractor (Clevenger's Apparatus). The distillation was conducted in a thermostatically controlled heater at first for 2 h at 70°C

and subsequently at 100°C for 4–6 h for recovering the oil [1].

$$\% \text{ Oil v/w} = \frac{x}{50} \times 100,$$

where  $x$  is the volume of essential oil in the Clevenger's Apparatus.

### Curcumin estimation

For estimation of curcumin content 0.1 g of turmeric powder was weighed and prepared in the extraction flask. 30 ml of alcohol was added and refluxed for 2½ h. The extraction was allowed to cool and filtered quantitatively into a 100 ml volumetric flask. The extracted residue was transferred to the filter, washed thoroughly and diluted to the mark with alcohol. 20 ml of the filtered extract was pipetted into a 250 ml volumetric flask and distilled to volume with the alcohol. The absorbance of the extract was measured at the standard solution at 425 mμ in 1 cm cells of the alcohol [2].

### Calculation

$$\text{Absorptivity of curcumin, } a = \frac{\text{Absorbance of Std. solution at 425 m}\mu}{\text{Cell length (cm)} \times \text{conc. (g/l)}}$$

$$\text{Curcumin \%} = \frac{\text{Absorbance of extract at 425 m}\mu \times 125}{\text{Cell length (cm)} \times \text{a sample wt/g}}.$$

### Results and discussion

The quality parameters with respect to dry recovery percentage, oleoresin, oil and curcumin contents for 120 *C. domestica*, 44 *C. aromatica*, 6 exotic types and 14 types from related species are presented in Table 1.

### Curing percentage

Among the *C. domestica* accessions, the dry recovery percentage was maximum in 'Amrithapani Kothapetta' (32.4) and minimum in 'Pusa' (13.5%). In *C. aromatica*, it ranged from 28.0% in 'Burahazer (Dibrugarh)' to 14% in Cas No. 58B. The 32.4% dry recovery in 'Amrithapani Kothapetta' is the maximum reported for *C. domestica* so far. Philip et al. [19] analysed 19 turmeric cultivars for dry recovery and reported maximum recovery for 'Ca 69 - Dindigam'. In a subsequent paper, Philip [18] published the result of analysis of dry recovery in 32 cultivars and maximum was in 'Dindigam' (31.5%). While Philip [18] reported low dry recovery of 15.8% for 'Amrithapani Kothapetta', in the present study this cultivar has the maximum dry recovery. Earlier, variability in curing percentage was reported by Rao et al. [20] and Patil and Sapkal [17]. From the yield point of view, a high dry recovery percentage is desirable since the final yield in turmeric is the dried rhizomes.

Table 1. Percentage of dry recovery, oleoresin, oil and curcumin in turmeric accessions

Sl. no.	Cultivar/accessions	Dry recovery	Oleoresin	Oil	Curcumin
<i>Curcuma domestica</i> Val.					
1.	Maran	26.0	13.5	7.0	8.7
2.	Jorhat	21.7	10.8	7.5	6.9
3.	Dadra, Gauhati	23.2	16.6	7.0	7.7
4.	Kaziranga, Jorhat	24.5	13.2	6.0	10.2
5.	Anogiri, Garohills	26.9	13.6	6.0	5.2
6.	Nowgong, Assam	20.0	10.0	5.0	4.0
7.	Mekhozer	20.0	12.0	5.0	4.0
8.	Hajo, Gauhati	21.0	13.0	7.5	5.5
9.	Rajasagar	16.6	10.3	6.0	5.0
10.	Teliamura, Agarthala	23.5	13.0	7.0	5.5
11.	Barhola, Jorhat	25.0	13.3	7.0	5.3
12.	Kahikuchi	21.2	12.1	9.5	3.1
13.	Along	21.7	13.0	5.0	6.6
14.	Besar, Along	20.6	11.6	5.0	6.1
15.	Gaspani, Nagaland	24.4	11.0	8.0	4.5
16.	Singhat, Manipur	19.7	15.0	7.0	7.9
17.	Kongpopkri	21.4	13.2	7.5	5.6
18.	Aigal	20.0	14.0	5.0	9.0
19.	Amampuri, Jumptoi Hills	25.7	11.5	5.0	4.0
20.	Amkara, Tripura	22.7	12.7	8.0	5.6
21.	Torku	19.5	10.9	6.0	6.0
22.	Barpathar, Galoghat	23.3	12.0	3.0	4.3
23.	Rorathong, E. Sikkim	22.8	16.8	4.0	4.7
24.	CII 316, Gorakpur	18.7	15.0	6.0	6.0
25.	Pusa	13.5	14.5	7.5	7.2
26.	PTS 5	20.0	12.7	5.0	6.0
27.	PTS 10	22.5	15.0	5.0	7.7
28.	PTS 24	23.0	14.1	5.0	7.9
29.	PTS 68	22.6	12.9	5.0	5.1
30.	Amalapuram	20.2	16.0	8.0	6.0
31.	Cls No. 34	23.8	14.0	5.0	5.0
32.	Amalapuram II	20.0	13.3	4.0	4.3
33.	Cls No. 15	21.8	16.0	5.5	4.8
34.	Cls No. 3	22.3	12.5	6.6	5.0
35.	Amalapuram Selection III	30.0	16.5	6.0	5.0
36.	CII 390 Amalapuram	19.4	13.7	7.5	7.0
37.	Amrithapani	23.2	19.0	7.0	7.0
38.	Amrithapani, Kothapetta	32.4	15.0	4.0	7.0
39.	Nandyal Type	22.0	13.5	8.0	4.7
40.	Cls No. 13	23.4	16.8	5.0	5.4
41.	Vontimitta	18.0	10.5	6.5	5.4
42.	Cls No. 11A	21.2	13.0	5.0	4.0
43.	CII 322 Vontimitta	24.5	11.4	6.0	7.4
44.	GL Puram II	19.6	13.1	6.0	6.2
45.	Cls No. 5A	30.1	13.5	6.0	4.9
46.	GL Puram III	21.8	12.9	6.0	5.1
47.	CII 324 Armoor	18.0	15.6	6.5	7.0
48.	Cls No. 1	25.0	10.8	5.0	6.0
49.	Cls No. 1A	24.0	15.8	5.0	6.4
50.	Cls No. 1C	20.0	11.1	5.0	6.3
51.	Ethamukula	22.5	15.0	5.0	5.5
52.	Cls No. 26	24.6	12.0	5.0	5.7

Table 1 (Continued)

Sl. no.	Cultivar/accessions	Dry recovery	Oleoresin	Oil	Curcumin
53.	CII 321 Ethamukula	26.2	11.3	6.5	6.0
54.	Cls No. 27B	19.9	10.2	5.0	4.0
55.	Duggirala	17.6	14.6	5.0	7.5
56.	Cls No. 22	18.1	15.4	6.6	5.2
57.	CII 325 Duggirala	21.0	11.7	8.0	5.0
58.	Kuchipudi	18.6	14.0	7.0	7.5
59.	Cls No. 8B	14.7	12.9	5.0	6.0
60.	Cls No. 8C	19.4	14.3	6.0	7.9
61.	T, Sunder	20.0	16.0	6.0	6.9
62.	Sugandham	22.6	12.0	8.5	9.1
63.	Cls No. 19	19.0	13.8	6.0	5.4
64.	Dindigam	17.0	10.6	6.0	6.4
65.	CII 327, Takkurpet	21.0	14.0	6.5	6.1
66.	CII 326, Mydukkur	19.4	11.8	6.0	2.8
67.	Karhadi local	18.3	13.0	6.0	4.9
68.	Cls No. 7	26.9	12.7	7.0	5.0
69.	CII 323 Avanigadda	19.4	14.5	7.5	7.0
70.	Cls No. 30	22.0	13.0	7.0	6.5
71.	Cls 328 Sugandham	20.0	12.8	6.0	9.0
72.	Cls No. 9A	14.5	11.6	4.0	7.9
73.	No. 24	23.0	16.0	5.0	5.0
74.	Cls No. 24	22.0	14.3	6.0	4.5
75.	Cls No. 6	21.0	13.9	4.0	6.7
76.	Cls No. 6A	24.0	15.8	5.0	6.4
77.	Palani	21.0	16.5	5.0	7.6
78.	Kayyam, Gudalur	23.0	16.5	5.0	8.4
79.	Pathavayal, Gudalur	25.0	14.0	4.0	3.6
80.	Upper Dinamala, Gudalur	24.0	12.0	5.5	7.8
81.	Rajpuri local	16.3	13.8	7.0	7.8
82.	Cls No. 14B	18.5	13.5	5.0	6.5
83.	CII 390 Rajpuri	18.3	12.2	8.0	6.0
84.	Moovatupuzha	20.1	11.5	5.0	7.0
85.	Varapetty, Kothamangalam	18.0	10.9	8.0	5.4
86.	Pathanapuram	17.0	14.0	8.0	6.7
87.	Karimala, Mannarghat	27.0	12.5	8.0	5.5
88.	Ochira	21.8	12.0	5.0	5.6
89.	Cls No. 29	23.5	11.7	4.0	4.0
90.	Alleppey	17.2	13.0	8.0	6.0
91.	Cls No. 21	25.5	12.1	8.0	6.2
92.	Valra Falls, Adimali	20.0	14.0	6.5	6.0
93.	Mundakkayam	23.4	10.5	8.5	3.2
94.	Mananthody	22.5	16.5	8.5	9.1
95.	Cls No. 16	25.0	18.3	9.0	7.0
96.	Vandoor, Nilambur	22.6	10.5	4.0	5.4
97.	Manjapally, Perumbavoor	16.4	10.6	6.5	5.6
98.	Murangathapally, Meenachil	20.0	13.0	8.5	7.8
99.	Puthuppadi, Meenangadi	24.4	11.3	5.9	5.4
100.	Edapalayam	22.3	14.5	6.0	10.9
101.	Erathupetta	20.0	11.2	5.0	6.0
102.	Erathukunnam	21.0	12.0	6.0	10.3
103.	Idukki No. 1	21.6	10.8	4.0	8.5
104.	Idukki No. 2	28.5	13.7	4.0	9.0
105.	Thodupuzha	21.2	14.8	6.9	9.5
106.	Cls No. 28	24.0	13.0	5.0	5.7

Table 1 (Continued)

Sl. no.	Cultivar/accessions	Dry recovery	Oleoresin	Oil	Curcumin
107.	Palapally, Trichur	21.0	15.3	6.0	10.7
108.	Kolathuvayal	20.0	13.5	7.0	4.2
109.	Elanji, Idukki	20.0	12.6	7.0	2.7
110.	Karuvilangad	21.0	13.9	4.0	6.2
111.	Ayur	21.5	12.4	4.6	5.1
112.	Kothamangalam	23.5	10.7	5.0	4.2
113.	Kakkayam Local	20.5	14.5	9.0	7.5
114.	Chamakuchi	26.5	16.9	4.0	7.0
115.	Anchal	28.0	12.4	5.0	5.4
116.	Muringakalla	23.1	11.8	5.0	7.0
117.	Mongam, Malappuram	26.2	12.0	7.0	5.7
118.	Maramboor	18.0	13.0	4.0	5.6
119.	Ernad	30.5	12.9	9.0	5.2
120.	Wynad Local	20.0	15.3	7.0	9.4

*C. aromatica* Salisb.

1.	Silapather, N. Lekhimpur	21.7	12.5	5.0	3.2
2.	Burahazer, Dibrugarh	28.0	11.6	4.0	3.1
3.	Tura, Garo Hills	25.0	13.9	4.0	4.3
4.	Dibrugarh	20.3	12.5	6.5	8.0
5.	Hahim	27.2	13.0	6.0	2.3
6.	Aseemgiri, Garohills	17.8	10.5	7.0	3.5
7.	Bahumura, Agarthala	18.0	13.5	4.0	5.0
8.	Nagsar, Titagar, Jorhat	18.5	10.5	5.0	2.5
9.	Besar, Along	18.8	14.4	5.0	5.0
10.	Kanchanpur, Tripura	24.1	12.1	5.5	4.1
11.	Namachi	20.0	9.6	8.0	3.5
12.	Pakyong	18.7	12.4	6.0	3.7
13.	Nayabunglow, Meghalaya	22.4	12.5	5.5	3.9
14.	Shillong	26.0	14.0	5.0	4.0
15.	Phu, E. Sikkim	23.2	14.0	5.5	4.7
16.	Pedong, Kalimpong	20.6	14.6	5.0	4.7
17.	Ca 72 Udayagiri	21.0	13.0	5.5	4.0
18.	Cas No. 57	22.5	12.9	9.0	7.4
19.	GL Puram I	21.0	10.9	8.0	4.1
20.	Ca 66 GL Puram	23.0	11.5	8.5	4.0
21.	Armoor	17.8	12.8	9.0	3.5
22.	Kodur	20.6	14.5	8.0	4.0
23.	Chayapasupu	20.3	14.2	8.0	2.5
24.	Ca I Chayapasupu	17.2	16.0	5.0	3.5
25.	Ca 69 Dindigam	18.9	12.0	6.0	2.8
26.	Ca 68 Dhagi	20.2	12.4	8.0	3.1
27.	Ca 70 Katergia	20.6	13.5	7.0	2.8
28.	Ca 67 Jobedi	18.8	13.0	8.5	4.1
29.	Kasturi	25.7	12.0	9.0	3.2
30.	Kasturi Tanuka	18.8	10.5	6.5	2.9
31.	Ca 73 Amalapuram	19.2	14.0	6.0	3.0
32.	Cas No. 58	22.0	13.3	8.0	3.8
33.	Cas No. 58B	14.0	11.7	8.0	6.0
34.	Erode	20.9	12.0	7.0	3.1
35.	Nadavayal	25.5	11.5	9.0	4.7
36.	Keeranthele	19.8	10.3	5.0	5.0
37.	Makkapuzha, Ranni	21.3	12.5	5.0	4.0

Table 1 (Continued)

Sl. no.	Cultivar/accessions	Dry recovery	Oleoresin	Oil	Curcumin
38.	Konni	26.1	19.2	5.0	5.0
39.	Thachanatukara, Mannarghat	24.2	10.7	8.5	6.6
40.	Mampad, Nilambur	23.8	11.7	4.0	5.7
41.	Chamakuchi	18.5	16.0	5.0	3.0
42.	Adimali	18.0	12.0	5.0	2.3
43.	Amnicad	20.0	10.8	5.0	4.7
44.	Bigmathi, Meenachil	22.0	10.3	8.5	4.0

*Exotic types* (Solomon Islands)

1.	Mamarei	20.0	13.2	6.0	3.0
2.	Vatuloro	18.0	10.0	6.0	3.4
3.	Vanagobulu	17.5	11.0	5.0	3.1
4.	Cokuma	—	12.0	6.0	4.1
5.	Tsavana	—	10.5	6.0	3.9
6.	Tuva Vitalio	—	12.0	6.0	2.8
<i>Curcuma</i> sp.					
1.	<i>Curcuma angustifolia</i> Roxb.	30.0	7.6	3.0	0.2
2.	<i>C. xanthorrhiza</i> Roxb.	25.8	10.0	2.0	1.5
3.	<i>C. zedoaria</i> (Berg.) Rosc.	20.5	6.0	2.0	2.0
4.	Wild unidentified (1)	22.7	6.4	2.0	0.3
5.	Wild unidentified (2)	30.0	7.9	2.0	2.2
6.	Wild unidentified (3) from Uttar Pradesh	23.6	7.2	5.0	1.3
7.	Wild unidentified (4)	26.5	8.6	3.0	0.8
8.	Wild unidentified (5)	30.8	4.5	4.0	0.2
9.	Wild unidentified (6) from Nagsar, Titasar, Jorhat	24.0	6.2	1.0	0.5
10.	Wild unidentified (7) (Dergoni, Jorhat)	21.4	5.8	4.0	1.6
11.	Wild unidentified (8) (Kattapana, Idukki)	31.4	8.6	2.0	0.02
12.	Wild unidentified (9) (Taranagar, Agarthala)	30.7	4.0	1.5	2.6
13.	Wild unidentified (10) (Sibsagar)	25.0	9.6	3.0	0.05
14.	<i>C. amada</i> Roxb.	30.0	5.0	1.5	—

*Oleoresin*

In the present analysis, the maximum percentage of oleoresin was found in 'Amrithapani' (19.0%) followed by 'Clis No. 16' (18.3%) and 'Kaziranga, Jorhat' (18.2%) among *C. domestica* cultivars, and the minimum was in 'Nowgong', Assam (10.0%). An *aromatica* type 'Konni' had maximum oleoresin percentage (19.2%) among all the accessions analysed. Krishnamurthy et al. [8] found a maximum oleoresin of 10.4% in 'Kasturi' (*aromatica*) and minimum of 7.9% in 'Erode' (*C. domestica*) among 12 cultivars analysed by them. However, Philip et al. [19] reported high percentage of oleoresin (21.0%) for 'ClI, 325 Duggirala' among 19 cultivars. Significant variation in oleoresin content among turmeric cultivars was recorded by Lewis [10] and Krishnamurthy et al. [7, 8].

From the present study as well as from earlier published literature on oleoresin, it seems that the yield of oleoresin varies from cultivar to cultivar and the method of extraction also seems to have influence on the percentage of oleoresin.

#### Essential oil

Considerable variation in oil percentage has also been recorded both in *C. domestica* and *C. aromatica* in the present investigation, though the ranges of variation within the species are almost the same. Krishnamurthy et al. [8] determined volatile oil content for 12 cultivars of cured turmeric and the value ranged from 2.5 to 9.5 per cent. Mathai [13] also observed a maximum content of 7.0% oil in *aromatica* var. 'Kasturi'. The variation in oil percentage can arise not only due to varietal differences but also from the origin and method of curing turmeric, its age of harvesting and the conditions of distillation [9].

#### Curcumin

Among *C. domestica* accessions, 'Edapalayam' from West Coast of India had the maximum curcumin content (10.9%) followed by 'Palapally' (10.7%). Three other accessions from this region also had very high curcumin content, namely Erathukunnam (10.3%), 'Thodupuzha' (9.5%) and 'Wynad local' (9.4%). The present investigation has also indicated that generally *C. aromatica* types have lower curcumin content compared to *C. domestica* types, the maximum curcumin percentage recorded for *C. aromatica* being 8.0 for 'Dibrugarh'.

The related species of *Curcuma* investigated and reported here were characterized by very low percentage of curcumin content (Table 1), the maximum being 2.6% for a type from Taranagar, Agarthala. Malingre [12] reported curcumin content of 1.1% in *C. xanthorrhiza*, whereas in the present study the species had a curcumin content of 1.5%. The exotic types collected from Solomon Islands had lower percentage of curcumin which varied from 2.8–4.1. Govindarajan [4] reported a lower curcumin content (0.2–0.5%) in Indonesian species. Curcumin content for various accessions of *C. aromatica* and *C. domestica* was determined and reported earlier by Janaki and Bose [6], Krishnamurthy et al. [9], Malingre [12], Philip et al. [19] and Sastry [21]. Mathai [13] reported high percentage of curcumin (8.1) in 'Vontimitta' and 'Duggirala' (*longa* types) and minimum (2.5) in 'GL Puram I' (*aromatica* type). Muralidharan and Ramankutty [14] observed a high percentage (6.2%) of curcumin in 'Alleppey' among 29 types analysed by them. From the published reports it seems that the curcumin content in various cultivars ranged from 1.5% [20] to 14.5% [15] and mostly around 5 to 6%.

A reinvestigation for the curcumin content for the 16 types earlier reported by Nambiar [15] indicated that one accession, namely 'Moovatupuzha', actually had only 7.0% of curcumin instead of 14.5%. While influence of

climatic factors and stage of maturity in percentage of curcumin content have been reported [3], such abnormal variability as reported by Nambiar [15] is not likely to occur. Liu, Yang and Chu [11] examined the effect of NPK fertilizers and found that plant yield and curcumin contents increased with increase in dosage of potassium fertilizer.

Nambiar [15] had reported low oil percentage in cultivars with high curcumin content among 16 cultivars investigated by him. The same trend has been observed in the present investigation also, though a negative correlation of these two characters could not be established.

Programmes have already been initiated at this Institute to evolve varieties combining high oleoresin as well as high curcumin contents. Spice oils and oleoresins are being increasingly manufactured in India. The present study has clearly brought out the variability available within *C. domestica* itself not only for high yield but also for high percentage of oleoresin as well as curcumin. The recent study by the author (Ratnambal – unpublished data) has also indicated that a few of the cultivars of *C. domestica* set seed and hence it would be feasible to evolve varieties combining yield and quality characteristics in turmeric.

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