**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.

**Introduction**

India is known as “spice bowl of world”, for its production of superior quality of spices. Turmeric which is one of the essential spices found in every Indian kitchen. Turmeric belongs to the Zingiberaceae family and has a 2n=3x=63 chromosome. It is native to South East Asia and widely cultivated throughout South and South East Asian countries. Globally, turmeric is grown in India, Srilanka, Taiwan and China (Singh *et al*., 2015).

The main constituent of turmeric is curcumin. Curcumin is a polyphenol that gives turmeric its colour. Curcumin is a polyphenol and is lipophillic in nature, hence insoluble in water but soluble in ethanol, dimethylsulfoxide, and other organic solvents (Aggarwal *et al*., 2003).

Essential oil is another important active constituent of turmeric. It is collected from turmeric leaves and rhizomes by hydro-distillation in Clevenger's apparatus. GC–MS analysis reveals that the oil from turmeric contains many important constituents having varied properties like anti microbial, anti-inflammatory, anti-wounds, anti-dermatosis, insect repellant, antiseptic, antacid and carminative and also used in various digestion ailments (Purseglove *et al*., 1981). These essential oils are valuable for pharmaceutical as well as cosmetic industries.

Turmeric oleoresins consist of curcumin and other resinous compounds (Krishnamurthy *et al*., 1976). It is used increasingly by the processed food industries in the West to impart colour and aroma.

Turmeric has numerous pharmaceutical, nutraceutical, and natural colourant property. Consequently, there is worldwide demand to develop varieties with high drug yielding potential i.e., plants with higher content of curcumin/oleoresin/essential oil. Hence, the present study on “Comparative studies in relation to morphological and biochemical active compound in turmeric (Curcuma longa L.) rhizome” was carried out.

**MATERIALS AND METHODS**

The field experiment was conducted in Randomized Block Design with three replications in Kharif season in year 2012-2013 at Main Experimental Station, Vegetable Science, A.N.D.U.A. &T., Kumarganj, Ayodhaya located in the Indo- Gangetic plains of Eastern U.P. at 26.4 N latitude and 82.12 E longitude at an altitude of 113 meter above the mean sea level.

**Physical parameters:**

After harvesting, the rhizome of each plant were cleaned by removing adhered soil particles, number of clump per plant was weighed. Length of finger and mother rhizome was taken with the help of scale in centimetres. Then, all the varieties of turmeric were brought to the laboratory of Biochemistry, A.N.D.U.A. &T. for biochemical analysis.

**Biochemical parameters:**

The powders obtained from dried rhizome of 10 different cultivars viz. NDH-7, NDH-8, NDH-45, NDH-68, NDH-69, NDH-86, NDH-88, NDH-116, NDH-1 and Prabha were taken for analysis of mineral, carbohydrates, protein, oleoresin, essential oils and curcumin content. Mineral content was estimated by Hart and Fisher (1971). Carbohydrate content was analyzed by Mc Cready *et al.* (1950). Protein content is estimated by Lowry's method (1951). Curcumin content was estimated by the procedure suggested by the S.K. Thimmaiah (1999). Oleoresin content in turmeric rhizome was estimated by the method given by A.O.A.C (1975). Essential oil content of various samples was estimated by conventional soxhlet method as described in A.O.A.C. (1965).

**RESULT AND DISCUSSION**

Data regarding to yield of rhizome/plant, length of finger rhizome and length of mother rhizome in turmeric varieties/ germplasm have been shown in Table 1 and graphically depicted in Fig.1. The data showed that yield of rhizome/plant varied from 198.40 g to 305.93 g. Maximum yield of rhizome/plant was recorded in NDH-8 (305.93 g) followed by Prabha (297.30 g) and NDH-86 (296.90 g) whereas, minimum yield of rhizome/plant was accounted in germplasm NDH-86 (198.40 g). The data regarding to the yield of rhizome/plant in varied significantly. The results have been favourably supported by Chaudhary *et al.* (2006).

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| --- | --- | --- | --- |
| **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 |

The data showed that length of finger rhizome varied from 5.33 to 12.23 cm, maximum length of finger rhizome was recorded in Prabha (12.23 cm) followed by NDH-8 (11.50 cm) and NDH- 68 (9.26 cm) whereas, minimum yield of rhizome/plant was accounted in germplasm NDH-116 and NDH-88 (5.33 cm). Chaudhary *et al.* (2006) reported that Krishna recorded maximum finger length (10.20 cm) followed by Rajendra Sonia. The results indicate close correlation with finding of Jalani *et al.* (2012).

The study highlighted that length of mother rhizome in turmeric varieties/ germplasm varied significantly. It was observed that length of mother rhizome varied from 10.20 cm to 5.13 cm, maximum length of mother rhizome was found 10.20 cm in NDH-8 followed by 9.80 cm in NDH-69 and 8.56 cm in NDH-1 while minimum value was recorded in 5.13 cm in NDH-45. The result was close agreement with finding of Kamal and Yousuf (2012). The variation in rhizome characters and fresh yield among various turmeric varieties could be due to genetic factors rather than the environmental condition as reported by Chaudhary *et al.* (2006).

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

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

The data regarding to total mineral content was shown in Table. 2 and graphical depicted in Fig. 2. It was revealed from the data that total mineral content in turmeric varieties/ germplasm varied significantly. It was indicated that total mineral content varied from 3.89 to 5.21 per cent in 2012-13. Highest total mineral content was recorded in NDH-8 (5.21%) followed by NDH-7 (5.12%) and NDH-1 (4.96 %) whereas, lowest value was recorded in NDH-68 (3.86%). These results are in close coherence with Niranjan *et al.* (2003) and Fattepurkar *et al.* (2009). Lokhande *et al.* (2013) also reported variation in mineral content from 6.27-6.81 per cent.

In reference to data on carbohydrate content and protein content have been shown in Table 2 and graphically depicted in Fig. 2. In respect to carbohydrate content in turmeric rhizome varieties/ germplasm varied non significantly. Carbohydrate content ranged between 60.00 to 69.50 per cent. It was noticed that maximum carbohydrate content was found in NDH-8 (69.50%) followed by NDH-1 (69.23%) and NDH-88 (68.74%) while minimum was noticed in NDH-45 (60.00%). The result is in close favour with Lokhande *et al.* (2013) who reported that carbohydrate content of all cultivars was in the range of 67.9 to 69.9 per cent. Same result was also supported by Kumari *et al.* (2022) where carbohydrate content ranged from 61.50 to 70.40% and maximum carbohydrate was found in NDH-2 (70.40%).

The study showed that protein content in turmeric rhizome varied significantly. It is ranged between 3.34- 6.66 g/100g in turmeric rhizome varieties/ germplasm. Highest protein content was found in NDH-8 (6.66 g/100g), followed by NDH-7 (6.38 g/100g) whereas lowest content was recorded in NDH-68 (3.34 g/100g). In respect to essential oil content in turmeric rhizome varieties/ germplasm varied significantly. This result is in coherent with Niranjan *et al.* (2003) observed that protein content ranged between 3.6-6.8% in dried rhizomes of C. longa, C. amada and C. zeodaria.

Data pertaining to essential oil content, oleoresin content and Curcumin content in turmeric rhizome have been shown in Table 2 and graphically depicted in Fig. 2. In respect to essential oil content in turmeric rhizome varieties/ germplasm varied significantly. Essential oil content ranged between 3.48- 8.21%, maximum essential oil content was found in NDH-8 (8.21%) followed by NDH-69 (8.18%) and NDH-86 (7.43%) whereas, minimum value was recorded in NDH-45 (3.48%). Results are in close agreement with text of Kumar *et al.* (1997).

Oleoresin content ranged from 8.64 to 13.26 per cent in year 2012-13. Maximum oleoresin content was found 13.26 per cent in NDH-8 followed 11.77 per cent in NDH-68 and 11.16 per cent in NDH-88 while minimum oleoresin content was recorded in 8.64 per cent in NDH-45. The study highlighted that oleoresin content in turmeric varieties/ germplasm varied significantly. Lokhande *et al*. (2013) reported significant difference in oleoresin contents of the three cultivars. Tekurpetha had lowest amount of oleoresins (5.85 %) and Krishna had the highest amount (8.13 %).

It was indicated that curcumin content varied from 3.9 to 5.8 per cent, NDH-1 had maximum curcumin content (5.8 per cent) followed by NDH-7 (5.6 per cent) whereas, minimum value was recorded 3.9 per cent in NDH-86. This result is in close agreement with Sasikumar *et al.* (1996) 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.

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

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| --- | --- | --- | --- | --- | --- | --- |
| **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: Variability 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 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 prefer as food preservatives, additives and for the production of value added turmeric products to food and pharmaceutical industry.

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