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Registration of Two Ginger Landraces UMUGIN 1 AND UMUGIN 2, for Commercial Use in Nigeria

***Amadi, C. O., Nwaigwe, G., Amanze, N. J., Ohaeri, J.E., Afuape, S., Onyekwere, I.N., Aboaja, F., Mohamed, M., Idris, B., Opia, H., Ewuziem, J. E., Ezebuiro, V., Amadi, G., Ebeniro, C.N., Amajor, E., Uwandu, Q. and Ukpabi, U. J.**
National Root Crops Research Institute, Umudike, PMB 7006, Umuahia, Abia State
*Corresponding author's email: okeyamadi2013@gmail.com

Abstract
National Root Crops Research Institute, Umudike, nominated two ginger landraces, UMUGIN 1 and UMUGIN 2, and they were officially registered by the National Variety Registration Committee in January 2022 to encourage formal seed production. These landraces were evaluated on-station and multi-locationally in 7 states across the rainforest, guinea savannah, and derived savannah agroecologies of Nigeria. The outstanding characteristics of UMUGIN 1 include a potential root yield of 39 t/ha. moderate resistance to yellow leaf spot, robust rhizomes with yellow flesh colour, and upright leaves. UMUGIN 2 is characterized by slightly drooping leaves, a pale yellowish-grey rhizome flesh, a potential root yield of 30 t/ha, moderate resistance to yellow leaf spot, and high oleoresin content. UMUGIN1 is most suitable for fresh market and culinary use, while UMUGIN2, which is hotter due to higher oleoresin content, is most suitable for industrial use.
Keywords: Ginger, Zingiber officinale, Landrace, UMUGIN1, UMUGIN 2, Registration

Introduction

Ginger (*Zingiber officinale* Rosc) is a monocotyledonous perennial plant grown mainly as an annual for its spicy and aromatic rhizomes. The hotness and aroma of ginger are due to the presence of oleoresin and volatile essential oils. It is traded globally in various forms such as fresh, preserved, dried, and powdered ginger. Ginger also enters the world market as processed products such as ginger oil, ginger oleoresin, ginger candy, ginger soft drinks, shreds, prickles, and chutney (FAO, 2001). Ginger is usually added to food to maintain and improve its quality and preservation, and has been used for years in traditional medicine (Amadi, 2012; Kashefi *et al*., 2014). Ginger was introduced into Nigeria about a century ago (Erinle, 1988) and became established as a cash crop grown by farmers in the south of Kaduna State and a few other states in the country (Dauda and Waziri, 2006; Ejechi *et al*, 2018). It is the most important rhizomatous spice produced in Nigeria (Amadi *et al*., 2013).

Two landraces of ginger, namely UMUGIN1 (known locally as yellow ginger or Tafingiwa,

meaning elephant foot) and UMUGIN2 (known locally as black ginger or Yatsunbiri, meaning monkey fingers), are mostly grown (Amadi, 2012; Ibrahim, 2018). Most farmers grow yellow ginger probably because of its higher yield and more appealing colour of the rhizome flesh, skin, and aroma (Chukwu and Emehute, 2003). UMUGIN1 fits into the Ginger for fresh market and culinary use, while UMUGIN2, which is hotter due to higher oleoresin content, fits into the Ginger for industrial use product profiles.

The inability of ginger to fruit and set seed is a major obstacle to its improvement by conventional means, hence, most improvement programmes are confined to the evaluation and selection of naturally occurring clonal variations and the introduction of cultivars from abroad (Abbas *et al*., 2011). No ginger landrace has been officially registered in Nigeria. This has hampered the development of the formal seed system. NRCRI nominated two ginger land races, UMUGIN1 and UMUGIN2, for official registration, to enable and encourage their formal seed production. These were evaluated on-station and multi-locationally in 7 states across the rainforest, guinea savannah, and derived savannah agroecologies. This registration will improve the productivity of this important domestic and export spice and enhance its impact on the economy and livelihood of ginger farmers in Nigeria.

Materials and Methods

At each site, two ginger landraces, UMUGIN 1 and UMUGIN 2, and one local check were laid out in a randomized complete block design in 5 replications on 2 m x 3 m beds. The same methodology was used both on-station at National Root Crops Research Institute fields at Umudike (2015 and 2016) and multi-location trials at Umudike (Abia State) and Iburu (Kaduna State) in 2020 and 2021 at Ireshi (Osun State), Asaba (Delta State), Kuru (Plateau State), Nyanya (Nassarawa State), Maro (Kaduna State), Igbariam (Anambra State), and Umudike (Abia State), Figure 1. Following adequate land preparation, 8 kg of battery cage poultry manure was incorporated into each plot and allowed to stay for 14 days before planting. 20g sets of seed ginger were planted at 20 cm x 20 cm spacing at 5-8cm deep. The beds were sprayed with Premextra Gold 660 SC (S-Metalochlor + Atrazine) at 2.5 kg ai/ha, a day after planting, followed by mulching within 2 days of planting. The beds were kept weed-free subsequently by hand pulling weeds. NPK 15:15:15 was added at 4 weeks after planting (WAP) at the rate of 300kg/ha. Data on the following attributes were collected: Establishment (2, 4 WAP), Plant height, Number of leaves, and Number of tillers (3, 4, and 5 WAP), Number of rhizome heads, number of primary rhizome fingers, and weight of rhizomes (at harvest). Data were subjected to appropriate analysis using Genstat software.

For proximate and oleoresin analysis, freshly harvested rhizomes of the 2 ginger landraces were analysed at the Biochemistry laboratory at the NRCRI, Umudike. The nutritional constituents of the samples in triplicate were determined using the Association of Official Analytical Chemists (AOAC, 2006) official methods. The ash content, crude protein, moisture content, crude fibre, carbohydrate, and dry matter content were determined. The methods of Onwuka (2005) were used to determine the oleoresin content; 10 g of each of the fresh ginger rhizomes was washed properly with distilled water, sliced into chips of approximately 0.5 cm in diameter, and dried in an oven at a temperature of 70ºC for 8 hours to a constant weight. About 5 g of the dried samples (W1) were mashed with 100 ml of acetone, and the mixture was left overnight. It

was later filtered (Whatman No. 1 filter paper) into a pre-weighed empty beaker (W2), and the acetone evaporated on a water bath at 65ºC, cooled, and the whole setup was re-weighed (W3). The percentage oleoresin content of the samples was determined by weight difference as follows;

Percentage oleoresin (dry weight) = W3 – W2/ W1 × 100 /1

W3 = Weight of beaker + oleoresin, W2 = Weight of empty beaker

Results and Discussion

On Station Trial (2015 and 2016)

Some growth attributes (plant height, number of leaves, and number of tillers) and rhizome yield t/ha assessed on-station are presented in Table 1. Though the landraces didn't differ significantly in the growth attributes, UMUGIN1 yielded more rhizomes per hectare than the others in both years. When the performance of the landraces in both years was combined (Table 2), the significant difference in rhizome yield between the years and the interaction between landraces and years became evident. The yield was better in 2015.

Multi-locational Trials

The rhizome yield per hectare of ginger landraces evaluated at two locations Iburu (Guinea Savanna) and Umudike (Rainforest) in 2020, is presented in Table 3. Both landraces gave good yields, though UMUGIN I gave a significantly higher yield. The yields were higher at Umudike than at Iburu, perhaps due to the longer rainy period.

In 2021, the landraces were evaluated at seven different locations across the rainforest, derived savannah, and guinea savannah agroecologies. The mean rhizome yield and some important agronomic traits of ginger across 7 locations are presented in Table 4. UMUGIN 1 yielded more rhizomes than the others at Igbariam, Maro, and Umudike, while UMUGIN 2 was the better yielder of rhizomes at Iresi (Table 5). The GGE biplot (Figure 2) shows more clearly the relationship between the landraces and the locations (Environments). We had 5 locations clustering into one mega-environment, with UMUGIN 1 excelling while Iresi and Kuru clustered into the second, but much smaller mega-environment with UMUGIN 2.

Nutritional and oleoresin content

The percentage proximate composition and oleoresin content of the two landraces were sampled in triplicate, and the mean values are presented in Table 5. UMUGIN1 was slightly higher than UMUGIN2 in moisture, crude protein, and ash content, while UMUGIN2 contained slightly more oleoresin than UMUGIN1. This conforms to expectation as UMUGIN 2 is slightly hotter than UMUGIN 1 and hotness is attributed to oleoresin (Amadi, 2012; Ameh *et al*, 2020). This perhaps makes UMUGIN 2 more suitable for oleoresin production. Though not empirically assessed, the aroma of UMUGIN1, based on smell, was stronger than UMUGIN2, possibly because it contains more essential oils, which are responsible for the aroma of ginger. This makes UMUGIN 1 more suitable for culinary purposes.

Descriptors of the landraces

The descriptors for UMUGIN1 and UMUGIN2, and some pictorials, are presented in Table 6 and Figures 3 and 4

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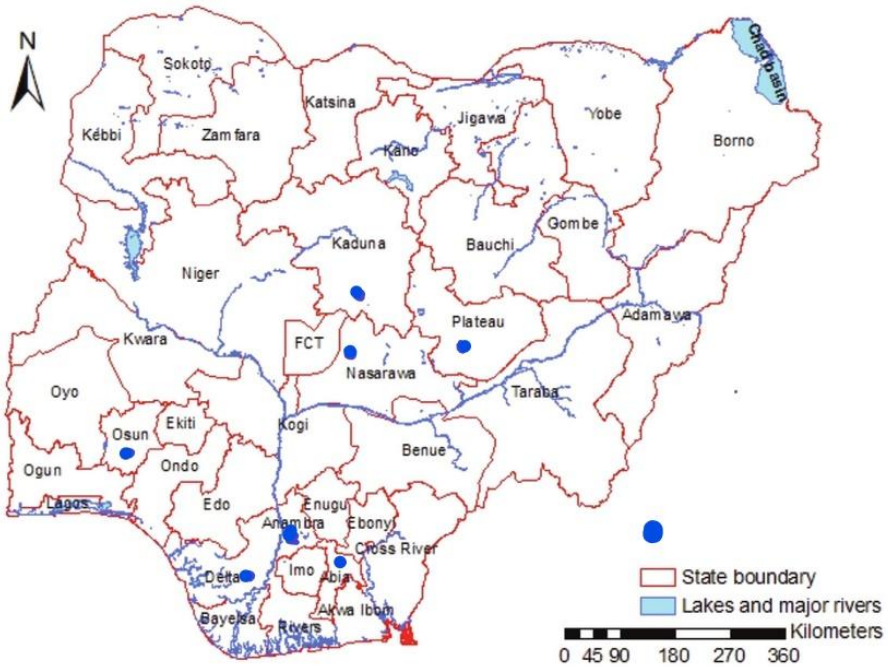

Figure 1: Map of Nigeria showing with blue dots the states where Ginger landraces were evaluated

Table 1: Rhizome yield and some growth attributes of ginger landraces evaluated on-station at Umudike in 2015 and 2016

Landrace	Rhizome yield t/ha	Tillers @ 20 wks	Plant Ht @ 20 wks	Number of leaves at 20wks
		2015		
UMUGIN 1	35.74	7.96	87.80	19.25
UMUGIN 2	29.23	8.22	86.90	18.53
local	26.00	7.53	82.50	16.12
Mean	**30.32**	**7.90**	**85.70**	**17.96**
Lsd 0.05	**2.63**	**1.25**	**8.15**	**3.37**
		2016		
UMUGIN 1	34.48	8.53	87.50	19.30
UMUGIN 2	26.68	8.42	88.30	17.98
local	24.58	8.42	81.50	17.12
Mean	**28.58**	**8.46**	**85.80**	**18.13**
Lsd 0.05	**2.92**	**1.41**	**7.22**	**3.72**

Table 2: Combined analysis of rhizome yield and some growth attributes of ginger landraces on-station at Umudike (2015 & 2016)

Landraces	2015	2016	Mean LR	Lsd (LR)
UMUGIN 1	35.74	34.49	35.11	**1.82**
UMUGIN 2	29.23	26.68	27.95	
local	26	24.58	25.29	
Mean (Year)	30.32	28.58		
Lsd 0.05 (Year)		**1.486**		

Lsd 0.05 (Year x LR): 2.574

Table 3: Effect of variety and location on rhizome yield (t/ha) of ginger landraces

	Variety				
Location	**UMUGIN 1**	**UMUGIN 2**	**local**	**Mean**	**Lsd 0.05 (Loc.)**
Iburu (Kaduna State)	26.33	21.72	20.52	22.86	0.991
Umudike (Abia State)	31.86	25.23	23.51	26.87	
Mean	29.09	23.48	22.01		
Lsd 0.05 (Variety)		1.214			

Lsd 0.05 (Var. x Loc. int.): 1.716

Table 4: Mean rhizome yield (t/ha) and some agronomic traits of ginger landraces at 7 locations in 2021

	Rhizome yield (t/ha	Tillers @ 20wks	Plant Ht @ 20wks	Num of Leaves @ 20wks
UMUGIN 1	24.97	7.56	84.50	18.75
UMUGIN 2	20.02	8.42	82.70	19.51
Local	19.67	7.33	80.50	17.19
Lsd 0.05	3.79	1.35	8.27	3.53

Table 5: Rhizome Yield (t/ha) of Ginger Land races at 7 locations in 2021

Land race (LR)	Asaba	Igbariam	Ireshi	Kuru	Maro	Nyanya	Umudike	Mean	Lsd0.05 (LR)
UMUGIN 1	19.81	32.33	22.33	5.78	23.39	32.5	38.67	24.97	
UMUGIN 2	14.5	19.89	33	7.11	13.92	27.33	24.39	20.02	3.79
Local	11.83	24.11	30.29	5.28	19.47	18.33	28.4	19.67	
Mean	15.38	25.44	28.54	6.06	18.93	26.06	30.49		

Lsd 0.05 (Location): 2.48; Lsd 0.05 (Location x Landraces): 6.555

Table 5: Percentage proximate composition and oleoresin content of ginger landraces (UMUGIN 1 and UMUGIN 2)

Composition (%)	UMUGIN 1	UMUGIN 2
Moisture Content	12.07	11.87
Crude Protein	8.04	7.94
Fat	0.65	0.71
Crude Fibre	6.86	7.00
Ash	3.94	3.71
CHO	68.42	68.78
Energy Value (kcal/100g)	311.87	313.26
Oleoresin content	6.55	7.02

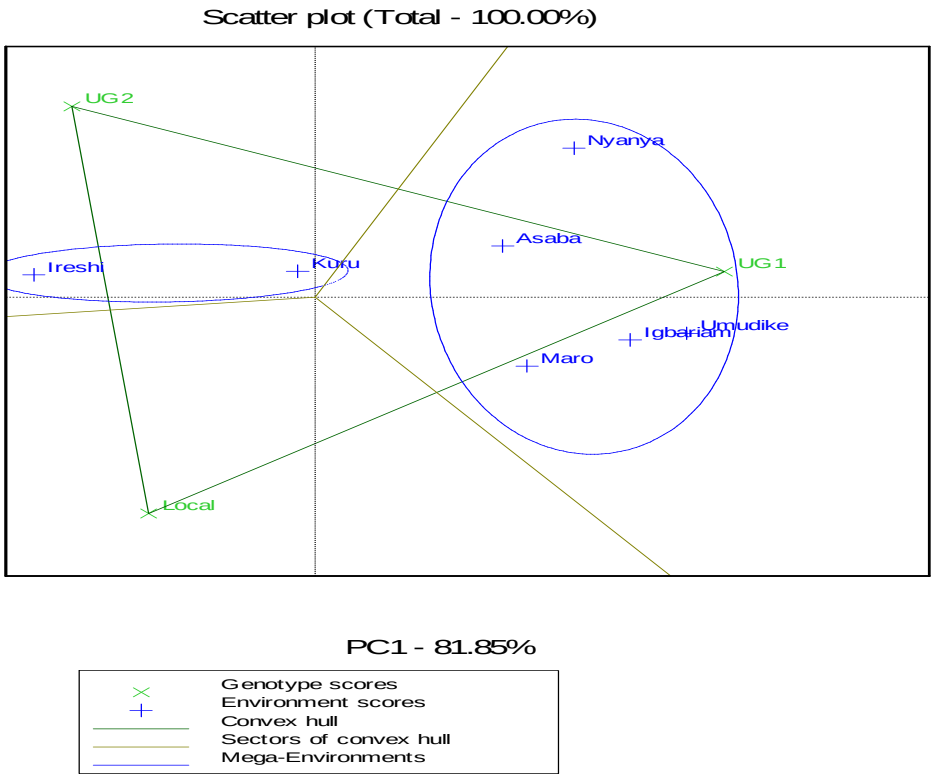

Figure 2: GGE Biplot showing performance of the landraces in mega-environments

Table 6: Some general and specific descriptors of UMUGIN 1 and UMUGIN 2

Descriptors	**UMUGIN 1**	**UMUGIN 2**
Plant growth habit:	Upright	Upright
Plant height:	60 – 100 cm	65 – 110 cm
Number of tillers:	4 - 10	4 - 10
Attitude of top leaf:	Erect	Erect with drooping tip
Number of leaves:	21 - 28	21 - 28
Leaf green colour intensity	Dark	Dark
Flowering	Flowers present	Flowers present
Rhizome skin colour	Light yellow	Pale grey
Rhizome flesh colour	light yellow	pale yellowish-grey
Rhizome skin surface	Smooth	Smooth
Anthocyanin coloration of the apical bud	Strong	Strong
Number of primary rhizome fingers	3 - 8	4 - 8
Size of primary rhizome fingers	2.5 – 3.0 cm	2.0 -2.5cm
Adaptation	Rainforest, and Guinea Savannah	Rainforest, and Guinea Savannah
Days to maturity	260 - 275 days	265-275
Potential root yield	39 t/ha	30 t/ha
Pest/Disease reaction	Moderately resistant to yellow leaf spot	Moderately resistant to yellow leaf spot
Oleoresin content (%)	6.55	7.02

Yellow rhizome skin, large primary fingers ***Yellow rhizome flesh colour***

Dark green, upright, pointed top leaves

Figure 3: Pictures of UMUGIN 1

Pale grey rhizome skin, slender primary fingers, Pale yellowish grey rhizome flesh colour

Dark green, upright, with drooping top leaves

Figure 4: Pictures of UMUGIN 2