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EVALUATION OF MANGO GINGER GENOTYPES (*CURCUMA AMADA* ROXB.) FOUND IN MANIPUR FOR YIELD, QUALITY AND PHYTOCHEMICAL ANALYSIS

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ABSTRACT

The experiment entitled "Evaluation of Mango ginger (*Curcuma amada* Roxb.) found in Manipur for yield, quality and phytochemical analysis" was conducted at Horticulture Experimental Field, Department of Horticulture, College of Agriculture, CAU, Imphal during *Kharif* season of 2023. The experiment was laid out in randomized block design with three replications consisting of 11 genotypes and one check variety. The result revealed that genotype CAUMGLC-1 recorded the highest values for growth parameters such as plant height (106.77 cm), leaf lamina length (53.6 cm), petiole length (14.53 cm), number of tillers per clump (5.93), number of leaves on main shoot (8.20) and number of leaves per clump (26.53). Yield and yield attributing parameters such as fresh weight of clump (398.50 g), number of mother rhizome (5.93), number of primary rhizome (20.53), number of secondary rhizome (24.5), primary rhizome length (8.22), primary rhizome breadth (2.59), weight of primary rhizome (133.93 g), yield per plot (15.40 kg), yield per hectare (51.29 t) and dry weight of rhizome per clump (84.5g) were also recorded highest in genotype CAUMGLC-1. Quality parameters such as essential oil (1%), starch content (30.2%), curcumin content (0.052%), oleoresin content (5.1%) and sensory quality for aroma (7.8) were recorded highest in CAUMGLC-2. Total phenolic content (40.80 GAE/mg of extract) was recorded highest in CAUMGLC-4 and total flavonoid content (7.6 QE/mg of extract) was recorded highest in CHECK Var. Amba). Antioxidant activity was recorded highest in CAUMGLC-5 with an IC_{50} value of 113.9 $\mu\text{g/ml}$ and anti-diabetic activity was recorded higher in (CAUMGLC-4 with an IC_{50} value of 75.69 $\mu\text{g/ml}$ and was at par with CAUMGLC-5 with an IC_{50} value of 78.14 $\mu\text{g/ml}$). The highest gross income, net income and B:C ratio was recorded in genotype CAUMGLC-1. On the basis of the present investigation, it can be concluded that genotype CAUMGLC- 1 is ideal for high yield of mango ginger and genotype CAUMGLC-2 is ideal for quality purposes whereas genotypes CAUMGLC- 4 and CAUMGLC- 5 may be recommended for medicinal properties.

Key words : Mango ginger, Yield, Quality, Medicinal properties and Economics.

Introduction

Mango ginger (*Curcuma amada* Roxb.) is a unique rhizomatous perennial herb that belongs to Zingiberaceae family. It is known as Yai-heinounambi in Manipuri and Am-Haldi in Hindi (Singh *et al.*, 2003). The crop is native to India; grows wild in West Bengal and cultivated in states like Gujarat, Karnataka, Kerala, Orissa, North Eastern states particularly Manipur, etc. The rhizome is used in preparation of chutneys, pickles, candies, sauces, etc. (Ravindran *et al.*, 2012). The rhizome fleshy tissue

is pale yellow in colour (Chatterjee *et al.*, 2012) and gives raw mango flavor which is mainly attributed to the presence of car-3-ene and cis-ocimene compound (Rao *et al.*, 1989). There are numerous biological properties associated with mango ginger like antiallergic, antioxidant, antibacterial, antifungal, anti-inflammatory, etc (Policegoudra *et al.*, 2011). Mango ginger being a potential crop with many uses and benefits is however underexploited in Manipur. The performance of a crop primarily depends on its genetic constitution and the

environmental condition of the region where it is cultivated. Hence, this study was conducted with the aim of identifying the most promising local genotype of mango ginger for growth; yield as well as to explore the quality and medicinal properties of the genotypes.

Materials and Methods

The present investigation was carried out during *kharif* season of 2023 at College of Agriculture, Central Agricultural University, Imphal. The experimental field is situated at 24°81'N latitude, 93°89'E longitude and at an altitude of 806 m above mean sea level. The soil of the experimental field was found to be clay in texture, acidic with pH of 5.07, organic carbon 1.41 %, available Nitrogen 220.23 kg/ha, available P₂O₅ 20.43 kg/ha and K₂O 250.45 kg/ha. The minimum and maximum temperature was 11.0°C and 30.95°C during the period of investigation with a total rainfall of 976.90 mm. The experiment was laid out in Randomized Block Design with three replications consisting of eleven local Mango ginger genotypes namely CAUMGLC-1, CAUMGLC-2, CAUMGLC-3, CAUMGLC-4, CAUMGLC-5, CAUMGLC-6, CAUMGLC-7, CAUMGLC-8, CAUMGLC-9, CAUMGLC-10, CAUMGLC-11 and one CHECK Variety – Amba was considered for the study. Crop was planted using healthy, disease-free finger rhizome, whole or split mother rhizome having well developed buds. Planting was done on May, 2023 with a spacing of 30 cm × 25 cm.

Table 1 : List of genotypes and check variety used in the experiment along with its derived sources.

Genotypes	Source
CAUMGLC-1	Ukhrul
CAUMGLC-2	Khuringmol, Chandel
CAUMGLC-3	Sarei village, Chandel
CAUMGLC-4	Liwachangning, Chandel
CAUMGLC-5	Kapaam village, Chandel
CAUMGLC-6	Liwachangning, Chandel
CAUMGLC-7	Thoubal
CAUMGLC-8	Moirang
CAUMGLC-9	Monshang Pantha, Chandel
CAUMGLC-10	Loitang Khunou, Imphal West
CAUMGLC-11	Kurkam village, Chandel
Check Variety – Amba	TCA, Dholi, Bihar

The crop was harvested when the plant leaves turn yellow and start drying. Freshly harvested rhizomes are clean, sliced and dried in hot air oven and grinded (Huang *et al.*, 2012; Sangwan *et al.*, 2014). The estimation of different quality parameters from the samples were analyzed chemically according to the method of the

Association of Official Analytical Chemists (AOAC) (Lantona *et al.*, 2012).

Essential oil content (%) : Essential oil content was analyzed using hydro distillation method with Clevenger-type apparatus and was calculated as follows (Anonymous, 1975):

$$\text{Essential oil content (\%)} = \frac{\text{Oil yield (ml)}}{\text{Weight of sample (g)}} \times 100$$

Dry recovery (%) : Dry recovery percentage was measured using the formula according to AOAC (Lantona *et al.*, 2012):

$$\text{Dry recovery (\%)} = \frac{\text{Dry weight (g)}}{\text{Fresh weight of sample (g)}} \times 100$$

Oleoresin content (%) : Oleoresin content was estimated by Soxhlet apparatus as per AOAC (Anonymous, 1980). The recovery of oleoresin was calculated and expressed in percentage by using the following formula:

$$\text{Oleoresin \% (g/100g)} = \frac{\text{Weight of oleoresin (g)}}{\text{Weight of sample taken (g)}} \times 100$$

Starch content (%) : The starch content in dried mango ginger powder is analyzed using a modified anthrone reagent method, with general AOAC principles. The method involves acid hydrolysis of starch to glucose followed by a colorimetric reaction with anthrone reagent (Anonymous, 1980).

Sensory evaluation for aroma : Sensory evaluation for aroma was carried out by a panel of 10 judges. Good and healthy rhizomes were selected and used for the evaluation. The mango aroma of the rhizome was evaluated on a nine point hedonic scale using a score card mentioned below (Ranganna, 2009).

Hedonic Scale	Score
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like or dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

Sample extraction for medicinal properties analysis : The dried mango ginger powder is extracted using methanol as solvent, via maceration method. The extract is then filtered and oven dried.

Total Flavonoid content : It is analyzed by using

Aluminum Chloride colorimetric method, with results expressed as quercetin equivalents (QE) per mg of the extract. (Chang *et al.*, 2002; Zhishenet *et al.*, 1999).

Total Phenolic content : It is analyzed by using Folin-Ciocalteu method with the results expressed as Gallic acid equivalent per mg of extract (AOAC, 2017; Waterhouse, 2001).

Antioxidant activity : The free RSA of the dilute rhizome extract of the sample was tested using a 1,1-diphenyl-2-picryl hydrazyl (DPPH) technique. Ascorbic Acid is used as the standard. The absorbance was determined at 517 nm using UV/VIS spectrophotometer. The percentage of antioxidants was calculated by using the following formula (Baliyan *et al.*, 2022):

$$\% \text{ of antioxidant activity} = [(Ac - As) \div Ac] \times 100$$

Where, Ac - Control reaction absorbance; As - Testing specimen absorbance.

Anti-diabetic activity : For determining anti-diabetic activity, α -glucosidase assay was performed. Absorbance was determined at 405 nm using UV/VIS spectrophotometer. The inhibition percentage was calculated by the formula (Florenco *et al.*, 2016):

$$\text{Inhibition\%} = [\text{Abs (test sample)} - \text{Abs (sample blank)}] / \text{Abs (control)} \times 100$$

Results and Discussion

Performance of different Mango ginger cultivars on growth

The result presented in Tables 2 and 3 revealed that maximum plant height (106.77 cm), number of tillers per clump (5.93), number of leaves on main shoot (8.20) and number of leaves per clump (26.53), leaf lamina length (53.57 cm) and petiole length (14.53 cm) were recorded in CAUMGLC-1. However, maximum leaf lamina width was recorded in CAUMGLC-11 (17.26 cm) and found at par with CAUMGLC-3 (15.67 cm). Longest crop duration was observed in CHECK Variety – Amba (229.67 days) and it was at par with CAUMGLC-11 (229.00 days). The photograph of field view of crop was depicted in Fig. 1.

Lowest growth characters *viz.*, plant height, number of tillers per clump, number of leaves on main shoot, number of leaves per clump, leaf lamina length and petiole length were observed in genotype CAUMGLC-7 and crop duration was recorded shortest in CAUMGLC-8 (211.67 days). There is significant variation in relation to growth characters among the different genotypes of Mango ginger. These differences might be due to different genetic constitution of the genotypes. Similar reports

Table 2 : Performance of Mango ginger genotypes on growth parameters.

Genotypes	Plant height (cm)	Number of tillers	Number of leaves on main shoot	Number of leaves per clump	Leaf lamina length(cm)	Leaf lamina width(cm)	Petiole length (cm)	Crop duration (days)
CAUMGLC-1	106.77	5.93	8.20	26.53	53.57	15.01	14.53	222.67
CAUMGLC-2	81.47	5.03	6.20	23.87	46.35	15.08	12.15	220.00
CAUMGLC-3	91.07	5.33	6.80	25.37	49.77	15.67	13.92	220.00
CAUMGLC-4	86.31	4.93	7.43	25.00	46.00	14.74	13.23	218.00
CAUMGLC-5	74.33	4.47	6.67	23.47	42.05	14.39	11.23	225.67
CAUMGLC-6	78.50	4.90	6.00	23.00	45.85	15.47	12.31	218.00
CAUMGLC-7	50.73	2.67	5.80	15.60	28.37	10.21	8.45	216.33
CAUMGLC-8	75.91	3.93	6.00	21.87	37.69	13.01	11.89	211.67
CAUMGLC-9	76.70	4.73	5.93	21.87	45.58	14.49	12.90	218.00
CAUMGLC-10	67.54	3.13	6.13	16.73	36.66	12.88	11.70	222.67
CAUMGLC-11	92.23	5.20	6.60	24.83	46.25	17.26	13.40	229.00
CHECK Var. Amba	93.23	5.10	6.47	24.67	49.03	14.73	11.63	229.67
SEm (\pm)	2.18	0.22	0.28	0.48	1.38	0.67	0.45	1.57
CD (5%)	6.40	0.31	0.81	1.41	4.03	1.96	1.33	4.61

Table 3 : Performance of Mango ginger genotypes on yield and yield attributing parameters.

Cultivars	Fresh weight of clump(g)	Weight of primary finger(g)	Primary rhizome length(cm)	Primary rhizome breadth(cm)	Dry weight of rhizome per clump	Number of primary finger	Number of secondary finger	Number of mother rhizome	Yield per plot (kg)	Yield per hectare (t)
CAUMGLC-1	398.50	133.93	8.22	2.59	84.50	20.53	24.50	5.93	15.40	51.29
CAUMGLC-2	239.21	91.11	7.25	1.80	56.88	14.46	18.23	5.00	9.26	30.83
CAUMGLC-3	282.52	115.07	7.38	1.99	66.62	17.67	21.43	5.40	11.02	36.71
CAUMGLC-4	229.35	89.77	7.19	1.78	53.77	13.99	17.73	4.80	8.95	29.80
CAUMGLC-5	188.28	73.33	6.35	1.74	47.49	12.30	16.37	4.47	7.22	24.04
CAUMGLC-6	225.43	89.56	7.16	1.77	52.63	13.30	17.10	4.67	8.72	29.04
CAUMGLC-7	94.23	38.00	5.12	1.45	28.17	9.23	12.37	3.00	3.65	12.15
CAUMGLC-8	164.04	46.87	4.17	1.62	48.40	12.00	15.43	4.40	6.34	21.13
CAUMGLC-9	214.94	85.54	6.79	1.75	45.61	13.06	16.77	4.53	8.32	27.70
CAUMGLC-10	136.77	58.83	5.67	1.57	34.19	11.00	14.83	3.33	5.24	17.46
CAUMGLC-11	248.34	97.60	7.93	2.01	59.84	16.30	20.27	5.27	9.69	32.28
CHECK Var. Amba	242.29	95.27	7.63	2.37	49.72	15.17	18.53	5.13	9.45	31.46
SEm (±)	4.45	3.04	0.16	0.12	1.33	0.77	0.55	0.17	0.30	0.99
CD (5%)	13.05	8.92	0.47	0.36	3.91	2.27	1.60	0.49	0.87	2.89

regarding variation in growth characters have been mentioned by earlier workers in Mango ginger (Deb *et al.*, 2018), ginger (Goudar *et al.*, 2017) and turmeric (Salimath *et al.*, 2014; Mariam Anal, 2019; Indumathi *et al.*, 2023; Sarkar *et al.*, 2024).

Performance of different Mango ginger cultivars on yield

The yield attributing characters like fresh weight of clump (398.50 g), weight of primary finger (133.93 g), number of primary finger (20.53), number of secondary finger (24.50), number of mother rhizome (5.93) and dry weight of rhizome per clump (84.50 g) was found in genotype CAUMGLC-1 and was significantly superior to CHECK Var. Amba and other genotypes (Table 3). However, longer primary rhizome length (8.22 cm) was obtained in CAUMGLC-1 and was statistically at par with CAUMGLC-11 (7.93 cm) but was significantly higher than CHECK Variety-Amba and other genotypes. Maximum primary rhizome breadth (2.59 cm) was obtained in CAUMGLC-1 and found statistically at par with CHECK Variety - Amba (2.37 cm) but was significantly higher than the remaining genotypes. The highest yield per plot (15.4 kg) and yield per hectare (51.29 t) were also recorded in CAUMGLC-1 and was found superior over the rest of the genotypes. The superiority of yield might be attributed to its significantly higher fresh weight of clump (Netravathi *et al.*, 2022). Whereas yield and yield attributing parameters like fresh weight of clump (94.23 g), weight of primary finger (38.00 g), number of primary finger (9.23), number of secondary finger (12.37), number of mother rhizome (3.00), primary rhizome breadth (1.45 cm), dry weight of rhizome per clump (28.17 g), yield per plot (3.65 kg) and yield per hectare (12.15 t) were recorded lowest in CAUMGLC-7. Lowest primary rhizome length (4.17 cm) was recorded in CAUMGLC-8.

Number of leaves per clump is an important factor in which leaves are the primary centers where photosynthesis occurs and photosynthates are utilized for better growth and yield (Venkatesa and Siddhlingayya, 2016; Goudar *et al.*, 2017). Many earlier workers on turmeric (Salimath *et al.*, 2014; Venkatesa and Siddhlingayya, 2016) and ginger (Goudar *et al.*, 2017; Ravi *et al.*, 2017; Netravathi *et al.*, 2022) have reported that genotypes showing vigorous growth resulted in higher yield. Similar result interpretation can be followed in this present study. Differences in yield and yield attributing parameters among the different Mango ginger cultivars may be due to different genetic response of the cultivars as were also mentioned in the report given by workers earlier on turmeric (Maurya *et al.*, 2018; Mariam Anal,

Table 4 : Performance of mango ginger genotypes on quality parameters.

Genotypes	Essential oil content (%)	Dry recovery (%)	Oleoresin content (%)	Starch content (%)	Sensory score for aroma
CAUMGLC-1	0.33	21.21	2.70	23.36	6.25
CAUMGLC-2	1.00	23.78	5.10	30.20	7.75
CAUMGLC-3	0.50	23.56	2.20	21.90	7.50
CAUMGLC-4	0.60	23.44	2.37	22.53	7.63
CAUMGLC-5	0.50	25.22	3.07	20.53	6.88
CAUMGLC-6	0.50	23.33	4.20	21.32	7.13
CAUMGLC-7	0.50	29.89	2.66	21.34	6.13
CAUMGLC-8	0.50	29.44	1.77	23.53	6.63
CAUMGLC-9	0.83	21.22	2.67	22.15	6.75
CAUMGLC-10	0.30	25.00	2.77	18.98	5.75
CAUMGLC-11	0.50	24.11	4.90	21.08	3.38
CHECK Var. Amba	0.33	20.52	2.37	22.98	5.50
SEm (±)	0.01	0.39	0.13	0.48	0.09
CD (5%)	0.03	1.15	0.37	1.40	0.26

Table 5 : Performance of mango ginger genotypes on medicinal properties.

Genotypes	Total flavonoid content (QE/mg of extract)	Total phenolic content (GAE/mg of extract)	Antioxidant activity (IC ₅₀ value-µg/ml)	Anti-diabetic activity (IC ₅₀ value-µg/ml)
CAUMGLC-1	3.64	9.56	142.10	87.49
CAUMGLC-2	1.33	14.84	122.40	86.40
CAUMGLC-3	2.21	15.87	137.50	86.48
CAUMGLC-4	3.38	40.80	140.80	75.69
CAUMGLC-5	1.65	36.38	113.90	78.14
CAUMGLC-6	2.26	19.95	131.40	92.92
CAUMGLC-7	3.24	24.55	127.00	89.70
CAUMGLC-8	3.80	12.03	178.50	93.27
CAUMGLC-9	5.92	34.97	183.70	85.54
CAUMGLC-10	1.03	23.11	156.50	88.08
CAUMGLC-11	4.34	26.58	178.50	86.93
CHECK Var. Amba	7.60	4.41	166.20	88.78
SEm (±)	0.06	0.59	1.85	1.35
CD (5%)	0.17	1.73	7.38	3.97

2019) and ginger (Goudar *et al.*, 2017; Netravathi *et al.*, 2022) grown under different agro-climatic conditions.

Performance of mango ginger with respect to quality parameters

Study on performance of different mango ginger cultivation showed significant variations with respect to quality parameters. Essential oil content (1%) and starch content (30.20%) were found highest in CAUMGLC-2. Oleoresin content was found higher in CAUMGLC-2 (5.10%) and CAUMGLC-11 (4.90%). Sensory score for aroma was found higher in CAUMGLC-2 (7.75) and was followed by CAUMGLC-4 (7.63) and CAUMGLC-

3 (7.50) and was statistically at par with each other. Dry recovery % was found higher in CAUMGLC-7 (29.89%) and CAUMGLC-8 (29.44%) and was statistically at par with each other, but significantly higher to all other cultivars under consideration. The variations in quality parameters among the genotypes of mango ginger might be due to inherent characters of the genotypes. Similar variations in quality characters like essential oil content, dry recovery, oleoresin content etc. were reported by earlier workers in mango ginger (Chatterjee *et al.*, 2012), turmeric (Shashidhar *et al.*, 2018; Mariam Anal, 2019; Praneetha *et al.*, 2020) and ginger (Rajni *et al.*, 2007; Sanwal *et al.*, 2012; Babu *et al.*, 2017; Karthik *et al.*, 2017; Singh *et*



Fig. 1 : General Field view.

Table 6 : Economics of mango ginger cultivation.

Genotypes	Gross return (Rs./ha)	Net return (Rs./ha)	Benefit-cost ratio
CAUMGLC-1	1538700	1279012	4.93
CAUMGLC-2	924900	665212	2.56
CAUMGLC-3	1101300	841612	3.24
CAUMGLC-4	894000	634314	2.44
CAUMGLC-5	721200	461512	1.78
CAUMGLC-6	871200	611512	2.35
CAUMGLC-7	364500	104812	0.40
CAUMGLC-8	633900	374212	1.44
CAUMGLC-9	831000	571312	2.20
CAUMGLC-10	523800	264112	1.02
CAUMGLC-11	968400	708712	2.73
CHECK Var: Amba	943800	684112	2.63

al., 2023). Variation in sensory score for aroma was also reported by earlier worker in mango ginger varieties (Reis *et al.*, 2021).

Performance of different mango ginger genotypes on medicinal value

Total flavonoid content (7.60 QE/mg of extract) was obtained maximum in CHECK Variety - Amba. While minimum total flavonoid content (1.03 QE/mg of extract) was obtained in CAUMGLC-10. Total phenolic content of 40.80 GAE/mg of sample extract was recorded maximum in CAUMGLC-4 and was followed by CAUMGLC-5 (36.38 GAE/mg of sample extract) but were not at par with each other whereas minimum total phenolic content (4.41 GAE/mg of sample extract) was obtained in CHECK Variety - Amba. The lower IC₅₀ value indicates the higher antioxidant activity and anti-diabetic activity. Hence from the data given in Table 5, Antioxidant activity was found highest in CAUMGLC-5 with an IC₅₀ value of 113.90 µg/ml. Anti-diabetic activity was recorded maximum in CAUMGLC-4 with an IC₅₀ value of 75.69 µg/ml and comes at par with CAUMGLC-

5 with an IC₅₀ value of 78.14 µg/ml. Variations among different cultivars regarding medicinal traits might be due to different genetic constituents of the cultivars. Kaur *et al.* (2009) reported earlier that total phenolics, flavonoids and antioxidant activity exhibited significant variation among different onion cultivars.

Economic analysis

From the economic analysis of different Mango ginger genotypes under study, it is found that highest gross return (Rs. 1538700/ha), net return (Rs. 1279012/ha) and maximum B:C ratio (4.93) was recorded in CAUMGLC-1. The maximum B:C ratio in CAUMGLC-1 is due to higher rhizome yield which leads to higher returns. This emphasizes the need to select high yielding suitable genotypes for cultivation along with optimization of farm resources to get maximum profit under Manipur condition. Similar results related to the present study have been reported by earlier workers in ginger (Soni *et al.*, 2023) and potato crops (Mishra *et al.*, 2020).

Conclusion

With its high yielding character and showing high record of B:C ratio in the economic analysis, genotype CAUMGLC-1 is recommended for high yielding commercial production. Whereas, for quality purposes, genotype CAUMGLC-2 can be recommended. Genotypes CAUMGLC-4 and CAUMGLC-5 can be recommended for medicinal and pharmacological purposes.

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