**Comparative studies in relation to morphological and biochemical active compound in turmeric (*Curcuma longa* L.) rhizome**

**ABSTRACT**

The present investigation on comparative studies of morphological and biochemical active compound in turmeric (*Curcuma longa* L.) rhizome was carried out Main Experimental Station, Vegetable Science, A.N.D.U.A. &T., Kumarganj, Ayodhaya in Kharif season in year 2012-2013. One variety and 9 germplasm was selected namely, Prapha, NDH-1, NDH-7, NDH-8, NDH-45, NDH-68, NDH-69, NDH-86, NDH-89 and NDH-116. Regarding morphological characteristic *viz*. yield of rhizome/plant and length of mother rhizome, NDH-8 recorded highest yield 305.93 g and 10.20 cm, respectively. While the maximum length of finger rhizome was recorded in Prabha (12.23 cm) followed by NDH-8 (11.50 cm). NDH-8 had also recorded highest total mineral content (5.21 %), carbohydrate content (69.50 %), protein content (6.66 %), essential oil (8.21 %) and oleoresin content (13.26 %). NDH-1 had maximum curcumin content (5.8 per cent) followed by NDH-7 (5.6 per cent).

In the light of reviewing physical characteristics and biochemical composition NDH-8 and NDH-1 are recommended as a promising turmeric germplasm.

KEYWORDS: finger rhizome, turmeric germplasm, essential oil, Prapha, mineral

**Introduction**

India is referred to as the "spice bowl of the world" due to the high caliber of spices it produces. One of the key ingredients in every Indian kitchen is turmeric. Turmeric contains 2n=3x=63 chromosomes and is a member of the Zingiberaceae family. Originating in South East Asia, it is extensively grown in South and Southeast Asian nations. Globally, turmeric is grown in India, Srilanka, Taiwan and China (Singh *et al*., 2015).

Curcumin is the primary ingredient in turmeric. Turmeric gets its color from a polyphenol called curcumin. As a polyphenol with a lipophilic character, curcumin is soluble in ethanol, dimethylsulfoxide, and other organic solvents but insoluble in water (Aggarwal *et al*., 2003).

Another significant active ingredient in turmeric is essential oil. It is extracted from the rhizomes and leaves of turmeric using Clevenger's equipment for hydro-distillation. According to Purseglove et al. (1981), GC-MS analysis shows that turmeric oil contains a number of significant constituents with a variety of properties, including antimicrobial, anti-inflammatory, anti-wounds, anti-dermatosis, insect repellent, antiseptic, antacid, and carminative. It is also used to treat a number of digestive disorders. Both the cosmetic and pharmaceutical sectors benefit from these essential oils.

Curcumin and other resinous substances make up turmeric oleoresins (Krishnamurthy et al., 1976). In the West, the processed food industry are using it more and more to add color and scent.   
Turmeric contains several natural coloring, medicinal, and nutritional properties. The development of plant types with high medicine producing potential—that is, those with a greater amount of curcumin, oleoresin, or essential oil—is therefore in high demand globally. In order to better understand the morphological and biochemical active compounds found in the rhizome of turmeric (Curcuma longa L.), comparative research was conducted.

**MATERIALS AND METHODS**

At the Main Experimental Station, Vegetable Science, A.N.D.U.A. &T., Kumarganj, Ayodhaya, situated in the Indo-Gangetic plains of Eastern Uttar Pradesh at 26.4 N latitude and 82.12 E longitude, at an elevation of 113 meters above mean sea level, the field experiment was carried out in Kharif season of 2012–2013 using a Randomized Block Design with three replications.

**Physical parameters:**

Each plant's rhizome was cleaned after harvesting by removing any adherent soil particles, and the quantity of clumps per plant was counted. Using a scale, the length of the mother rhizome and finger was measured in centimeters. After that, all of the turmeric variants were taken to the A.N.D.U.A. &T. Biochemistry Laboratory for biochemical examination.

**Biochemical parameters:**

The dried rhizomes of ten distinct cultivars—NDH-7, NDH-8, NDH-45, NDH-68, NDH-69, NDH-86, NDH-88, NDH-116, NDH-1, and Prabha—were ground into powders, which were then used to analyze the levels of minerals, proteins, carbohydrates, oleoresins, essential oils, and curcumin. Hart and Fisher (1971) calculated the mineral concentration. Mc Cready et al. conducted an analysis of the carbohydrate content (1950). Lowry's technique is used to assess the protein content (1951). The method recommended by S.K. Thimmaiah (1999) was used to estimate the curcumin concentration. The A.O.A.C. (1975) technique was used to assess the amount of oleoresin in turmeric rhizome. The traditional Soxhlet technique, as outlined in A.O.A.C. (1965), was used to evaluate the essential oil concentration of different samples.

**RESULT AND DISCUSSION**

Table 1 and Fig. 1 provide information on the length of the mother rhizome, the length of the finger rhizome, and the production of rhizome/plant in turmeric varieties and germplasm. According to the statistics, the rhizome/plant production ranged from 198.40 g to 305.93 g. The germplasm NDH-86 had the lowest rhizome/plant yield (198.40 g), whereas NDH-8 had the highest yield (305.93 g), followed by Prabha (297.30 g) and NDH-86 (296.90 g). The information on the rhizome/plant output varied greatly. Chaudhary et al. have provided positive support for the findings (2006).

|  |  |  |  |
| --- | --- | --- | --- |
| **Variety/ Germplasm** | **Yield of rhizome/Plant (g)** | **Length of fingers rhizome (cm)** | **Length of mother rhizome (cm)** |
| NDH-7 | 284.56 | 5.50 | 7.20 |
| NDH-8 | 305.93 | 11.50 | 10.20 |
| NDH-45 | 295.16 | 6.13 | 5.13 |
| NDH-68 | 249.63 | 9.26 | 6.80 |
| NDH-69 | 254.00 | 5.36 | 9.80 |
| NDH-86 | 198.40 | 6.83 | 8.10 |
| NDH-88 | 279.66 | 5.33 | 7.50 |
| NDH-116 | 210.46 | 5.33 | 6.20 |
| NDH-1 | 289.13 | 7.06 | 8.56 |
| Prabha | 297.30 | 12.23 | 8.36 |
| CD at 5% | 20.433 | 0.948 | 1.600 |
| SEm± | 6.875 | 0.320 | 0.538 |

According to the results, finger rhizome length ranged from 5.33 to 12.23 cm. Prabha had the longest finger rhizome (12.23 cm), followed by NDH-8 (11.50 cm) and NDH-68 (9.26 cm). Germplasm NDH-116 and NDH-88 had the lowest rhizome/plant yield (5.33 cm). According to Chaudhary et al. (2006), Rajendra Sonia and Krishna both recorded the longest fingers (10.20 cm). The outcomes show a strong agreement with the findings of Jalani et al. (2012).

The length of the mother rhizome differed greatly among turmeric types and germplasm, according to the study. Mother rhizome length was found to vary between 10.20 and 5.13 cm, with the longest measured at 10.20 cm in NDH-8, followed by 9.80 cm in NDH-69 and 8.56 cm in NDH-1, and the shortest measured at 5.13 cm in NDH-45. The outcome closely matched Kamal and Yousuf's (2012) findings. According to Chaudhary et al. (2006), genetic factors rather than environmental conditions may be the cause of the variance in rhizome characteristics and fresh production among different turmeric types.

**Table 1: Physical characteristics of different germplasm/ variety of turmeric:**

**Fig. 1: Physical characteristics of different germplasm/ variety of turmeric**

The information about the total mineral content was displayed graphically in Fig. 2 and in Table 2. The findings showed that there were considerable differences in the total mineral content of turmeric cultivars and germplasm. According to reports, the overall mineral concentration in 2012–13 ranged from 3.89 to 5.21 percent. NDH-8 had the highest total mineral content (5.21%), followed by NDH-7 (5.12%) and NDH-1 (4.96%), while NDH-68 had the lowest value (3.86%). These findings closely align with those of Fattepurkar et al. (2009) and Niranjan et al. (2003). According to Lokhande et al. (2013), the mineral concentration ranged from 6.27 to 0.81%.

Regarding the protein and carbohydrate content statistics, they are displayed in Table 2 and graphically represented in Fig. 2. There was no substantial variation in the amount of carbohydrates found in the turmeric rhizome types and germplasm. The percentage of carbohydrates varied from 60.00 to 69.50 percent. NDH-8 had the highest carbohydrate content (69.50%), followed by NDH-1 (69.23%) and NDH-88 (68.74%), while NDH-45 had the lowest (60.00%). The outcome closely matches that of Lokhande et al. (2013), who found that all cultivars had carbohydrate contents between 67.9 and 69.9 percent. The same conclusion was also corroborated by Kumari et al. (2022), who showed that the largest amount of carbohydrates was found in NDH-2 (70.40%), with a range of 61.50 to 70.40 percent.

The study revealed substantial variation in the protein content of turmeric rhizome. The range of turmeric rhizome types and germplasm is 3.34 to 6.66 g/100g. NDH-8 had the highest protein content (6.66 g/100g), followed by NDH-7 (6.38 g/100g), while NDH-68 had the lowest protein level (3.34 g/100g). Turmeric rhizome types and germplasm differed greatly in terms of essential oil content. This outcome is consistent with the findings of Niranjan et al. (2003), who found that the protein content of dried rhizomes of C. longa, C. amada, and C. zeodaria varied from 3.6 to 6.8%.

Information on the amount of curcumin, oleoresin, and essential oil in turmeric rhizome is displayed in Table 2 and is visually represented in Fig. 2. Turmeric rhizome types and germplasm differed greatly in terms of essential oil content. The essential oil content varied from 3.48 to 8.21%; NDH-8 had the highest essential oil content (8.21%), followed by NDH-69 (8.18%) and NDH-86 (7.43%), while NDH-45 had the lowest value (3.48%). The findings closely match the text of Kumar et al. (1997).

In 2012–13, the oleoresin concentration varied between 8.64 and 13.26 percent. The lowest oleoresin concentration was 8.64 percent in NDH-45, while the highest was 13.26 percent in NDH-8, followed by 11.77 percent in NDH-68 and 11.16 percent in NDH-88. The study showed that there were considerable differences in the oleoresin concentration of turmeric cultivars and genotypes. According to Lokhande et al. (2013), the three cultivars' oleoresin concentrations varied significantly. The highest concentration of oleoresins (8.13%) was found in Krishna, while Tekurpetha had the lowest (5.85%).

It was shown that the curcumin concentration ranged from 3.9 to 5.8%; NDH-1 had the highest curcumin content (5.8%), followed by NDH-7 (5.6%), while NDH-86 had the lowest value (3.9%). This outcome closely matches the findings of Sasikumar et al. (1996), who found that IISR Prabha and Pratibha had curcumin contents of 6.25 and 6.21%, respectively. However, according to Kamble et al. (2011), the largest range of curcumin percentage was found in Pratibha (3.584 to 7.730%), followed by Salem (2.169 to 5.932%), Rajapuri (2.812 to 4.366%), and Krishna (1.599 to 3.520%).

**Table 2: Variability in biochemical content of different turmeric germplasm/ variety:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Varieties/ Germplasm** | **Total Mineral (%)** | **Carbohydrate**  **content (%)** | **Protein (g/100g)** | **Essential oil content (%)** | **Oleoresin content (%)** | **Curcumin content (%)** |
| NDH-7 | 5.12 | 64.50 | 6.38 | 7.35 | 9.87 | 5.6 |
| NDH-8 | 5.21 | 69.50 | 6.66 | 8.21 | 13.26 | 4.8 |
| NDH-45 | 4.83 | 60.00 | 3.88 | 3.48 | 8.64 | 4.1 |
| NDH-68 | 3.89 | 68.07 | 3.34 | 4.28 | 11.77 | 5.3 |
| NDH-69 | 4.95 | 67.85 | 4.99 | 8.18 | 10.35 | 4.3 |
| NDH-86 | 4.43 | 64.89 | 4.16 | 7.43 | 10.42 | 3.9 |
| NDH-88 | 4.72 | 68.74 | 3.60 | 6.71 | 11.16 | 5.4 |
| NDH-116 | 4.79 | 66.15 | 5.27 | 6.08 | 11.63 | 5.4 |
| NDH-1 | 4.96 | 69.23 | 5.55 | 6.68 | 9.35 | 5.8 |
| Prabha | 4.58 | 66.82 | 5.83 | 4.24 | 10.80 | 5.1 |
| CD at 5 % | 0.414 | NS | 1.756 | 0.970 | 1.971 | 0.993 |
| SEm± | 0.135 | - | 0.589 | 0.326 | 0.663 | 0.335 |

**Fig. 2: Variabilty in biochemical content of different turmeric germplasm/ variety:**

**Conclusion:**

In the light of qualitative investigation of turmeric variety and germplasm, salient conclusions may be drawn as NDH-1 and NDH-8 were found to be best in comparison to select variety and germplasm in respect to morphological and biochemical analysis. As such, these germplasm is recommended to farmers to cultivate it at different geographical locations. It may also be preferred as food preservatives, additives and for the production of value-added turmeric products to food and pharmaceutical industry.

**Disclaimer (Artificial intelligence):**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

**REFRENCE:**

AOAC (1965). Official Methods of Analysis. 10th Ed. Association of Official Analytical Chemists, Washington, D.C.

AOAC (1975) Official Methods of Analysis. 12th Ed. Association of Official Analytical Chemists, Washington, D.C.

Chaudhary, A.S.; Sachan, S.K. and Singh, R.L. (2006). Studies on varietal performance of turmeric (Curcuma longa L.) Indian J. Crop Science, 1 (1-2):189-190.

Fattepurkar, S.C.; Damame, S.V. and Ghadge, S.N. (2009). Chemical composition of finger rhizome of *Curcuma aromatic* L. and *Curcuma longa* L. *Asian journal of Experimental Chemistry*, **4** (1): 84-86.

Hart, F.L. and Fisher, H.S. (1971). Modern food analysis. Spinger veralog. New York, 135-137.

Kamble, K.J.; Ingale V.M. and Kaledhonkar, D.P. (2011). Comparative study of curcumin extraction from Turmeric varieties grown in Maharashtra. *African Jour. of Food Sci.*, **5**(14): 780-789

Kamal, M. Z. U and Yusuf, M. N. (2012). Effect of Organic Manures on Growth, Rhizome Yield and Quality Attributes of Turmeric (*Curcuma longa* L.), *The Agriculturists*  10(1):16-22.

Krishnamurthy, N.; Mathew, A. G.; Nambudini, E.S.; Shivashankar, S.; Lewis, Y.S. and Natarajan, C.P. (1976). Oil and oleroresin of turmeric. Tropical Sci. 18(1): 37-42.

Kumar, N.; Khader, A.; Rangaswami, P. and Irulappan, I. (1997). Major Spices- Turmeric. Introduction to spices and Plantation Crops. *Medicinal and Aromatic Plants*, **24** (2): 27-35.

Kumari, A.; Prasad, C. and Kumar, R. (2022) Biochemical studies in different varieties of turmeric (*Curcuma longa* L.) The Pharma Innovation J. 11 (1): 1639-1645.

Lokhande, S. M., Kale, R. V., Sahoo, A. K., and Ranveer, R. C. (2013). Effect of curing and drying methods on recovery, curcumin and essential oil content of different cultivars of turmeric (Curcuma longa L.) International Food Research Journal 20(2): 745-749.

Lowry,O. H.: Rosebrough N. J., Farr A. L and Randal R J. 1951. Protein measurement with folin's phenol reagent. 265-275.

Mc cready, R.M.; Guggolz, J.; Silviera, V. and Owens, H.S. (1950). Determination of starch and amylose rice. Analytical Chemistry, 22:1156-1158.

Niranjan, A.; Dhan. P.; Tewari, S. K.; Pandey, A.; Pushpangadan, P. and Prakash, D. (2003). Chemistry of Curcuma spp. Cultivated on Sodic soil. Journal of Medicinal and Aromatic Plants Sciences.25: 69-75.

Purseglove, J.W.; Brown, G.; Green, C.L. and Robbins, S.R.J. (1981) Spices. Vol.2. Longman Scientific and Tecnial Co. and John Wiley and Sons, Inc., New York, 457.

Sasikumar, B.; Johnson, George K.; Zachariah, John T.; Ratnambal, M. J.; Nirmal Babu K and Ravindran, P. N. (1996). IISR Prabha and IISR Prathibha – two new high yielding and high quality turmeric (Curcuma longa L.) varieties. Journal of Spices and Aromatic Crops, 5 (1): 41-48.

Singh, A. K.; Nanda, P.; Singh, A. and Singh, B., (2015) Genetic diversity analysis in Turmeric (Curcuma longa L.) Based on SSR Markers, Journal of Biological Engineering Research and Review, 2015; 2(1): 20-24

Thimmaiah SK. Standard Methods of Biochemical Analysis. Kalyani Publishers, New Delhi. 1999, 534.