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EVALUATION OF DIVERSITY OF PLANT GENETIC RESOURCES GROWN IN MYANMAR HOME GARDEN: DISTRIBUTION AND UTILIZATION OF *HIBISCUS* GENUS PLANT "CHINBAO"

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ABSTRACT

The main objective of the survey was to collect accessions of Chinbao (Generic name of five species in the genus *Hibiscus* that used as vegetables in Myanmar) (Nagashima et al., 2016) and clarified current status of those in Myanmar. From 2014 to 2018, a total of 342 samples were collected in Myanmar, including 244 *Hibiscus sabdariffa* samples, 58 samples of *Hibiscus cannabinus*, 30 samples of *Hibiscus radiatus*, 8 samples of *Hibiscus acetosella* and 2 samples of *Hibiscus surattensis*. In Myanmar, *H. sabdariffa* is the most dominant among the five species. Next, the frequency of appearance was higher in order of *H. cannabinus, H. radiatus*, *H. acetosella*, *H. surattensis*. The frequency of appearance of *H. cannabinus* was distinctly different between the peninsula and the central dry area. Clear differences in utilization of *H. radiatus* and *H. acetosella* between the northern west mountainous area (Chin state) to other area were noted.

Key words: accession collection, ethnobotany, nomenclature

INTRODUCTION

Myanmar has a great diversity of climates, ranging from Am (Tropical monsoon) in the peninsula to Aw (Savanna) in the center, and to Cw (Temperate: dry in winter) in the north. The topography varies, with mountains in the north and west area, a high plateau in the east side, and flat land in center, in the delta and river basin in the south. The country has borders with Bangladesh, India, China, Laos, and Thailand, and diverse tribe minorities live in their own food cultures (Cummings, 1996). The agro-climatic diversity in Myanmar is favorable for growing a variety of crops, and the country possesses a great diversity of crop genetic resources that remain to be explored (Nakagawa et al, 2002, Wakui et al, 2016).

According to previous studies of Nagashima et al. (2016), there found 5 kinds of *Hibiscus* plants called Chinbao, cultivated in large quantities throughout whole Myanmar (Fig.1). As in the African countries, it was observed that even in Myanmar young leaves are used as daily vegetables (Wilson and Menzel, 1964; Wilson, 1999). The leaves and shoots of 5 kinds of *Hibiscus* plants were eaten raw or cooked as a sour-flavored vegetable or condiment. The seeds were ground into oil and the fleshy fruiting calyces were used like cranberries in jellies. The crop is a good choice for low-rainfall

areas because of high drought tolerance (Mohamed et al. 2015). Future improvement in functionality and cultivation properties of these *Hibiscus* species is highly anticipated, but the information on the diversity and utilization of *Hibiscus* genetic resources in Myanmar is still insufficient. This study sought to fill this gap and special focus on areas with different geographical features to clarify the differences in utilization and distribution of five *Hibiscus* plants there.

MATERIALS AND METHODS

The survey was conducted 7 times from August 2014 to September 2018 with the permission of Department of Agricultural Research (DAR) of the Ministry of Agriculture, Livestock and Irrigation, Myanmar (MOALI). We visited 75 townships in 12 states and regions as shown in Table 1. We collected fruit, seed and cutting samples of local or wild landraces from farmers and roadside. In addition, we gathered samples with interviewing farmers to collect information, including local plant name, sowing place, usage, cultivation methods, cropping pattern and additional information.

RESULTS AND DISCUSSION

Collection samples. In this survey, the *Hibiscus* genus observed in this survey could be categorized into five species; *H. sabdariffa*, *H. cannabinus*, *H. radiatus*, *H. acetosella* and wild relative *H. surattensis* (Fig.1). About 71% of the total 342 collected seeds were identified with *H. sabdariffa*. The method of collecting seeds samples were done by dividing it from farmers, sampling in the field and buying at the seed shop. *H. sabdariffa* and *H. cannabinus* were able to buy seeds at the seed store. But, other Chinbao were limited to very small cultivation in the home garden or wild condition on roadside, and seeds were not sold at the seed store. Therefore, some samples were collected in rooted cutting instead of seed. Regional differences in frequency distribution of 5 *Hibiscus species* is shown in Table 1. The samples that we collected in this survey were divided into two subsets. One was conserved for further research and crop improvement at the Seed Bank in DAR, MOARI, which is located in Yezin, Nay Pyi Taw, Myanmar. The other was transferred to and conserved at Tokyo University of Agriculture (TUA) at Tokyo, Japan, under a Standard Material Transfer Agreement (SMTA) for the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) of the United Nations (UN), Food and Agriculture Organization (FAO) and a phytosanitary certificate that was issued by the Plant Quarantine Office of Department of Agriculture, MOALI, Yangon, Myanmar to introduce to Japan.

Utilization and distribution of 5 *Hibiscus* species

***H. sabdariffa* (roselle).** in this survey, *H. sabdariffa* was found to be cultivated in all the investigated administrative areas with market-oriented purpose. Of the 342 seeds collected, 244 seeds were *H. sabdariffa* (Table 1). Among the five species, *H. sabdariffa* was the most frequently grown one, especially cultivated in large-scale field in Sagaing and Mandalay region located in central dry zone. Most Myanmar farmers depend on rainfall, and crop cultivation is greatly affected by the weather. Because *H. sabdariffa* is excellent in drought tolerance, cultivation is possible in a vast arid region spreading along the Ayeyarwady River (Mohamed et al., 2015). In particular, farmers in the Saganing area cultivate *H. sabdariffa* after the second stage of rice. *H. sabdariffa* appears most frequently in markets among Chinbao, to be used as vegetables for stir-fry and soup.

The farmers' eaves price of leaf is about 300 to 500 MMK (1 MMK = about 0.08 JPY) in one cup, but the price rises in winter season to about 500 to 1000 MMK. Although this vegetable is inexpensive, it is a stable revenue source for farmers due to high demand throughout a year. *H. sabdariffa* is called Chinbao, Birra (foreign)-Chinbao or Chinbao-Ni (red) in all over Myanmar. In addition, *H. sabdariffa*, which has no branches and reaching 4 m in height, was called Show (fiver) -Chinbao, and long stem fibers were used as rope. In some areas, there were local names by tribe-specific language. For example, the Chin tribe called "Anthol", the Gurka tribe called Bell chyanlee, and the Mon tribe called Baey. In

addition to tribe-specific languages, there were also names that could be attributed to the cultivation time and history (Table 2). Thus, as there are many local names, we have found that *H. sabdariffa* is being used on a daily used by many tribe groups throughout Myanmar.

Table 1. Regional differences in frequency distribution of 5 *Hibiscus* species

State or Region	*H. sabdariffa*			*H.cannabinus*			*H.radiatus*			*H.acetosella*			*H.surattensis*			Subtotal	χ2- value & Significance	Classes with relatively high frequency
	No. of seeds	in %	*Deviation	No. of seeds	in %	*Deviation	No. of seeds	in %	*Deviation	No. of seeds	in %	*Deviation	No. of seeds	in %	*Deviation			
Delta area																		
Ayeyarwady	11	78.6	58.7	0	0.0	-1.8	3	21.4	17.6	0	0.0	-2.0	0	0.0	0.0	14	5.44	
Bago	15	60.0	40.1	6	24.0	22.2	3	12.0	8.2	0	0.0	-2.0	1	4.0	4.0	25	7.05	
Yangon	14	87.5	67.6	2	12.5	10.7	0	0.0	-3.8	0	0.0	-2.0	0	0.0	0.0	16	2.64	
Coastal areas of the peninsula																		
Mon	17	100.0	80.1	0	0.0	-1.8	0	0.0	-3.8	0	0.0	-2.0	0	0.0	0.0	17	6.83	
Tanintharyi	8	100.0	80.1	0	0.0	-1.8	0	0.0	-3.8	0	0.0	-2.0	0	0.0	0.0	8	3.21	
Central dry area																		
Sagaing	37	75.5	55.6	8	16.3	14.6	2	4.1	0.3	1	2.0	0.0	1	2.0	2.0	49	3.15	
Magway	38	73.1	53.2	11	21.2	19.4	3	5.8	2.0	0	0.0	-2.0	0	0.0	0.0	52	2.62	
Mandalay	36	53.7	33.8	25	**37.3**	**35.6**	6	9.0	5.2	0	0.0	-2.0	0	0.0	0.0	67	21.24**	*H.cannabinus*
Mountainous area																		
Kachin (north)	16	94.1	74.2	1	5.9	4.1	0	0.0	-3.8	0	0.0	-2.0	0	0.0	0.0	17	4.45	
Chin (west)	11	37.9	18.0	2	6.9	5.1	11	**37.9**	**34.1**	5	**17.2**	**15.2**	0	0.0	0.0	29	62.08**	*H.radiatus* & *H.acetosella*
Shan (east)	39	84.8	64.9	3	6.5	4.8	2	4.3	0.5	2	4.3	2.3	0	0.0	0.0	46	6.21	
Kayah (east)	2	100.0	80.1	0	0.0	-1.8	0	0.0	-3.8	0	0.0	-2.0	0	0.0	0.0	2	0.80	
Subtotal	244	71.3	-	58	17.0	-	30	8.8	-	8	2.3	-	2	0.6	0	342	125.74**	

Notes) * : Deviation in % from the expected value.

Table 2. List of local names of five Hibiscus genus plants in Myanmar

District	*H. sabdariffa*	*H. cannabinus*	*H.radiatus*	*H.acetosella*	*H.surattensis*
Kachin	bell chyanlee*1(CHINBAO/ Gurkha) BIRRA-CHINBAO*2(Foreign) CHINBAO-NI(Red) SHOW-CHINBAO(Fiver)	CHINBAO-KA (Bitter) SHOW-CHINBAO(Fiber) CHINBAO-PYU(White)	CHINBAO-KA(Bitter) RECHA-CHINBAO(Split into five)	CHINBAO-NI(Red)	-
Sagaing	BIRRA-CHINBAO(Foreign) CHINBAO -NI(Red) KATHE-CHINBAO(Kathe tribe)	CHINBAO-KA (Bitter) SHOW-CHINBAO(Fiber) CHINBAO-PYU(White) RECHA-CHINBAO(Split into five)	CHINBAO-KA (Bitter) RECHA -CHINBAO(Split into five)	-	CHINBAO-WIN(Wild)
Chin	antol (CHINBAO/ Chin) CHINBAO-NI(Red)	antol ka(Bitter CHINBAO/ Chin) CHINBAO-KA(Bitter)	antol ka(Bitter CHINBAO/ Chin)	antol ni(Red CHINBAO/ Chin)	-
Shan	BIRRA-CHINBAO(Foreign) CHINBAO-NI (Red) CHINBAO-PYU(White)	CHINBAO-KA (Bitter) SHOW-CHINBAO(Fiber)	CHINBAO-KA (Bitter) RECHA -CHINBAO(Split into five)	CHINBAO-NI(Red) BAN-CHINBAO(Flower)	-
Mandalay	BIRRA-CHINBAO(Foreign) CHINBAO-NI (Red) CHINBAO-PYU(White)	CHINBAO-KA(Bitter) SHOW-CHINBAO (Fiber) CHINBAO-PYU(White)	CHINBAO-KA(Bitter) CHINBAO-YOWPYU(White stem)	-	-
Magway	BIRRA-CHINBAO(Foreign) CHINBAO-NI (Red)	CHINBAO-KA(Bitter)	CHINBAO-KA(Bitter) CHINBAO-RECHA(Split into five)	-	-
Kayah	CHINBAO-NI(Red)	CHINBAO-KA (Bitter)	-	-	-
Bago	BIRRA-CHINBAO(Foreign) CHINBAO-NI(Red) RECHA-CHINBAO(Split into five)	CHINBAO-KA (Bitter) CHINBAO-PYU (White) CHINBAO-RECHA(Split into five)	CHINBAO-RECHA(Split into five) CHINBAO-KA(Bitter)	-	CHINBAO-WIN(Wild)
Yangon	BIRRA-CHINBAO(Foreign) CHINBAO-NI (Red) CHINBAO-YOWNI (Red stem)	CHINBAO-KA (Bitter) CHINBAO-YOWPYU (White stem) CHINBAO-RECHA(Split into five)	CHINBAO-RECHA(Split into five)	-	-
Mon	baey(Duck leg/ Mon) TAWNY-CHINBAO(Field・Mon) WOW-CHINBAO（Rrain season） CHINBAO-GYI(Tall)	NIIN-CHINBAO (Winter)	BAN-CHINBAO (Flower) SHWE-CHINBAO(Gold)	-	CHINBAO-WIN(Wild)
Ayeyarwady	CHINBAO-NI (Red)	CHINBAO-KA(Bitter)	CHINBAO-KA(Bitter)	CHINBAO-NI(Red)	-
Tanintharyi	WOW-CHINBAO（Rain season） CHINBAO-GYI(Tall)	CHINBAO-PYU(Whitea) CHINBAO-KA(Bitter)	-	-	CHAW-CHINBAO(Stone)

Upper case: Burma language name, Lower case: Local Language name, (/): Meaning of the word/ Tribe name

***H. cannabinus* (kenaf).** Among the 342 seeds collected, 58 seeds were found to be *H. cannabinus* and grown frequently next to *H. sabdariffa.* However, the cultivation was small and limited in home gardens or the outer circumference of the field. The frequency of appearance of *H. cannabinus* was distinctly different between the peninsula and the central dry area. Cultivation and utilization of *H. cannabinus* were confirmed mainly in the central arid area, especially Mandalay, also in the western mountainous areas and the east highland areas. However, cultivation was hardly confirmed in the coastal areas of the peninsula, and seeds could not be collected either (Table 1). (As an exception, a Shan woman who married to a peninsular house brought Shan State seeds and cultivated in the garden). Like *H. sabdariffa*, it was used for fry or soup, but harder and bitter in comparison with *H. sabdariffa*. Leaf or young stem of *H. cannabinus* was sometimes sold on the market (500-800MMK/bunch), which was a bit higher price than *H. sabdariffa.*

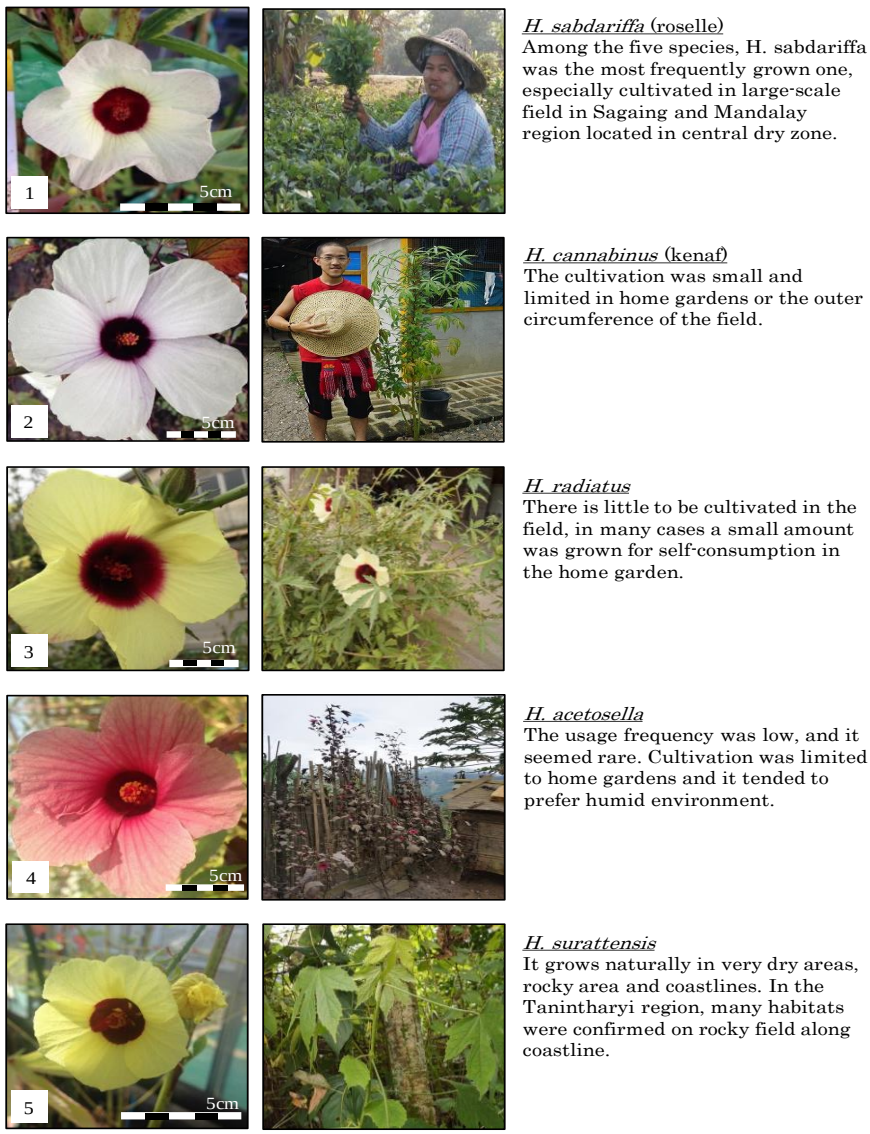
H. cannabinus is called Chinbao-Ka (bitter), Chinbao-Pyu (white/green) or Show (fiber)-Chinbao in Myanmar (Table 2). However, in the Mon state of the peninsula, the name NIIN (winter/snow)-Chinbao was discovered. This is the meaning of "Chinbao growing in the winter season". In contrast, *H. sabdariffa* had a unique name in the peninsular part of Tawny (field)-Chinbao and Wow (rainy season)-Chinbao. They mean "Chinbao cultivated in the field", and "Chinbao cultivated in rainy season. From this terminology, it was indicated that in the peninsula part, *H. sabdariffa* was cultivated in rainy season and *H. cannabinus* was grown in winter. *H. cannabinus* has been reported to grow under various soil and water conditions (Dempsey, 1975; Amaduccia et al., 2000). However, it was not cultivated during the rainy season in case of the peninsula. On the Peninsula, moisture in the soil is usually saturated due to rainfall due to heavy precipitation and gray sol soil (Ground water level is high and drainage is no good) (Fig.1). Seeds of *H. cannabinus* may sometimes germinate on stem under high temperature and high humidity conditions (Crane and Acuna, 1945). In addition, *H. cannabinus* seeds are susceptible to high relative humidity and temperature. In other words, improper seed production environment and seed preservation method greatly reduce seed quality and survival rate. It was speculated that this is the reason why *H. cannabinus* is not cultivated in the peninsula during the rainy season.

H. radiates. The country of origin of *H. radiatus* is India, Myanmar or Pakistan (Hooker, 1872; Bailey, 1899). Like *H. sabdariffa, H. radiatu*s is widely adopted in a wide range of environments, and it is shown that cultivation is possible throughout Myanmar. However, compared with *H. sabdariffa,* the leaves do not grow well, the stem has many thorns, the texture is bad and the taste is bitter, so it seems that usage frequency is low. There is little to be cultivated in the field, in many cases a small amount was grown for self-consumption in the home garden. When there is surplus for in self consumption, it may be sold in the market. *H. radiatus* seeds was not sold at market. There was a clear difference in the appearance of *H. radiatus* between the mountainous region (Chin state) in the northwest and other regions. *H. radiatus* frequently occurred in relatively high-altitude areas. Especially, the frequency of appearance in Chin State was higher than other area significantly (Table 1). One of the reasons for this was inferred that *H. radiatus* is more adaptable to low temperatures in winter than other Chinbao. The other was inferred to be due to the taste of people living in highlands. The elderly of the Shan tribe calls this Chinbao-Ka and likes to eat it. This is familiar to the people living in Takayama eating wild plants on a daily basis. Therefore, it was presumed that there is a tendency to like bitter taste as compared with tribe groups of other regions.

H. acetosella. In case of *H. acetosella*, the whole plant is red, and the flowers are bright red. It might be the reason that they call it Chinbao-Ni (red). It is vegetable in Africa, but decorative use is mainly done in tropical and subtropical countries (Morton and Ledin, 1952; Exell, 1961). In Myanmar, usage frequency was low, and it seemed rare. Cultivation was limited to home gardens and it tended to prefer humid environment. The leaves and seeds of *H. acetosella* were never observed in markets in Myanmar. According to Kachin tribe, they eat it as a medicine, but the medicinal efficacy could not identified in this survery. In addition, Shan tribe call it Ban-Chinbao (flower), using it as a vegetable and ornamental

plant in garden. Like *H. radiatus*, there was a clear difference in the appearance of *H. acetosella* between the mountainous region (Chin State) in the northwest and other states and regions (Table 1). *H. acetosella* occurred only in relatively high-altitude areas in Sagaing, Shan and Chin. Especially, the frequency of appearance in Chin State was higher than other states and regions significantly. One of the reasons for this was inferred that *H. acetosella*, like *H. radiatus*, is more adaptable to low temperatures in winter than other Chinbao.

H. surattensis. *H. surattensis* has stiff and sharp thorns on the stem and its leaves are hard. *H. surattensis* grows naturally in very dry areas, rocky area and coastlines. In the Tanintharyi region, many habitats were confirmed on rocky field along coastline. Therefore, Mon tribe call it Chwau (stone)-Chinbao (Table 2).



H. sabdariffa (roselle)
Among the five species, H. sabdariffa was the most frequently grown one, especially cultivated in large-scale field in Sagaing and Mandalay region located in central dry zone.

H. cannabinus (kenaf)
The cultivation was small and limited in home gardens or the outer circumference of the field.

H. radiatus
There is little to be cultivated in the field, in many cases a small amount was grown for self-consumption in the home garden.

H. acetosella
The usage frequency was low, and it seemed rare. Cultivation was limited to home gardens and it tended to prefer humid environment.

H. surattensis
It grows naturally in very dry areas, rocky area and coastlines. In the Tanintharyi region, many habitats were confirmed on rocky field along coastline.

Fig.1 CHINBAO(five *Hibiscus* plants) in Myanmar

It is a complete wild species, not cultivated, it is not sold in the market either. In Tanintharyi, Sagaing and Chin, only people living near this habitat collect and eat extremely young leaves. The taste is inferior to the other four *Hibiscus* plants. However, because it grows along the coast, high temperature dry area and dry mountainous area it is presumed that it is excellent in drought and salt tolerance.

The investigation from 2014 to 2018 revealed substance of identification of *Hibiscus* genus vegetable called Chinbao in Myanmar, cultivation situation, use, distribution and so forth. each tribe group classifies the name of each Chinbao according to its appearance, usage and cultivation period nomenclature is often determined by the application, the cultivation time and the characteristics of the plant itself (Table 2). in addition, it is clear from interview that there are differences in the introduction process and the cultivation scale of Chinbao for each region. Factors that cause the difference can be roughly divided into two, natural factors and human factors.

In natural factors, the difference in the elevation of the cultivated land will result in the difference in ecological environment, the production work will be stipulated. As for human factors, the preference difference for acidity and bitterness of each tribe group had a great influence on the selection of Chinbao to cultivate. However, in Myanmar located at low latitude, flowering started in November (daytime: less than 13 hours) (Tukamoto et al., 1963), leaf yield is greatly decrease. Therefore, breeding targets in the future are required to produce varieties that are hardly affected by short days. As a result, H. sabdariffa is cultivated throughout the year, and production is expected to increase.

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