SOLANACEAE DIVERSITY IN VIETNAM: A PRELIMINARY TAXONOMIC INVENTORY FOR CONSERVATION AND UTILIZATION

SUMMARY

Solanaceae plays an important role in providing food, vegetables, spices, medicine, and ornamentals in Vietnam. However, solanaceous genetic resources are facing serious threats of erosion and eradication. Our objective is to give a survey on the diversity as well as an evaluation of the role of solanaceous indigenous plants in the local communities to identify the current status and its importance for conservation and sustainable utilization in the future. The data comes from a survey and a collection in central Vietnam as well as herbarium specimens from the collections of Solanaceae in Vietnam. An analysis of these specimens and the result from the survey show that Solanaceae in Vietnam includes 15 genera with 63 species. Besides, there are 6 species belonging to 5 genera being in question regarding the taxonomy. Three genera, Solanum (31 species), Lycianthes (7 species) and Physalis (5 species) represent 68% of the total number of species. Among the 63 recorded species, there are 29 wild species, 22 cultivated species and 12 species being wild and cultivated. 6 species are used as fruits, 41 species as medicine, 16 species as ornamentals, 4 species as spices and 22 species as vegetables. The indigenous solanaceous plants include 24 species belonging to three genera: Lycianthes (7 species), Solanum (13 species) and Tubocapsicum (1 species). The indigenous solanaceous species in Vietnam are mostly wild species, among them there are three endemic species as Lycianthes baviensis V. V. Hop, Solanum robinsonii Bonati and Solanum thorelii Bonati.

Keywords: Solanaceae, diversity, genetic resource, species richness, Vietnam

INTRODUCTION

Solanaceae is one of the most important families of flowering plants to human beings with considerable value in economical, agricultural, and medicinal respects (Bennett, 2010; Knapp et al., 2004; Wiart, 2006), especially valuable they are as vegetable crops (Hawkes, 1999; Mueller et al., 2005; Samuels, 2015).
In Vietnam, solanaceous plants play an important role in providing food, vegetables, spices, medicine and ornamentals as well as improving income for the local people (Chi, 1997; Ho, 1999; Hop and Phuong, 2003). In recent years, the solanaceous genetic resources in Vietnam are still facing serious threats of erosion and eradication. The main reasons are the fast replacement by new, high-yielding crop varieties and the intensive farming process, human activities as destruction and non-rational exploitation of forests and lands, urbanization and modernization, the pressure of population with growing food demands, natural disasters along with negligence and insufficient management of humans (Sen and Trinh, 2010; Trinh, 1996).

The Solanaceae are ranked the eighth of 37 families in valuable and rare species that are needed to conserve in Vietnam including 107 rare genetic resources belonging to 26 species and 3 genera (MARD, 2005a), however, conservation of these species received very little attention so far (Tuong et al., 2010; Tuong et al., 2013). One of the biggest obstacles for the conservation of indigenous species including solanaceous species are incomplete statistics, classification and evaluation of them. This would be necessary especially for wild species having close relationships with crops in different ecological regions in Vietnam to provide information for ex-situ or in-situ conservation (Catacutan et al., 2014; Hue et al., 2012). Besides, determining and selection of important indigenous solanaceous genetic resources for conservation have not been done. Therefore, the utilization of germplasm collections, particularly in the wild species, is still very limited (PGRV, 2012; PGRV, 2014; Tuong, 2014; Tuong et al., 2010). The objective of this study is to give a survey on the diversity as well as the evaluation of the role of solanaceous indigenous plants in the local communities to identify the status as well as importance of them for conservation and sustainable utilization in the future.

**MATERIALS AND METHODS**

The study was designed as an investigation based on the results of a survey and collection in 5 provinces in central Vietnam (Figure 1) from September 2013 to February 2014 and the data come from 308 herbarium specimens from the collections of Solanaceae in Plant Genetic Resource in Vietnam.

The provinces were selected for the survey based on eco-geographic data (Guarino et al., 2005). Identification of Solanaceous species used the method of comparing morphological characteristics with using the identification keys by Ho (1999), Hop (2006) and Zhang (1994). Useful solanaceous plants were determined by surveys and interviews with 155 randomly-selected households base on questionnaire. Additionally, special collecting trips were organized with indigenous experts: traditional doctors, village elders and other local people who knew about useful plants. The information was also checked and compared with documents on medicinal plants by Loi (1995), Chi (1997), Ho (1999) and Batugal (Batugal et al., 2004).
RESULTS AND DISCUSSION

According to solanaceous system by Hunziker (2001), Solanaceae in Vietnam can be classified into 2 subfamilies (Cestroideae, Solanoideae) with 7 tribes (Cestreae, Nicotianae, Francisceae, Browallieae, Datureae, Lycieae, Solaneae) and 5 subtribes (Nicotianinae, Physalinae, Iochrominae, Capsicinae, Solaninae) with 15 genera (Cestrum, Nicotiana, Petunia, Brunfelsia, Browallia, Datura, Brugmansia, Lycium, Physalis, Tubocapsicum, Capsicum, Solanum, Cyphomandra, Lycopersicon, Lycianthes). In addition, there is one genus (Atrichodendron) that’s affinity with Solanaceae is debated.

The table 1 shows that the Solanaceae in Vietnam are represented by 15 genera with 63 species. Besides, there are 6 species belonging to 5 genera being doubtful (Table 2). Solanum and Lycianthes are the most diverse genera. Three genera, Solanum (31 species), Lycianthes (7 species) and Physalis (5 species) represent 68% of the total number of species. Capsicum (3), Cestrum (2), Datura (3), Lycium (3) and Nicotiana (2) group only few species. Browallia, Brugmansia, Brunfelsia, Cyphomandra, Lycopersicon, Petunia and Tubocapsicum are represented by only 1 species each (Table 1 and Figure 2).
Comparing with some countries in Asia the number of genera and species of solanaceous plants in Vietnam is diversity of species (Figure 3). Some genera belonging to Solanaceae are not found in Vietnam as *Anisodus*, *Atropa*, *Atropanthe*, *Hyoscyamus*, *Mandragora*, *Nicandra*, *Nierembergia*, *Przewalskia*, *Physaliastrum*, *Physochlaina*, *Salpiglossis*, *Schizanthus*, *Scopolia*, *Solandra* and *Withania*. However, the number of species in *Solanum* is quite large with 31 species (only smaller than China and Taiwan).

### Table 1. Genera and species of Solanaceae in Vietnam

| Sub-family | Tribe | Subtribe | Genus   | The number of species |
|-----------|-------|----------|---------|-----------------------|
| Cestroideae | Cestreae |         | Cestrum  | 2                     |
|           | Nicotianae | Nicotianinae | Nicotiana | 2                     |
|           | Francisceae  |           | Brunfelsia | 1                     |
|           | Browallieae  |         | Browallia | 1                     |
|           | Datureae  |         | Datura  | 3                     |
| Solanoideae | Lycieae  |         | Lycium  | 3                     |
|           | Solaneae  | Physalinae | Physalis  | 5                     |
|           | Iochrominae | Tubocapsicum | 1         |                       |
|           | Capsicinae  |         | Capsicum  | 3                     |
|           | Solaninae  |         | Solanum  | 31                    |
|           | Cyphomandra  |         | Cyphomandra  | 1                     |
|           | Lycopersicon  |         | 1         |                       |
|           | Lycianthes  |         | Lycianthes  | 7                     |

* Genus *Atrichodendron* is not mention in this table.
* Not including the species which being doubtful

### Table 2. List of doubtful taxon belong to Solanaceae in Vietnam

| Genus              | Scientific name              | Reasons                                                                 |
|--------------------|------------------------------|-------------------------------------------------------------------------|
| *Atrichodendron*   | *Atrichodendron tonkinense*  | no herbarium specimen, can belong to Boraginaceae (Ho, 1993)             |
|                    | Gagnep.                      |                                                                         |
| *Cyphomandra*      | *Cyphomandra godefroyi*      | leaves and interpetiolar stipules characteristic of Rubiaceae (Bohs, 1994) |
|                    | Bonati                       |                                                                         |
| *Lycianthes*       | *Lycianthes denticulata*     | no herbarium specimen, unknown distribution                              |
|                    | (Blume) Bitter.              |                                                                         |
| *Lycium*           | *Lycium cochinchinensis*     | no herbarium specimen, excluded from this genus (Zhang et al., 1994)     |
|                    | Lour.                        |                                                                         |
| *Solanum*          | *Solanum mauritianum*        | no herbarium specimen, unknown distribution                              |
|                    | Scop.                        |                                                                         |
|                    | *Solanum virginianum*        | doubt about existence                                                  |
|                    | L.                           |                                                                         |
There are 29 wild species, 22 cultivated species and 12 species being wild and cultivated (Table 3 and Figure 4). Genus Solanum is highly diverse regarding morphological characteristics as well as its distribution in nature and species of Solanum are found everywhere from mountains areas to delta areas. Some wild species are distributed everywhere as Solanum nigrum L. and Solanum torvum
Sw. while some species are only distributed in the mountains areas as *Solanum erianthum* D. Don.

This genus has many species, which are very similar so it is easy to have confusion as *Solanum capsicoides* or *Solanum viarum* (Hop, 2006). Genus *Lycianthes* has 20 native species in South East Asia (Hunziker, 2001) in which 7 wild species in North Vietnam. This shows that Vietnam is also one of the central areas of this genus in Asia (Hop, 2006; Zhang et al., 1994).

Figure 4. Status of solanaceous species in Vietnam

Figure 5. Value of solanaceous plants in Vietnam
Table 3. Species of Solanaceae in Vietnam

| Species                          | Voucher collection                      | Bio. status | Type | Used |
|---------------------------------|----------------------------------------|-------------|------|------|
| **Browallia americana** L.      | Lâm Đồng, V. V. Họp 19 (HN)           | C           | I    | O    |
| **Brugmansia suaveolens** (Humb. & Bonpl. ex Willd.) Bercht. & J.Presl | Lâm Đồng, N. D. Khôi 20 (HN)         | C, W        | I    | M, O |
| **Brunfelsia pauciflora** (Cham. & Schlecht) Bentham. | Phú Thọ, V. X. Phường 7861 (HN)     | C           | I    | O    |
| **Capsicum annuum** L.          | Nghệ An, N. N. Thin 550 (HNU)         | C           | I    | M, O, S, V |
| **C. baccatum**                 | None, recorded in this study           | C           | I    | M, O, S, V |
| **C. frutescens** L.            | V. X. Phường 3705 (HN)                | C           | I    | M, O, S, V |
| **Cestrum elegans** (Brongn.) Schlechter | None, recorded by Ho (1993) and Nhan (1996) | C           | I    | O    |
| **C. nocturnum** L.             | Hà Nội, T. D. Lý 1 (HN)               | C, W        | I    | M, O |
| **Cyphomandra betacea** (Cav.) Sendtn. | None, recorded by G. Bonati (1927) and Nhan (1996) | C, W        | I    | M, O |
| **Datura innoxia** Mill.        | Hà Nội, N. Tạp 2610A-B-C (HNPM)       | C, W        | I    | M, O |
| **D. metel** L.                 | Tuyên Quang, V. X. Phường 6991 (HN)   | C, W        | I    | M, O |
| **D. stramonium** L.            | Hòa Bình, V. X. Phường 1938 (HN)      | C           | I    | M, O |
| **Lycianthes baviensis** V. V. Hop | Hà Tây, Lý-Nhan-Vẻ 237 (HN)          | W           | E    |      |
| **Lycianthes biflora** (Lour.) Bitter | Sơn La, V. X. Phường 16150 (HN)     | W           | N    | M    |
| **Lycianthes bigeminata** (Nees) Bitter | Hà Giang, sine nom. coll. (HN)       | W           | N    | M    |
| **Lycianthes laevis** (Dunal) Bitter | Sơn La, V. X. Phường 16142 (HN)    | W           | N    |      |
| **Lycianthes lysimachioides**    | Hà Tây, Đoàn Trung Quốc 3802 (HN)    | W           | N    |      |
| **Lycianthes macrodon** (Wal. ex Nees) Bitter | Cao Bằng, sine nom. coll. 8295 (HN) | W           | N    |      |
| **Lycianthes neesiana** (Wall. Ex Nees) D’Acry & Z. Y. Zhang | Hà Tây, Đư-Croat 77996 (HN)     | W           | N    |      |
| **Lycium barbaryum**            | None, recorded by Ho (1993)           | C           | I    | M, V |
| **Lycium chinense** Mill.       | Hà Giang, N. K. Đảo 73 (HN)           | C           | I    | M, V |
| **Lycium ruthenicum** Murray    | Hà Nội, sine nom. coll. & sine num. (HNIP) | C           | I    | M, V |
| **Lycopersicon esculentum** Mill. | Hà Nội, 72HN Bách-Tâm 283 (HN)   | C, W        | I    | F, M, V |
| **Nicotiana rustica** L.        | Thanh Hóa, V. X. Phường 10902 (HN)   | C           | I    | M    |
| **Nicotiana tabacum** L.        | eğitim 333 (HN)                       | C           | I    | M    |
| **Petunia hybrida** Vilm.        | Lâm Đồng, V. V. Họp 20 (HN)         | C           | I    | O    |
| **Physalis alkekengi** L.       | Hà Nội, 72HN4 sine nom. coll. 233 (HN) | C           | I    | M, V |
| **Physalis angulata** L.        | Lạng Sơn, N. Đ. Khôi 327 (HN)        | W           | I    | F, M, V |
| **Physalis minima** L.          | Kon Tum, N. H. Hiền 275 (HN)         | W           | I    | M, V |
| **Physalis peruviana** L.       | Lâm Đồng, N. H. Hiền 676 (HN)       | C, W        | I    | F, M |
| **Physalis pubescens**          | None, recorded by Ho (1993)           | C           | I    | F, O |
| **Solanum album** Lour.         | Kon Tum, V. V. Họp 06 (HN)           | C           | N    | M, V |
| **Solanum aethiopicum**         | None, recorded in this study          | C           | I    | M, V |
| **Solanum americanum**          | None, recorded by Ho (1993)           | W           | I    | F, M, V |
| Species                        | Location                  | Biological Status | Type | Abbreviations |
|-------------------------------|---------------------------|-------------------|------|---------------|
| *Solanum capsicoides* All.    | Đà Nẵng, ĐK 7266 (HN)   | C, W              | I    | M             |
| *Solanum cyanocarphium* Blume | Kon Tum, N. V. Hiền 240 (HN) | W                 | N    |               |
| *Solanum diphyllym* L.        | None, recorded in this study | W                 | I    | M             |
| *Solanum dulcamara* L.        | Ninh Bình, ĐK 4805 (HN)   | W                 | I    | M             |
| *Solanum erianthum* D. Don    | Hà Giang, ĐK 6208 (HN)    | C, W              | I    | M             |
| *Solanum ferox* L.            | Khánh Hòa, Poilane 3245 (HM) | W                 | N    | M             |
| *Solanum incanum* L.          | Hà Nội, N. V. Phú 15538 (HN) | W                 | I    | M             |
| *Solanum involucratum*        | None, recorded by Ho (1993) | W                 | N    | M, V          |
| *Solanum laciniatum* Ait.     | Hà Nội, N. V. Phú 16300 (HN) | C                 | I    | M             |
| *Solanum lasiocarpum* Dunal    | Ngọc An, ĐK 4201 (HN)     | W                 | N    | M, V          |
| *Solanum lyratum* Thunb.      | Đà Nẵng, ĐK 3692 (HN)   | W                 | N    | M             |
| *Solanum mammosum* L.         | Lâm Đồng, ĐK 7651 & 7652 (HN) | C, W              | I    | M, O          |
| *Solanum melongena* L.        | Lâm Đồng, ĐK 16306 & 16307 (HN) | C                 | N    | M, V          |
| *Solanum nienkui* Merr. & Chun| Đà Lạt, Đ. T. Nhan 695 (HN) | W                 | N    |               |
| *Solanum nigrum* L.           | Lâm Đồng, ĐK 2565 (HN)   | W                 | I    | F, M, V       |
| *Solanum pittosporifolium* Hemsl.| Cao Bằng, CBL 552 (HN) | W                 | N    |               |
| *Solanum praetermissum* Kerr ex Barnett | Hà Tây, ĐK 20 (HN) | W                 | N    |               |
| *Solanum procumbens* Lour.    | Phú Thọ, N. V. Phú 7658 (HN) | C, W              | N    | M             |
| *Solanum pseudocapsicum* L.   | Hà Nội, V. V. Họp 05 (HN) | C, W              | I    | O             |
| *Solanum robinsonii* Bonati   | Khánh Hòa, N. V. Phú sine nom. (HN) | W                 | E    |               |
| *Solanum seaforthianum* Andr. | Hải Phòng, LX-VN 3229 (HN) | C, W              | I    | O             |
| *Solanum spirale* Roxb.       | Yên Bái, VN 934 (HN)     | W                 | N    | M, V          |
| *Solanum thorelii* Bonati     | Lâm Đồng, ĐK 3344 (HN)   | W                 | E    |               |
| *Solanum torvum* Sw.          | Điện Biên, ĐK 5875 (HN)   | W                 | I    | M, V          |
| *Solanum trilobatum* L.       | None, recorded by G. Bonati (1927), Ho (1993), and Nhan (1996) | W                 | N    | M             |
| *Solanum tuberosum* L.        | Hà Nội, sine nom. coll. 7220 (HN) | C                 | I    | M, V          |
| *Solanum viarum* Dunal        | Phú Thọ, V. X. Phường 8047 (HN) | W                 | I    |               |
| *Solanum violaceum* Ortega    | Hà Giang, V. X. Phường 305 (HN) | C, W              | N    | M, V          |
| *Tubocapsicum anomalum* (Franch. & Sav.) Makino | Lai Châu, ĐK 5915 (HN) | W                 | N    |               |

1 Biological status: W = Wild; C = Cultivated

2 Type: ecological state of a species in Vietnam: N = Native/Indigenous; I = Introduced; E = Endemism

3 Used: F = Fruit; M = Medicine; O = Ornament/decoration; S = Spice; V = Vegetable

Abbreviations: HN = Institute of Ecology and Biological Resources, HNU = College of Natural Sciences - Vietnam National University in Hanoi, HNIP = Hanoi University of Pharmacy, HNPM = National Institute of Medicinal Materials.

The wild species belonging to Solanaceae in Vietnam have common features that grow near forests, wastelands, roadsides and thickets so it is quite convenient for humans to exploit and use them, but also easy to be negatively affected by human activities. The valuable species of solanaceous plants include...
51 species (80.95 percentage of total species), in which 6 species for fruits, 41 species for medicine, 16 species for ornamentals, 4 species for spices and 22 species for vegetables (Table 3 and Figure 5). The important solanaceous species in Vietnam are *Capsicum annuum* L., *Lycopersicon esculentum* Mill., *Nicotiana rustica* L., *Solanum tuberosum* L. and *Solanum melongena* L.. The most important medicinal species is *Solanum procumbens* Lour.

| Botanical name                  | Common name                  | Biological status | Distribution | Type | Used |
|--------------------------------|------------------------------|-------------------|--------------|------|------|
| *Lycianthes baviensis*         | Cà ngũ bà vi                | W                 | N            | E    |      |
| *Lycianthes biflora*           | Cà hai hoa                   | W                 | N/M/S        | N    | M    |
| *Lycianthes bigeminata*        | Cà ngũ cắp đồi               | W                 | N            | N    | M    |
| *Lycianthes laevis*            | Cà ngũ nhân                  | W                 | N            | N    |      |
| *Lycianthes lysiachimoides*    | Cà ngũ đang tran châu        | W                 | N            |      |      |
| *Lycianthes macrodon*          | Cà ngũ cuồng to              | W                 | N/M/S        | N    |      |
| *Lycianthes neesiiana*         | Cà ngũ ness                  | W                 | N            | N    |      |
| *Solanum album*                | Cà pháo                      | C, W              | N/M/S        | N    | M, V |
| *Solanum cyanocarphium*        | Cà trái lam                  | W                 | M/S          | N    |      |
| *Solanum ferox*                | Cà lòng                      | W                 | M/S          | N    | M    |
| *Solanum involucratum*         | Cà tông bao                  | W                 | N            | N    | M, V |
| *Solanum lasiocarpum*          | Cà trái lòng                 | W                 | N/M/S        | N    | M, V |
| *Solanum lyratum*              | Cà đọn                       | W                 | N            | N    | M    |
| *Solanum melongena*            | C                            | C                 | N/M/S        | N    | M, V |
| *Solanum nienkui*              | Cà cùm hoa dài               | W                 | M            | N    |      |
| *Solanum pittosporifolium*     | Cà lâ cúm thào               | W                 | N            | N    |      |
| *Solanum praetermissum*        | Cà đại bao quả               | W                 | N            | N    |      |
| *Solanum procumbens*           | Cà gai leo                   | C, W              | N/M          | N    | M    |
| *Solanum robinsonii*           | Cà robinson                  | W                 | M            |      | E    |
| *Solanum spirale*              | Cà xoắn                      | W                 | N/M          | N    | M, V |
| *Solanum thorelii*             | Cà thorel                    | W                 | N/M/S        | E    |      |
| *Solanum trilobatum*           | Cà ba thùy                   | W                 | M/S          | N    | M    |
| *Solanum violaceum*            | Cà đại hoa típ               | C, W              | N/M/S        | N    | M, V |
| *Tubocapsicum anomalum*        | Ót đáng                       | W                 | N/M          | N    |      |

* Biological status: W = Wild; C = Cultivated
* Distribution: Abbreviations: letters for three areas (N = North, M = Middle, S = South) in Vietnam
* Type: ecological state of a species: N = Native; E = Endemism
* Used: M = Medicine; V = Vegetable;
* Belong to rare genetic resources exchange international in case special (MARD, 2005b)
The indigenous solanaceous plants include 24 species belonging to three genera: *Lycianthes* (7 species), *Solanum* (13 species) and *Tubocapsicum* (1 species) (Table 4).

The indigenous solanaceous species in Vietnam are mostly wild species, in which there are three endemic species including *Lycianthes baviensis* V. V. Hop, *Solanum robinsonii* Bonati and *Solanum thorelii* Bonati.

**CONCLUSIONS**

The results of this analysis show that the Solanaceae flora of Vietnam is very diverse with 15 genera and 63 species. Solanum and Lycianthes are the most diverse species in Vietnam. Solanaceous species are mostly wild species, but the most cultivated species are introduced to Vietnam and there are 51 valuable species including 6 species for fruit, 41 species for medicine, 16 species for ornament, 4 species for spice and 22 species for vegetable. Economic value is mainly in vegetables and medicines. The indigenous solanaceous plants include 24 species belonging to three genera with three endemic species. *Solanum album*, *Solanum melongena* and *Solanum procumbens* are indigenous species with high value.

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