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# TURMERIC RESEARCH AT NRCRI UMUDIKE: HIGHLIGHT OF MAJOR ACHIEVEMENTS

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**ABSTRACT**
Turmeric (Curcuma longa L.) a member of ginger family Zingiberaceae, is a cross-pollinated triploid (2n =3x = 63); vegetatively propagated by means of yellow fleshed rhizomes; and widely used for culinary and medicinal purposes. Owing to its numerous uses, National Root Crops Research Institute (NRCRI) Umudike began research on turmeric in 1998. This paper highlights the major achievements from almost two decades of turmeric research at NRCRI Umudike. NRCRI pioneered collection of germplasm and indigenous knowledge about the production and utilization of Turmeric. 76 accessions of Turmeric were collected from several expeditions. The highest number of collections (12) was from Ekiti State. Following multi-locational evaluation at Jos, Otobi, Umudike and Igbariam, ten genotypes, viz., UT39, UT44, UT46, UT58, UT50, UT14, UT41, UT6, UT38 and UT35, were identified as promising and require further evaluation as pre-condition for official registration and release to farmers. The proximate composition and potential use of turmeric as food colourants have been established. Agronomic management packages for optimal yield of turmeric have been developed by NRCRI Umudike. Results of economic studies carried out at NRCRI Umudike revealed high profitability of turmeric production with returns per naira (R/N) being N233.90, Net income N326, 918.22 and benefit cost ratio (RCR) of 3.3. Value added products like turmeric powder, have been developed. These and high quality planting materials are being produced and their production technologies extended to farmers and other end users.

**Keywords: Expedition, Evaluation, proximate composition, economic studies and value addition**

## Introduction

Turmeric (*Curcuma longa* L.) is a monocotyledonous, herbaceous, rhizomatous spice belonging to the ginger family Zingiberaceae. It is thought to be indigenous to the Indian subcontinent and due to its potent and popular uses, its cultivation spread from India to Southeast Asia, China, Northern Australia, the West Indies, and South and Central America (Jiang, 2005). In Nigeria, it can be found growing from low altitude (5m above sea level) in the Southern coastal plains of the rainforest to the mid-altitude (823m above sea level) in the Derived Savanna within Longitude 03°02'E - 09°30'E and latitude 4°37'N – 10°04'N (Olojede and Nwokocha, 2011). It is grown mainly in small plots around homes (Olojede, *et al*., 2005) and can be found in the wild (Olife *et al*., 2013). In the last few years as awareness of its many uses continue to increase, many farmers have begun to grow it as cash crop especially in the ginger growing areas of southern part of Kaduna State. Turmeric is a cross-pollinated, triploid species (2n =3x = 63), which can be vegetatively propagated using its underground rhizomes (Sasikumar 2005). Since hybridization is ineffective in most cases, genetic improvement is often limited to germplasm selection and mutation breeding (Ravindran *et al*., 2007). Curcuminoids and essential oils are the major active constituents in turmeric, crucial for the quality of both the plant and its processed products (He e*t al*., 1998; Jiang, 2005). The three major curcuminoids found in turmeric are curcumin, demethoxycurcumin, and bisdemethoxycurcumin (3-5% of raw plant)

(Verma *et al*., 2013). In addition to their role in the colourants of curries, these compounds have been reported to have anti-inflammatory (Lukita-Atmadja *et al*., 2002), anti-arthritic, anti-oxidant (Masuda *et al*., 1999), anti-allergic, anti-bacterial (Chattopadhyay *et al*., 2004; Fagbemi *et al*., 2009), anti-cancer (Shao *et al*., 2002; Duvoix *et al*., 2005), anti-coagulant, antispasmodic, anti-parasitic, anti-mutagenic (Shukla *et al*., 2002) and anti-viral (HIV) properties (Ammon and Wahl, 1991). The major essential oils in turmeric are bisabolane sesquiterpenes that include ar-turmerone, curlone, α-turmerone, β-turmerone as well as some other sesquiterpenes like zingiberene, curcumenone, curcumenol, procurcumenol, dehydrocurdione, and germacrone-13-al (He e*t al*., 1998; Chattopadhyay *et al*., 2004). Sesquiterpenes such as ar-turmerone in turmeric have also been reported to have hepatoprotective (Miyakoshi *et al*., 2004), mosquitocidal (Roth, 1998) and apoptosis inducing properties (Ji *et al*., 2004). For these and many other reasons, turmeric has been widely used as a food additive, condiment, and medicine. Owing to its numerous uses, NRCRI began research on turmeric in 1998. This paper highlights the major achievements from almost two decades of turmeric research at NRCRI Umudike chronicled in honour of Dr Julius Chukwuma Okonkwo (Executive Director NRCRI (2012-June, 2017)

**Highlights of Achievements**

**Exploration and collection of baseline data on turmeric**

NRCRI pioneered collection of germplasm and indigenous knowledge about the production and utilization of Turmeric and some other minor root and tuber crops in Nigeria. This was achieved as reported by Olojede and Nwokocha, (2011) through several exploration trips made separately and jointly in collaboration with the International Institute of Tropical Agriculture (IITA), Ibadan between 2004 and 2006. The exploration trips adopted the Rapid Rural Appraisal method (RRA) using structured questionnaires to collect basic information on location, local name, production, marketing and utilization of the crops. The coordinates of the locations were also collected using the handheld Global Positioning System (GPS) equipment. The data collected through the GPS was then used to delineate minor root and tuber crops growing areas in the country. The areas were turmeric are grown as derived from this study are shown in fig 1.


**Fig 1: Map showing areas where turmeric is grown in Nigeria (adapted from Olojede *et al*., 2005)**

## Germplasm Collection and Acquisition

One of the basic requirements for a sound crop improvement programme is an active gene bank with strong genetic base. The gene bank for minor root and tuber crops at onset was nearly non-existent for any meaningful crop breeding efforts to take off. However, within the last decade from several exploration trips made a total of 76 accessions of Turmeric were collected (Olojede and Nwokocha, 2011). The highest number of collections (12) was from Ekiti State while one each from Abia and Kwara were the least. The number of collections and the local use at the source of collection are presented in Table 1.

**Table 1: Turmeric germplasm collection by states and uses**

| State | Number of Collections | % of total collections | Utilization |
|---|---|---|---|
| Abia | 1 | 1.3 | Ornamental |
| Akwa Ibom | 6 | 7.9 | Medicinal |
| Bayelsa | 2 | 2.6 | Soup seasoning |
| Benue | 3 | 3.9 | Medicinal |
| Cross River | 2 | 2.6 | Medicinal/Cosmetic/Rice colourant |
| Delta | 3 | 3.9 | Medicinal |
| Ebonyi | 2 | 2.6 | Medicinal |
| Edo | 9 | 11.8 | Medicinal/Soup seasoning |
| Ekiti | 12 | 15.8 | Medicinal/Soup seasoning |
| Enugu | 4 | 5.3 | Medicinal |
| Kaduna | 4 | 5.3 | Medicinal/Dye |
| Kogi | 3 | 3.9 | Medicinal |
| Kwara | 1 | 1.3 | Medicinal |
| Niger | 2 | 2.6 | Dye |
| Ondo | 9 | 11.8 | Medicinal/Soup seasoning |
| Osun | 5 | 6.6 | Medicinal/Soup seasoning |
| Ogun | 4 | 5.3 | Medicinal/Soup seasoning |
| Oyo | 2 | 2.6 | Medicinal/Soup seasoning |
| Rivers | 2 | 2.6 | Medicinal |
| Total | 76 | 100 | |

**Source: Olojede et al., 2005**

## Germplasm Evaluations

Accessions of Turmeric assembled from explorations were evaluated for a period ranging between 2 to 6 years to assess their yield, adaptability, culinary and biochemical potentials with a view to selecting some varieties for cultivation by farmers. 10 promising varieties of Turmeric were identified ready to go on multilocational evaluation trial as one of the preconditions for registration as varieties. The ten promising Turmeric varieties are; NCL 41, NCL 58, NCL 44, NCL 39, NCL 14, NCL52, NCL 04, NCL 25, NCL 60 and NCL 36 (Olojede and Nwokocha, 2011). According to Amadi *et al*., (2013), fifteen turmeric genotypes from the germplasm held at National Root Crops Research Institute Umudike, Nigeria, were evaluated during the season of 2012-2013 at four locations: Jos (8.38°N, 7.18°E, 1,200 m a.s.l.), Otobi (7.11°N and 8.08°E), Umudike (5.47°N, 7.54°E) and Igbariam (6.4°N and 6.93°E) in order to select high yielding and stable turmeric cultivars with good quality for release in Nigeria. Results based on the combined data from four locations indicate that turmeric genotypes did not vary in percentage emergence and number of leaves.

**Table 2: Total rhizome number of turmeric genotypes across four locations**

| Genotype | Location Jos | Otobi | Umudike | Igbariam | Mean |
|---|---|---|---|---|---|
| UT6 | 8.55 | 46.62 | 89.13 | 64.54 | 52.2 |
| UT14 | 11.34 | 70.12 | 54.30 | 65.17 | 50.2 |
| UT16 | 11.11 | 25.04 | 88.70 | 58.80 | 45.9 |
| UT25 | 14.47 | 45.19 | 69.93 | 82.70 | 53.1 |
| UT30 | 12.85 | 51.25 | 69.97 | 51.13 | 46.3 |
| UT35 | 14.12 | 27.82 | 81.51 | 74.42 | 49.5 |
| UT37 | 9.34 | 47.88 | 88.80 | 53.53 | 49.9 |
| UT38 | 9.27 | 43.94 | 68.60 | 54.80 | 44.2 |
| UT39 | 12.57 | 49.91 | 84.01 | 47.83 | 48.6 |
| UT41 | 9.39 | 46.22 | 71.03 | 32.63 | 39.8 |
| UT44 | 8.81 | 61.00 | 79.50 | 62.90 | 53.1 |
| UT46 | 10.68 | 14.33 | 36.03 | 58.30 | 29.8 |
| UT50 | 19.34 | 33.57 | 67.07 | 65.97 | 46.5 |
| UT58 | 7.90 | 53.68 | 70.57 | 50.90 | 45.8 |
| UT60 | 10.16 | 51.56 | 52.93 | 50.04 | 41.2 |
| Mean | 11.3 | 44.50 | 71.50 | 58.20 | |

**SED0.05: genotype-8.04; location-4.15; loc. × gen. interaction-16.08**

However, they varied in height, main pseudo stem girth, tillering, number and yield of fresh rhizomes. Results for number and fresh rhizome yield are presented in tables 2&3. The effect of location on all attributes was significant ($P < 0.05$) with Jos location giving consistently the least values for all attributes thus suggesting that this location may not be suitable for the commercial production of turmeric. Genotype by environment interaction for most attributes was not significant indicating that the genotypes responded the same way across the locations. Ten genotypes, viz., UT39, UT44, UT46, UT58, UT50, UT14, UT41, UT6, UT38 and UT35, were identified as promising and require further evaluation as pre-condition for nomination for official release to farmers.

**Table 3: Rhizome yield (t/ha) of turmeric genotypes across four locations.**

| Genotype | Locations Jos | Otobi | Umudike | Igbariam | Mean |
|---|---|---|---|---|---|
| UT6 | 1.99 | 16.08 | 36.00 | 28.41 | 20.62 |
| UT14 | 2.61 | 30.22 | 30.42 | 32.00 | 23.81 |
| UT16 | 2.77 | 14.07 | 20.00 | 24.72 | 15.39 |
| UT25 | 4.14 | 17.67 | 15.56 | 34.44 | 17.95 |
| UT30 | 3.57 | 18.15 | 20.89 | 24.22 | 16.71 |
| UT35 | 3.48 | 9.81 | 24.79 | 36.47 | 18.64 |
| UT37 | 5.37 | 18.07 | 21.78 | 25.78 | 17.75 |
| UT38 | 2.88 | 21.27 | 19.11 | 34.44 | 19.43 |
| UT39 | 5.98 | 28.94 | 39.90 | 38.67 | 28.37 |
| UT41 | 3.08 | 33.93 | 20.89 | 28.22 | 21.53 |
| UT44 | 2.21 | 36.79 | 34.22 | 35.38 | 27.15 |
| UT46 | 2.95 | 40.37 | 26.81 | 36.22 | 26.59 |
| UT50 | 16.19 | 14.67 | 37.33 | 28.22 | 24.10 |
| UT58 | 2.86 | 36.07 | 29.33 | 30.67 | 24.73 |
| UT60 | 2.13 | 24.44 | 18.22 | 26.62 | 17.85 |
| Mean | 4.15 | 24.04 | 26.35 | 30.97 | |

**SED0.05: genotype-4.21; location-2.18; loc. × gen.-8.42.**

**Biochemical Analysis**

Biochemical characteristics of turmeric have been established. Its proximate composition as adapted from Olojede *et al*., (2011) is presented in Table 4. Ukpabi *et al*., (2004) showed that fresh rhizomes of local turmeric can be used as food colourants for local yam and beef soups. Going even further, Ukpabi *et al*., (2006), showed that rhizomes of two major turmeric cultivars in Nigeria could be used in the production of commercial colourants especially when dried at maximum temperature of 60$^{o}$C.

**Table 4: Proximate analysis of turmeric from NRCRI Umudike germplasm**

| C Composition (g/100g dm) | Turmeric |
|---|---|
| Moisture | 8.67 |
| Crude protein | 14.00 |
| Crude fibre | 8.63 |
| Lipids (fat) | 3.82 |
| Total cash | 6.97 |
| NFE | 66.70 |
| Ca | 0.45 |
| P | 0.59 |

**Adapted from Olojede et al., 2005**

### Agronomic management packages for turmeric

Agronomic management packages for turmeric developed by NRCRI Umudike include the following:

1. Turmeric should be planted on flat beds using mother rhizomes as planting material (Olojede, *et al*., 2005).
2. Turmeric should be mulched with straw (elephant grass) at the rate of 12 t/ha dry mulch. Planting should be at 10 cm depth to optimize yield on an Ultisol (Nwokocha, *et al*., 2005).
3. Turmeric should be planted from the onset of rains till first week in June, while 15 g sett rhizome obtained from mother rhizome should be used as planting material for maximum yield under rainforest agro-ecology (Olojede, *et al.*, 2008).
4. Turmeric field should be fertilized 2 weeks after planting (Onwubiko, *et al.*, 2007) at the rate of 60 kg N, 13 kg P and 25 kg K/ha on a sandy loam Ultisol. This recommendation translates to application of 200 kg /ha N P K 15:15:15 and augmenting with 30 kg N/ha (Nwokocha, *et al*., 2007).
5. Application of lime at 2 t/ha (Soil pH of 5.91) in combination with 200kg/ha of NPK 15:15:15 fertilizer is recommended for turmeric production on an Ultisol in South eastern Nigeria (Ohaeri, *et al*., 2008; Ohaeri and Olojede, 2011).
6. Yield loss due to weed interference in turmeric ranged between 3 and 55%, while critical period of weed interference is between 8 and 12 WAP under Umudike condition (Njoku, *et al*., 2009).

### Economics of Turmeric Production

Is it profitable to grow turmeric? The answer is an emphatic yes going by the results of economic studies carried out at NRCRI Umudike. One of such results presented in Table 5 revealed high profitability of Turmeric production with returns per naira (R/N) being N233.90, Net income N326,918.22 and return cost ratio (RCR) of 3.3 (Akinpelu *et al*., 2007)

**Table 5: Labour and inputs costs for production of 1 ha of turmeric at Umudike in 2007 and 2008 cropping season**

| Items | Quantity of items | Unit Cost (₦) | Total Cost (₦) |
|---|---|---|---|
| Returns (kg) | 2592.75 | 180.00 | 466,695.00 |
| **Fixed cost** | | | |
| Rent on land ($m^2$) | 10,000 | 1.25 | 12,500.00 |
| Opportunity cost of fixed inputs@21% | | | 2,625.00 |
| **Total fixed cost** | | | **15,125.00** |
| **Variable costs** | | | |
| Land preparation (hrs) | 12 | 1,208.34 | 14,500.00 |
| Planting material (kg) | 64 | 150.00 | 9,600.00 |
| De-thrashing (md) | 16 | 200.00 | 3,200.00 |
| Planting (md) | 17 | 200.00 | 3,400.00 |
| Fertilizer application (md) | 9 | 200.00 | 1,800.00 |
| Fertilizer requirement (kg) | 400 | 50.00 | 20,000.00 |
| Primextra (lt) | 5.36 | 1,300.00 | 6,968.00 |
| Gramazone (lt) | 1.10 | 1,300.00 | 1,430.00 |
| Herbicide application (md) | 4 | 200.00 | 800.00 |
| Supplementary hand weeding (2ce) | 76 | 200.00 | 15,200.00 |
| Harvesting (md) | 113 | 200.00 | 22,600.00 |
| Other costs** | | | 3,520.00 |
| Opportunity cost of variable inputs@21% | | | 21,633.78 |
| **Total variable costs** | | | **124,651.00** |
| Total costs (TFC+TVC) | | | 139,776.78 |
| Net farm income | | | 326,918.22 |
| Return per naira | | | 233.90 |
| Benefit cost ratio (BCR) | | | 3.33 |

**Source: Field data 2007 and 2008 Akinpelu et al., 2007, *** Haulage of planting materials from the store to the field, water for spaying herbicides, haulage of output from the field to the store, cost of 4 tins of milk***

**Value Addition and Extension**

In a study carried out at NRCRI Umudike by Husseni *et al*., 2008, drying turmeric at 50°C, 60°C and 70°C during the production of turmeric powder and packaging in 3 different materials - Low density polyethylene, Opaque polypropylene and Transparent glass bottle gave acceptable quality in-terms of absorbance and pH for 4 weeks storage period. Beyond 4 weeks there was significant increase in moisture which may cause spoilage due to activity of microbes as days of storage extend. Technologies for making value added products including turmeric power (for spice, food additives and cosmetics industries) from turmeric rhizome are being extended to farmers or are waiting take-up by private entrepreneurs. NRCRI Umudike has supplied planting materials of high yielding varieties of turmeric to surrounding communities through the adopted villages. According to Onuoha *et al*., (2011), the adopted village concept of extension has made it possible for popularization and dissemination of turmeric through school out-reach project for adoption.

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