

Conservation, Exploitation And Use Of The Ginger Family (Zingiberaceae) At The National Genebank In Vietnam

Thi Nga Hoang^{1,*}, Thuy Hang Nguyen Thi², Van Manh Bui³, Kha Tuong Le⁴, Hung Cuong Pham⁵,
Lan Huong Hoang Thi⁶, Quang Tin Nguyen⁷.

^{1,2,3,5,6}Plant Resources Center (PRC), An Khanh commune, Hoai Duc district, Hanoi city, Vietnam

⁴Vietnam Seed Association, Hanoi city, Vietnam

⁷Department of Science Technology and Environment, Ministry of Agriculture and Rural Development, Hanoi city, Vietnam

*Corresponding author: Hoang Thi Nga, Plant Resources Center, ngaht.prc@mard.gov.vn



Abstract – There are 741 accessions in the ginger family such as turmeric, galangal, and pinecone ginger collections conserved at Plant Resources Center, Vietnam. These collections were highly diverse in the number of accessions and species composition. The results of the Zingiberaceae exploitation shown the G10 ginger variety plants reached around 63.7 - 77.5 cm in height, 400 - 500 g/clumps in fresh weight, 25 - 27 tonnes/ha in fresh yield. The G10 ginger variety contained 4.37% oil, 1.2 mg/kg Zn and 9.31 mg/100g Vitamin C. This G10 ginger variety resistance to leaf spot and green aphids. In addition, the N8 turmeric variety plants reached 130 - 170 cm in height; 880 - 1000 g/clumps in fresh weight and 35 tonnes/ha in yield, curcumin content 6.2 - 6.6%, essential oil contents 2.5 - 2.7%. This turmeric resistance to heat stress, leaf spot, and green aphids. The conserved root and tuber crops at PRC are very diverse both of the amount of sample in collections and species. Conservation and evaluation on root and tuber crops reviewed the promising G10 ginger and N8 turmeric varieties had high yield, good oil content to release for production.

Keywords – Conservation, Exploitation, Zingiberaceae, Root And Tuber Crop, Utilization.

I. INTRODUCTION

Conservation of root and tuber crops in general, especially plants belong to the *Zingiberaceae* family, plays a significant role in agricultural production, medicine, cosmetic, and ornamental plant fields. Root and tuber crops are the third important food crop after rice and maize, particularly it plays the second food crops after rice in Vietnam. Root and tuber crops such as sweet potato, cassava, canna, taro, yam, ginger, and turmeric are cultivated popular in Vietnam, playing an important role in food and security. Research, conservation and exploitation plant resources of family Zingiberaceae are significant in both science and practice fields. Hence, this report presents some initial results on conservation, exploitation, and use of Zingiberaceae genetic resources that are conserving at the Plant Resources Center in Vietnam.

In Vietnam, the ginger family (Zingiberaceae) has about 21 genera with more than 100 species. Despite being a small family, there are a large number of valuable species used in medicine, pharmaceuticals, food technology such as galangal (*Alpinia officinarum* Hance), Turmeric (*Curcuma domestica* Val.), Ginger (*Zingiber officinale* Rosc), Amomum (*Amomum villosum*), ... etc (Nguyen, 2011). Nowadays, there are not any published reports of studies on conservation and utilization of the family Zingiberaceae resources conserved at the Plant Resources Center in Vietnam. It is really necessary for study on the ginger family, being basic scientific documents for exploiting, using and conserving these sustainable plant resources.

II. MATERIAL AND METHODS

2.1. Material

Materials include 741 accessions of ginger, turmeric, galangal, and pinecone ginger collections, which were collected at 37 provinces belong 8 eco-agriculture regions in Vietnam, it's are conserved at the Plant Resources Center.

2.2. Methods

Survey and collect plant resources by the PRA method. The *ex situ* conservation for family *Zingiberaceae* at the Plant Resources Center, Vietnam. Characteristics and evaluation for family *Zingiberaceae* base on the guideline in the Handbook for agricultural plant genetic resources conservation by La *et al.* 2015. The varieties compared and selected experiments by Nguyen and Pham 2005.

III. RESULTS AND DISCUSSION

3.1. Diversity of *Zingiberaceae*

At the Plant Resources Center, there are more than 3000 accessions of root and tuber crop collections such as cassava, sweet potato, canna, ginger, taro, galangal, etc. were stored by *ex situ* conservation. They were collected in Vietnam from 1990 up to 2015 (Hoang TN *et al.* 2016). The data in table 1 showed that the number of accessions collections belongs to the *Zingiberaceae* family reached 741 accessions. These consisted of four major collections such as ginger, turmeric, galangal, and pinecone ginger were 349, 296, 71 and 25 accessions, respectively. The number of samples big belongs to ginger and turmeric collections while extra ones are smaller. Therefore, the *Zingiberaceae* family high diverse both the number of accessions and species.

Table 1. Some main collections of the *Zingiberaceae* family conserved at the PRC

N ^o	Name of collections	Vietnamese name	Number of accessions
1	Ginger	Gung	349
2	Turmeric	Nghe	296
3	Galangal	Rieng	71
4	Pinecone ginger	Gung gio	25
	Total		741

3.2. Distribution of the *Zingiberaceae* family accessions

In Vietnam, the *Zingiberaceae* family is abundant in both of the wild types and cultivated types, it distributed in all ecological regions in Vietnam. Large populations of many wild types can be found in forest areas, hills, and rivers. The cultivated type is planted primarily in home gardens, intercropping with other crops or planted under the shade of forest trees. The *Zingiberaceae* plants, though they were planted with not many areas but widely distributed in all the country (Nguyen & Do, 2013).

The distribution of the *Zingiberaceae* family in table 2 based on collected varieties' information. The accessions of four major collections including ginger, turmeric galangal, and pinecone ginger of family *Zingiberaceae* are preserved at the PRC experience by *ex situ* conservation method.

These accessions collected from thirty-seven provinces belong to seven ecological regions in Vietnam. The number of collected accessions was the largest in Northeast following Northwest had 387 and 163 accessions, respectively. The *Zingiberaceae* family plants were not only in large quantities but also very diverse of species such as *Curcuma longa* L., *Curcuma zedoaria*, *Curcuma domestica*, etc. It is easy to understand that caused to the topography of the provinces in the Northeast and Northwest regions is mainly mountainous, humid and temperate, suitable for plants of the *Zingiberaceae* family's healthy grow. Besides, the local people regularly used ginger, turmeric, and galangal for their daily activities such as spices, food, medicine, etc. The number of samples collected in Red River Delta, North Central Coast and South Central Coast were quite equal 48, 40 and 41 accessions,

respectively. Another hand the number of accessions collected in Central Highlands was 27 accessions and 5 accessions in Mekong Delta. So far accessions of ginger turmeric galangal and pinecone ginger collections have been spread widely in all of the country areas at seven ecoregions from delta to mountainous areas. Hence, the results of this research were completely similar to identify of Nguyen and Do (2013) on their published paper about the assessment of *Zingiberaceae* genetic resources in Vietnam.

Table 2. Distribution of *Zingiberaceae* accessions conserved at the PRC

N ^o	Agro-ecological regions of Vietnam and provinces collected	Amount of accession of <i>Zingiberaceae</i>				Total
		Galangal	Ginger	Pinecone ginger	Turmeric	
I	Northeast	41	173	9	164	387
1	Bac Giang	1	21	0	18	40
2	Bac Kan	5	21	0	24	50
3	Cao Bang	4	15	2	13	34
4	Ha Giang	6	17	0	19	42
5	Lang Son	3	18	0	17	38
6	Phu Tho	1	10	0	9	20
7	Quang Ninh	5	42	0	21	68
8	Thai Nguyen	6	15	2	16	39
9	Tuyen Quang	10	14	5	27	56
II	Northwest	14	89	5	55	163
10	Dien Bien	5	22	0	9	36
11	Hoa Binh	1	22	0	18	41
12	Lai Chau	0	7	2	4	13
13	Lao Cai	4	24	2	11	41
14	Son La	3	10	1	11	25
15	Yen Bai	1	4	0	2	7
III	Red River Delta	1	27	1	19	48
16	Bac Ninh	0	2	0	1	3
17	Ha Nam	0	0	0	1	1
18	Ha Noi	0	5	0	3	8
19	Hai Duong	0	12	0	4	16
20	Hung Yen	1	7	0	8	16
21	Nam Dinh	0	1	0	0	1
22	Ninh Binh	0	0	1	2	3
IV	North Central Coast	4	14	4	18	40
23	Ha Tinh	1	2	0	1	4

Conservation, Exploitation And Use Of The Ginger Family (Zingiberaceae) At The National Genebank In Vietnam

24	Nghe An	1	3	3	5	12
25	Quang Binh	0	1	0	2	3
26	Quang Tri	0	3	0	0	3
27	Thanh Hoa	2	5	0	8	15
28	Thua Thien Hue	0	0	1	2	3
V	South Central Coast	6	14	2	19	41
29	Binh Dinh	0	1	0	3	4
30	Binh Thuan	0	1	0	0	1
31	Phu Yen	0	1	0	1	2
32	Quang Nam	6	11	2	15	34
VI	Central Hightlands	5	12	1	9	27
34	Dak Lac	0	3	0	4	7
33	Gia Lai	5	8	1	3	17
35	Lam Dong	0	1	0	2	3
VII	Mekong River Delta	0	2	0	3	5
38	Ben Tre	0	0	0	1	1
36	Dong Thap	0	1	0	0	1
37	Kien Giang	0	1	0	2	3
	<i>Others</i>	<i>0</i>	<i>18</i>	<i>3</i>	<i>9</i>	<i>30</i>
	TOTAL	71	349	25	296	741

3.3. Cultural and used values

Root and tuber crops, particularly the ginger family have a unique cultural value in the lives of the Vietnamese people in rural areas and mountainous ethnic groups. Root and tuber crops have important implications for poverty reduction and food security such as sweet potato, cassava, and taro collections. Species in the ginger family are well known in everyday life such as spices, in food, cosmetics and dyes, and as ornamental plants. The ginger family is not only valuable in its use but also has a cultural meaning of Vietnamese people. Many spice plants like galangal, ginger were important implications in Vietnamese cultural life. Vietnamese people have some idioms as “Gừng càng già càng cay” mean that the older people, who had good experiences in their life so when it is a difficult problem in life they will solve in easy ways even the best way and give good advice for their generation. Another idiom like “Vào vườn lấy củ gừng thơm. Trở vô cháo nóng mức lên bát đầy” mention that when someone gets flu, if that person eats a hot rice soup with litter ginger, being an excellent food for release muscle pain, hence patients will be better. Galangal is also an indispensable spice in many foods, it is planted very popularly in the north in the countryside.

Table 3. Classification of family Zingiberaceae based on using values.

N ^o	Values	Amount of accessions	Sciences name	Vietnamese name with genebank code
1	Spice	661	<i>Zingiber officinale</i>	Khe (Gung) - GBVN20060
			<i>Curcuma longa</i> L.	Vang chang(Nghe do) - GBVN20148
			<i>Alpania officinarum</i>	Rieng cay - GBVN11311
2	Medicine	71	<i>Zingiber zerumbet</i>	Co kinh - GBVN11164
			<i>Curcuma zedoaria</i>	Gung gio - GBVN20107
			<i>Curcuma longa</i> L	Khac lam keng - GBVN28661
3	Ornamental	5	<i>Curcuma zedoaria</i>	Nghe den - GBVN11129
			<i>Alpania purpurata</i>	Sung kia - GBVN28707
				Cong - GBVN20185
4	Dye	3	<i>Curcuma longa</i> L	Nghe do - GBVN28688
				Nghe vang - BGVN20131
				Khang man - GBVN28680
5	Multi-types using	1	<i>Curcuma longa</i> L	Nghe nep do - GBVN28715
Total		741		

Results on survey and collection of ginger, pinecone ginger, turmeric, and galangal accessions show there are four main using values such as spice, medicine, ornamental, and food (dye). Besides, it is only one accession used for multi-purposes both spice, food, dye, that is Nghe nep do variety with GBVN28715 genebak code.

Turmeric and ginger are indispensable spices in many dishes that chef used when processing many dishes. Besides ginger rhizomes, its leaves can be used to deodorize food (fishy smell) in braised fish, steamed fish. Also, ginger and turmeric powders make the dishes more attractive, colorful and delicious.

3.4. Exploitation and utilization

To select ginger and turmeric varieties that have a high yield and resistance ability to major diseases, adapt to environmental conditions, collection's evaluation experiments and varieties' comparison tests were conducted. The initial results have selected the promising G10 ginger and the N8 turmeric varieties, those selected from the indigenous clones of countless turmeric ginger samples kept at PRC.

Two of the four collections include ginger, turmeric, galangal, and pinecone ginger is more considered because it's high using values and large collected accession quantities. Evaluating of 349 ginger accessions and 296 turmeric accessions were selected promising ginger and turmeric varieties. The G10 ginger and N8 turmeric varieties are selected and released to expand production in many regions in Vietnam. The G10 ginger variety is a clonal selection from a ginger local variety. This variety was tested in the field of Hoa Binh province for 3 years under various climate conditions. The N8 turmeric variety is a clonal selection from a local variety, collected in Thanh Hoa. This variety was tested in Hung Yen province for 3 years under different climate conditions.

The G10 ginger and N8 turmeric varieties have been approved by MARD under decision No. 73 / QĐ-TT-CLT in 2012. The major traits of G10 ginger and N8 turmeric varieties include as bellow:

3.4.1. The G10 ginger variety

Table 4. Some characteristic features of the G10 ginger variety planted in Hoa Binh province.

N ^o	Characteristics	Amount
1	Maturity (days)	250 - 265
2	Plant height (cm)	63.7 - 77.5
3	Length of rhizome (cm)	9.6 - 14.6
4	Width of rhizome (cm)	2.4 - 2.7
5	Weigth of rhizomes/clumps (g)	400.0 - 500.0
6	Fresh yield (ton/ha)	25.0 - 27.0
7	Essential oil content (%)	4.37
8	Zinc content (Zn) (mg/kg)	1.20
9	Vitamin C	9.31
10	Leaf area (m ² /clump)	0.50 - 0.55
11	Leaf area index (a square meter of leaf/ a square of soil)	4.6 - 8.3

The G10 ginger maturity ranged 250 to 265 days and plant height varied from 63.7 to 77.5 cm. The color of the leaf is dark green and tuber skin grey-yellow. The color of ginger powder was a light yellow (Fig. 1). The length of rhizome ranged from 9.6 to 14.6 cm, the width of the rhizome is 24.0 to 27.3 mm. The average yield of the G10 ginger variety reached 27.4 ton per hectare, varied from 24.5 to 29.2 ton/ha. The G10 ginger consisted of 4.37% essential oil, 1.2 mg/kg zinc and 9.31 mg/100g Vitamin C. The leaf area index ranged from 0.51 to 0.57 square of leaf/clump and reached from 3.49 to 3.84 square of leaf/square of soil (Table 4).



a



b



c



Figure 1. Some images of the G10 ginger variety

a, b: The G10 ginger variety planted in Bac Kan province; c. The G10 ginger variety planted in Hoa Binh province; d. G10 fresh rhizomes; e. Ginger powder; f. Ginger powder products.

3.4.2. The N8 turmeric variety

The N8 turmeric variety was selected from the Nghe do variety population, collected at Ba Thuoc district, Thanh Hoa province. The N8 turmeric cultivar is planted in different turmeric growing areas in Vietnam such as Bac Giang, Hoa Binh, Hung Yen, Thanh Hoa provinces and others. Results show that the N8 turmeric cultivar grew well and adapted to various cultivated conditions.

Table 5. Some characteristics of N8 turmeric variety planted in Hung Yen province

N°	Characteristics	Amount
1	Maturity (days)	270 - 280
2	Plant height (cm)	130.0 - 170.0
3	Lenght of finger rhizome (cm)	8.2- 8.8
4	Width of finger rhizome (cm)	2.7 - 2.8
5	Weight of rhizomes/clump (g)	880.0 - 1000.0
6	Fresh yield (ton/ha)	34.4 - 38.8
7	Average fresh yield (ton/ha)	35.0
8	Essential oil content (%)	2.5 - 2.7
9	Curcumin content (%)	6.2 - 6.6
10	Leaf area (m ² /clumps)	0.97 - 1.67
11	Leaf area index (a square meter of leaf/ a square of soil)	4.6 - 8.3

The N8 turmeric cultivar matures from 270 to 280 days. The plant height ranges from 130 to 170 cm depended on different cultivated conditions. Size of a rhizome: the length of the finger rhizome is from 8.2 to 8.8 cm, the width of the finger rhizome is from 2.7 to 2.8 cm. The rhizome's weight varies from 880 to 1000 g/clumps. The average fresh yield reaches 35 tons per hectare and varies from 34.4 to 38.8 tones. The N8 turmeric contains 6.2 - 6.6% curcumin and 2.5 - 2.7% essential oil (Table 5). The N8 turmeric resists heat stress, leaf spot and green aphids. The flesh rhizomes and turmeric powder are an attractive red color. Besides turmeric powder can be used in face masks, cold-curing teas, anti-inflammatory drinks, and even toothpaste.

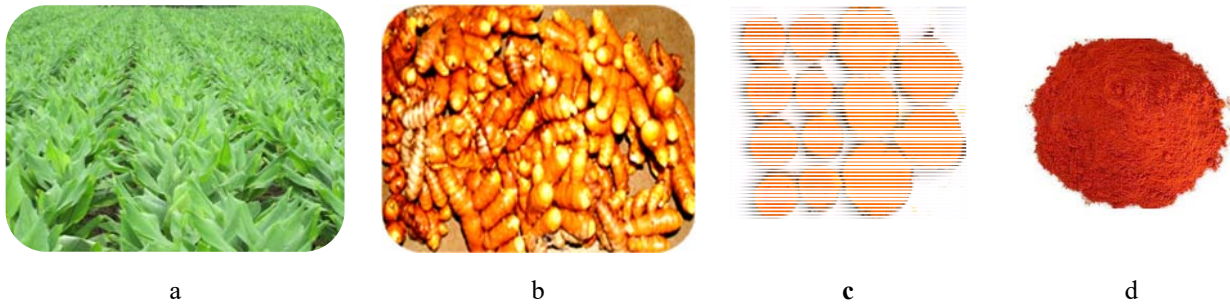


Figure 2. Some images of the N8 turmeric variety

- a. N8 turmeric variety planted in Hung Yen province, 2016; b. N8 flesh rhizomes; c. N8 fresh rhizomes color; d. N8 turmeric powder.



Nghe vang - GBVN 11120



Nghe xanh - FGB 436



Cheng – GBVN 20058

Figure 3. Some photos of other accessions conserved at PRC.

IV. CONCLUSIONS

1. There are 741 accessions belong the *Zingiberaceae* family stored *ex situ* conservation at the Plant Resources Center in Vietnam, consisting of four major collections such as ginger, turmeric, galangal, and pinecone ginger collections has 349, 296, 71 and 25 accessions, respectively.
2. The number collected samples of the ginger, turmeric, galangal and pinecone ginger collections distributed widely in thirty-seven provinces belong to seven agro-ecological regions in Vietnam. The Northeast and Northwest regions, it is widely diverse both species and the largest collected accessions are 387 and 163 accessions, respectively.
3. There are four main using types for plants of the *Zingiberaceae* family were spice, medicine, ornamental, dye and other multiple-using values.
4. The G10 ginger and N8 turmeric varieties are selected and released to expand production with high yield and good quality. The G10 ginger is plant height 63.7 - 77.5 cm, tuber weight 400 - 500g/clumps, fresh yield 25 - 27 tonnes/ha, 4.37% essential oil, 1.2 mg/kg Zinc and Vitamin C 9.31 mg/100g. This variety resists to leaf spots and green aphids. The N8 turmeric variety is plant height from 130 to 170 cm; tuber weight 880-1000 g/clumps and average fresh yield 35 tonnes/ha, 6.2-6.6% curcumin and 2.5-2.7% essential oil. This turmeric variety resists to heat stress, leaf spot, and green aphids.

REFERENCES

- [1] Hoang TN, Le VT, Tran TAN, Nguyen VK, Nguyen PH, La TN, Nguyen TTH, Duong TH, Truong TH, Nguyen AV, Bui VM, Nguyen TH. 2016. Conservation of root and tuber crops germplasm at plant resources center in 2011-2015 period: 795-804.

- [2] La TN, Nguyen TNH , Pham HC, Vu DT, Nguyen TH, Vu LC. 2015. Handbook for agricultural plant genetic resources conservation. Agricultural publisher, Hanoi city, Vietnam. 251 pp.
- [3] Nguyen QB. (2011). Research and classify ginger family (Zingiberaceae Lindl.) in Vietnam. PhD Dissertation in Biology, Institute of ecological and biological resources, Vietnam Academy of Science and Technology.
- [4] Nguyen TNH, Do QM. (2003). Assessment of Zingiberaceae genetic resources in Vietnam. The basic research in the living sciences, Ministry of science and technology: 137-140.
- [5] Nguyen TL, Pham TD. 2005. Curriculum experimental methods. Vietnam National University of Agriculture, Hanoi city. 205pp.