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Essential oil and curcumin content in different varieties of Turmeric (*Curcuma longa* L.)

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Abstract

An experiment on extraction of essential oil and curcumin content was carried out at chemistry lab of D.A.V. College, Kanpur. Turmeric samples were collected from A.N.D. University of Agriculture and Technology Kumarganj, Ayodhya (U.P.) and analysed for its curcumin content and essential oil in different varieties (N.D.H.-1, NDH-2, NDH-3, NDH-98 and Prabha) of turmeric (*Curcuma longa*). Curcumin, the most active polyphenolic constituent of turmeric curcuminoids obtained from rhizome *Curcuma longa* holds a high place in Ayurvedic medicine. It has been shown that curcumin have a wide spectrum of biological activities such as antifungal, antidiabetic, antioxidant, anti-inflammatory, anti-cancer, anti-allergic, anti-protozoal and antibacterial activities. The results of study disclosed that turmeric sample of variety NDH-2 has higher curcumin percentage (8.44%) followed by NDH-1 (7.715%), NDH-98 (7.626%) Prabha (6.733%) and minimum percentage was found in NDH-3 (2.248%). As regards essential oil content, maximum essential oil content was found in Prabha (3.91%) followed by NDH-3 (3.45%), NDH-2 (2.79%), NDH-1 (2.42%) and the lowest in NDH-98 (1.63%). Thus, result shows that maximum curcumin was found in NDH-2 and maximum essential oil content in Prabha.

Keywords: Turmeric, essential oil, Hydro-distillation, curcumin, verity

Introduction

Turmeric (*Curcuma longa* L.) belongs to the Zingiberaceae family grown in warm rainy regions of the world such as India, China, Indonesia, Jamaica and Peru. India is the world's largest producer and exporter of turmeric (90% of the world's total production). The country produced about 946mt of turmeric from approximately 257mha area and 3683kg/ha productivity of crops during 2019-2020 (Agricultural Statistics at a Glance Directorate of Economics and Statistics, New Delhi, September, 2020). The main turmeric growing states are Andhra Pradesh, Maharashtra, Orissa, Tamil Nadu, Karnataka and Kerala. Andhra Pradesh occupied the largest area coverage 36% with 47% production share in India. That means Andhra Pradesh topped in both area and production of turmeric. The second largest area is covered by Tamil Nadu at 16%, with a production share of 21%. In Ayurveda medicine, turmeric is primarily used as a treatment for inflammatory conditions and in traditional Chinese medicine, it is used as stimulant, aspirant, carminative, cardial, emmenagogue, astringent, detergent, diuretic and martinet (Remadevi *et al.*, 2007) [20]. Turmeric has also been used for centuries as traditional remedies such as stimulant, stomachic, carminative, diuretic, anti-diarrhoea, anti-emetic, anti-inflammatory, antipyretic, anti-microbial and antioxidant agent (Jayaprakash *et al.*, 2005) [6]. The use of turmeric as a spice and as a household remedy has been known to be safe for centuries. To date, no studies in either animals or humans have discovered any toxic effects associated with the use of turmeric (Lao *et al.*, 2006) [11], and it is clear that turmeric is not toxic even at very high doses. In a clinical study on the safety and tolerance of turmeric oil use, the oil was administered orally to healthy volunteers for 3 months. No side effects of turmeric oil intake were observed in 3 months on body weight, blood pressure, and hematological, renal, or hepatic toxicity (Joshi *et al.*, 2003). The main component of turmeric is named curcuminoids, which include mainly curcumin (diferuloyl methane), demethoxycurcumin, and bisdemethoxycurcumin (Chainani-Wu, 2003) [2]. Curcumin is a secondary metabolite and the most important fraction of turmeric which is responsible for the biological activities. The melting point of curcumin, $C_{21}H_{20}O_6$, is 184 °C. It is soluble in ethanol and acetone, but insoluble in water (Joe *et al.*, 2004) [7]. Curcumin was first isolated in 1815 (Vogel & Pelletier, 1815) [24] and its structure was determined by Roughley and Whiting in 1973 [23].

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The total of curcuminoids which is about 7-10%, turmeric also contains 2-4 per cent essential oil and 2-3 per cent of fixed oil and various volatile oils, including turmerone, atlantone, and zingiberone. Other constituents include sugars, proteins and resins. The value of the turmeric products is based on their curcuminoids content and estimated based on its absorbance at 420 nm (Merina Benny Antony., 2003) [15].

Curcuminoids are polyphenols having a pronounced yellow colour. Curcumin is unstable at basic pH and degrades within 30 minutes to trans-6-(4-hydroxy-3-methoxyphenyl)-2,4-dioxo-5-hexanal, ferulic acid, ferulomethane and vanillin. Under acidic conditions, the degradation of curcumin is much slower, with less than 20% of total curcumin decomposed at 1 hrs (Lin *et al.*, 2000) [14]. Curcuminoids are soluble in dimethyl sulfoxide (DMSO), acetone and ethanol. They are readily decomposed when exposed to bright light, high temperature or oxidative conditions (Schieffer, 2002) [26]. The content of curcuminoids may vary in turmeric rhizome grown in different agro-climatic zones (Revathy *et al.*, 2011) [22]. The curcuminoids, which consist mostly of curcumin 1, 7-bis (4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione and also demethoxy-curcumin and bisdemethoxycurcumin. The essential oil extracted from turmeric oleoresin has been reported to have antibacterial, antioxidant and antifungal activities (Vijayastelter *et al.*, 2011) [29]. Due to its ability to preserve food through its antioxidant activity, to give colour and taste to the food, its health promoting effects are less well recognized or appreciated and for being anti-microbial, it is used extensively for cosmetic applications. Turmeric is the only spice which finds application in all the three segments of life i.e. food, cosmetics and health.

Methods and material

Essential oil

The rhizome essential oil content was estimated by hydrodistillation method as described in A.O.A.C. (1970). 10g of powder rhizome were transferred into extractor by using pre-weighted thimble. The thimble was placed into extractor of soxhlet apparatus. The receiving flask of the soxhlet apparatus containing ethanol (40-60 °C) was heated on a water bath. Thus, the glass assembly with sample was refluxed on water bath containing 8 to 10 hours for extraction of oil. Finally the solvent in the receiving flask was distilled off leaving behind pure oil in the flask. The flask was weighed with oil and the observation recorded was calculated as given below:

$$\text{Oil content (\%)} = \frac{W_2 - W_1}{\text{weight of sample}} \times 100$$

W_1 = Weight of empty flask

W_2 = Weight of flask+ oil

Curcumin content

Thimmaiah (1999) [28]

Rhizomes were dried and grounded to fine powder. 10mg crude turmeric rhizome fine powder was dissolved in 5ml of 95% alcohol. Mixture was properly shaken in rocker for 1

hour and volume made upto 10ml with 95% alcohol. Mixture was filtered by Whatman filter paper and diluted 20X before reading. Absorbance was measured at 425nm in visible spectrophotometer. Standard curve was obtained using the standard solution in the range of 1µg/ml to 4µg/ml (about 40% - 160% of the standard concentration of 0.5 mg/ml). Absorbance of these solutions were taken at 425nm using UV-visible spectrophotometer.

Curcumin content was calculated using the following formula:

$$\text{Curcumin content (g/100g)} = \frac{0.002 \times A_{425} \times \text{volume made up} \times \text{Dilution factor} \times 100}{0.42 \times \text{weight of sample (g)} \times 1000}$$

0.42 absorbance at 425 = 0.0025g curcumin / litre

Result and discussion:

curcumin content in turmeric rhizome:

Curcumin, the most active polyphenolic constituent of turmeric curcuminoids obtained from rhizome *Curcuma longa* holds a high place in Ayurvedic medicine. It has been shown that curcumin have a wide spectrum of biological activities such as antifungal, antidiabetic, antioxidant, anti-inflammatory, anti-cancer, anti-allergic, anti-protozoal and antibacterial activities.

Data on curcumin content have been shown in Table:1 and depicted in fig:1. It was revealed from data that curcumin content varied with variety to variety. It was ranged from 2.22% to 8.44% among five varieties of turmeric. The maximum curcumin content was recorded in NDH-2 (8.442%) followed by NDH-1 (7.715%), NDH-98 (7.626%) Prabha (6.733%) and minimum percentage was found in NDH-3 (2.248%). The result was in close agreement with Krishnamurthy *et al.* (1975) [9], Kumar *et al.* (1997) [10] and Fatterpurkar *et al.* (2009). Sasikumar *et al.* (1996) [25] observed that IISR Prabha and Pratibha had 6.25 and 6.21 per cent curcumin content, respectively. Whereas, highest range of curcumin percentage was 3.584 to 7.730% in Pratibha followed by Salem 2.169 to 5.932%, Rajapuri 2.812 to 4.366%, Krishna 1.599 to 3.520% respectively, as observed by Kamble *et al.*, 2011. Factors such as the extraction method, solvent used for extraction, extraction time and temperature, the solvent ratio and extraction pressure were among the significant factors that were shown to be able to influence the efficiency of curcumin extraction (Wakte *et al.*, 2011) [30]. Curcumin content was reported to vary from one species to another. Several studies have shown that soil factors, including nutrients and level acidity as well as the genus diversity, may affect the content of curcumin (Nahak and Sahu, 2011) [16].

Table 1: Curcumin Content in Turmeric Rhizomes

Sample code	Curcumin Content (mg/gm)	Curcumin Content (%)
NDH-1	77.15	7.72
NDH-2	84.42	8.44
NDH-3	22.48	2.25
NDH-98	76.26	7.63
Prabha	67.33	6.73

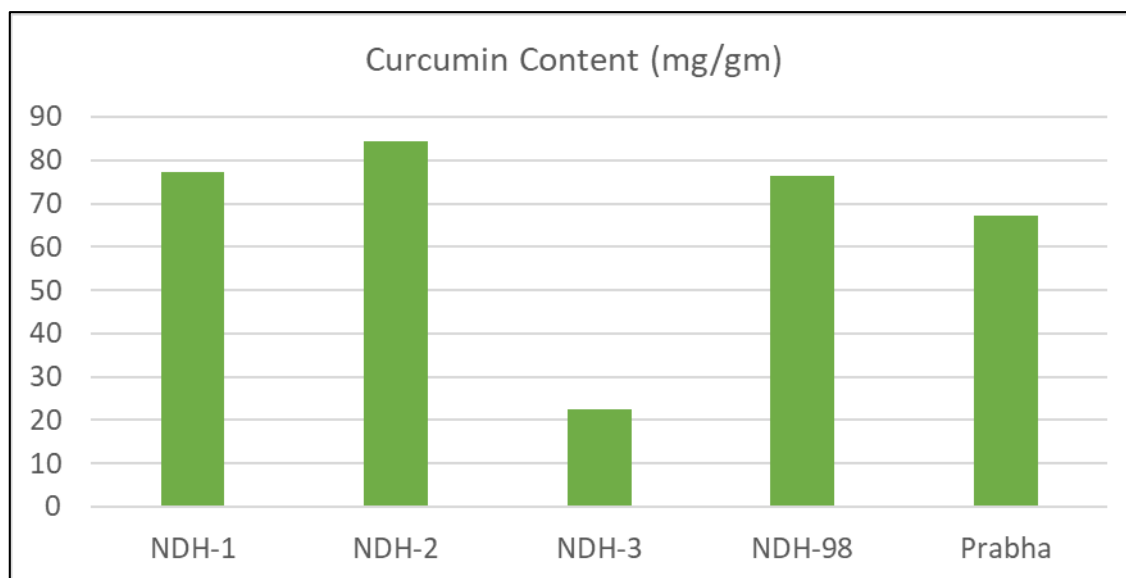


Fig 1: Curcumin Content in Turmeric Rhizomes

Extraction of essential oil

Hydro distillation for isolation of essential oil

Data pertaining to essential oil content in turmeric rhizome have been given in Table: 2 and depicted in Fig: 2, indicated that essential oil content varied from variety to variety and it ranged from 1.63 to 3.91%. Data further reveals that maximum essential oil content was found in Prabha (3.91%) followed by NDH-3 (3.45%), NDH-2 (2.79%), NDH-1 (2.42%) and the lowest in NDH-98 (1.63%).

Results are in close agreement with text of Krishnamurthy *et al.* (1975) ^[9], Sasikumar *et al.* (1996) ^[25] and Kumar *et al.* (1997) ^[10]. Corray *et al.* (1988) ^[3] reported that optimum time for harvest for maximum yield of turmeric oil was 7.0 to 8.0 months and oil content in bulb was higher than that of finger rhizome. The roots yield highest concentration of oil 4.3 percent followed by rhizome 3.8 percent (Leela *et al.*, 2002) ^[12]. Volatile oil content in dried powder of *C. longa* rhizome was investigated by hydrodistillation and average yields of volatile oil in dried turmeric powder were $8.20 \pm 1.66\%$ v/w (Singh and Jain, 2011) ^[27]. There were significant variations in the composition of essential oils of turmeric rhizomes with

varieties and geographical locations. Turmeric oil from different sources may have different chemical profile with different bioactivities. However, the production of these bioactive compounds depends on plant genotypes, postharvest processing (eg. Drying, extraction etc.), environment condition such as temperature, humidity, light, soil and geographical location (Li *et al.*, 2011) ^[13]. Plant maturity has also significant impact on chemical composition of turmeric oil. Both total curcuminoids and curcumin in rhizome reach the highest yield at 5-6 months and maturity result in decline of these pigments but the essential oils will not reach maximum yield until 7-10 months (Cooray *et al.*, 1988) ^[3]

Table 2: Oil content by hydro-distillation

S. No.	Name of sample	Oil content by hydro-distillation
1.	NDH-1	2.42%
2.	NDH-2	2.79%
3.	NDH-3	3.45%
4.	NDH-98	1.63%
5.	Prabha	3.91%

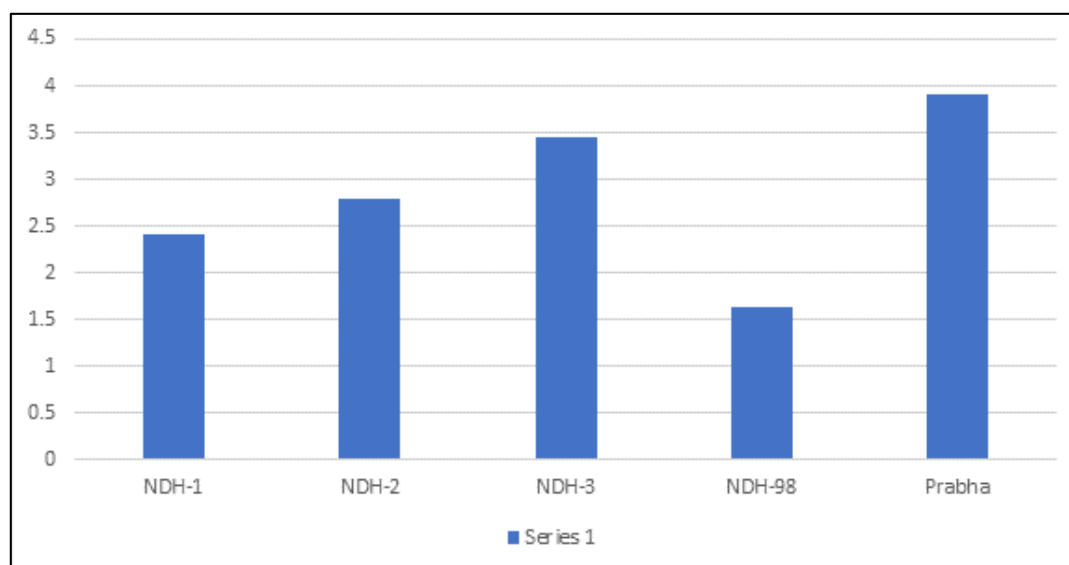


Fig 2: Oil content by hydro-distillation

Conclusion

The results obtained from the analysis of turmeric rhizome powder indicated that it contained highest curcumin content in NDH-2 (8.44%) while highest essential oil content in Prabha (3.91%) among all five varieties.

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