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Traditional Medicine Analysis and Sustainable Use of Korean Pond Wetland Plants in the Agricultural Landscape

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Abstract: This study surveyed the most commonly observed plants at 40 pond wetlands in rural villages in Korea and assessed their use patterns in traditional medicine (TM) with reference to the contents of the Korea Traditional Knowledge Portal (KTKP). In this survey, 457 taxa in 108 families were identified. For these, there are use patterns in TM for 314 taxa; overall, 68.8% of the surveyed plants have uses in TM. The 314 taxa that have applications in TM involve 596 types of disease treatment and 771 types of efficacy. On average, for each taxon, there are 4.0 types of efficacy and 6.6 types of disease treatment. TM from 210 taxa have been described as applied to organs in 10 regions of the body: liver 123, lung 82, spleen 57, stomach 57, heart 45, large intestine 43, kidney 40, bladder 23, small intestine 16, and gall bladder 8. The results of this study will help support the conservation of pond wetlands that provide national biodiversity and various ecosystem services, by increasing the recognized value of pond wetlands even when they are no longer used in farming. Thus, this study can support educational materials for eco-experience and can be applied in the conservation of Korean pond wetlands.

Keywords: traditional knowledge (TK); plant diversity; conservation; oriental medicine; agricultural landscape

1. Introduction

As rural and agricultural landscapes have given rise to various sustainable cultural spaces, land uses have developed to support traditional human activities [1]. There is thus an interface between nature and culture, characterized by factors of the environment, ecology, natural resources, biodiversity, landscape, land uses, and human culture [2–7].

Korea's main food staple is rice, with extensive paddy fields and water required for its production. However, Korea's environment and weather do not make it easy to produce rice. Production in winter has not been possible, and the required water depended on rainwater supplies alone. Further, all crops produced in rural areas were challenged by a lack of water. For this reason, Korea's agricultural landscape has included many pond wetlands [8,9].

Pond wetlands were originally small irrigation facilities made for rice farming. However, in recent years, they have been taken out of such use, as a result of the construction of large-scale dams [10,11]. Nevertheless, these places are a part of Korean farming culture and have been evaluated not only as water reservoirs but also as ecosystems with rich biodiversity. These wetlands have value as ecology resources, which in turn may contribute to knowledge in food preparation, traditional medicine

(TM), folk medicine, agriculture, and crafting [9,10,12–14]. Since pond wetlands are transitional areas between land and water, they represent habitats of a high number of plant species, including aquatic, floating, emergent, floating-leaf, and land plants. Therefore, the conservation, maintenance, and management of wetlands are very important [15–17]. In the Million Ponds Project in England, the importance of pond conservation has been promoted, and citizens collaborate in the restoration of these ponds [18].

Traditional knowledge (TK), traditional environmental knowledge, and traditional ecological knowledge (TEK) refer to inherited tangible and intangible resources throughout generations, including ecology, cultural conventions, knowledge, history, economy, customs, and rituals [19–21]. TK inherited from the past is still used in disciplines such as medicine, pharmacology, and science.

In order to conserve various resources, values need to be assigned to them. The use pattern for plant resources in TM is part of the history passed down from Korean ancestors. In recent history, the application of plant resources has led to the development of products like aspirin and Tamiflu, using Western science; therefore, pond wetland plants are considered to have very high value [22]. However, the TK of plant resource use has been overshadowed by the gains of Western medicine, advances in agriculture, and Westernization of food culture, such that the value of plants is no longer well recognized. Nevertheless, the marketability of some plant species represents more than $200 million per year in industries that use plants [23]. The Nagoya Protocol for protecting the rights to TK and sharing profits derived from that knowledge was adopted at the 10th general meeting of the Convention on Biological Diversity in 2010 [24]. This protocol recognized education about use patterns in TM as a valuable and essential field [25]. Recently, growing recognition of TK and TEK has drawn attention to their contributions to the conservation of ecological resources and biodiversity [26,27]. Additionally, significant efforts have developed to conserve TEK and cultural landscapes [28–31]. Thus, improving the TK regarding pond wetland plants may increase people's experiences and interactions with these wetlands.

The demand for agricultural tourism in Korea increases continuously, and there are now about 1900 operational agricultural tourism villages [32,33]. Relatedly, studies have examined the successful management of tourism villages, planning and management of tourism, and tourism development, including content development, resource utilization, and environmental issues to address [16,34–38]. With about 2.3 pond wetlands per agricultural village in Korea, efforts are being made toward utilizing these for wetland ecological experience and educational material [8,9,39]. Thus, TEK and the ecological resources of pond wetlands must be considered together in terms of social activity and ecological conservation [40,41].

In summary, Korea's pond wetlands have lost their value in terms of water use. However, they play an important role in national biodiversity. It is necessary to increase awareness of the importance of these spaces and to sustain them. One possible method involves promoting an experience of ecology in which agriculture, plants, and TM are connected. Therefore, in the present study, we asked two research questions: "How many plants used in TM are found in Korean pond wetlands?" and "How have these plants been used?"

The present study surveyed plant resources in pond wetlands and aimed to analyze the patterns of their use in TM. The plants most commonly observed in the survey inventory were selected for preferential application in developing contexts for experience. The results of this study contribute to educational data on agricultural and ecological experiences aimed at improving awareness of the value of pond wetlands in agricultural villages. The study also demonstrates the value of these resources with respect to TK and TM, thereby increasing their conservation value, and, hence, enhancing national biodiversity and the potential for various ecosystem services.

2. Materials and Methods

2.1. Study Sites and Plant Survey Methods

Forty study sites (see Figure 1 and Table S1) were selected from the ponds in rural areas across various agricultural tourism villages throughout Korea [42]. These study sites were chosen to include various land sizes, water depths, construction, regions, and land uses. The mean water area at these study sites was 733.3 m^2, and the mean total area was 1137.1 m^2. The mean water depth was 0.79 m and the maximum water depth was 1.13 m; thus, the ponds were all shallower than 2 m, the water depth threshold for wetlands, according to Cowardin [43] and Ramsar [42]. For each pond, the year of construction was identified through an interview with the owner, and the mean age of the sites was found to be 28.48 years. As an estimate, the oldest site dated back 105 years or further. The frequency of artificial water use was 5.63 times on average.

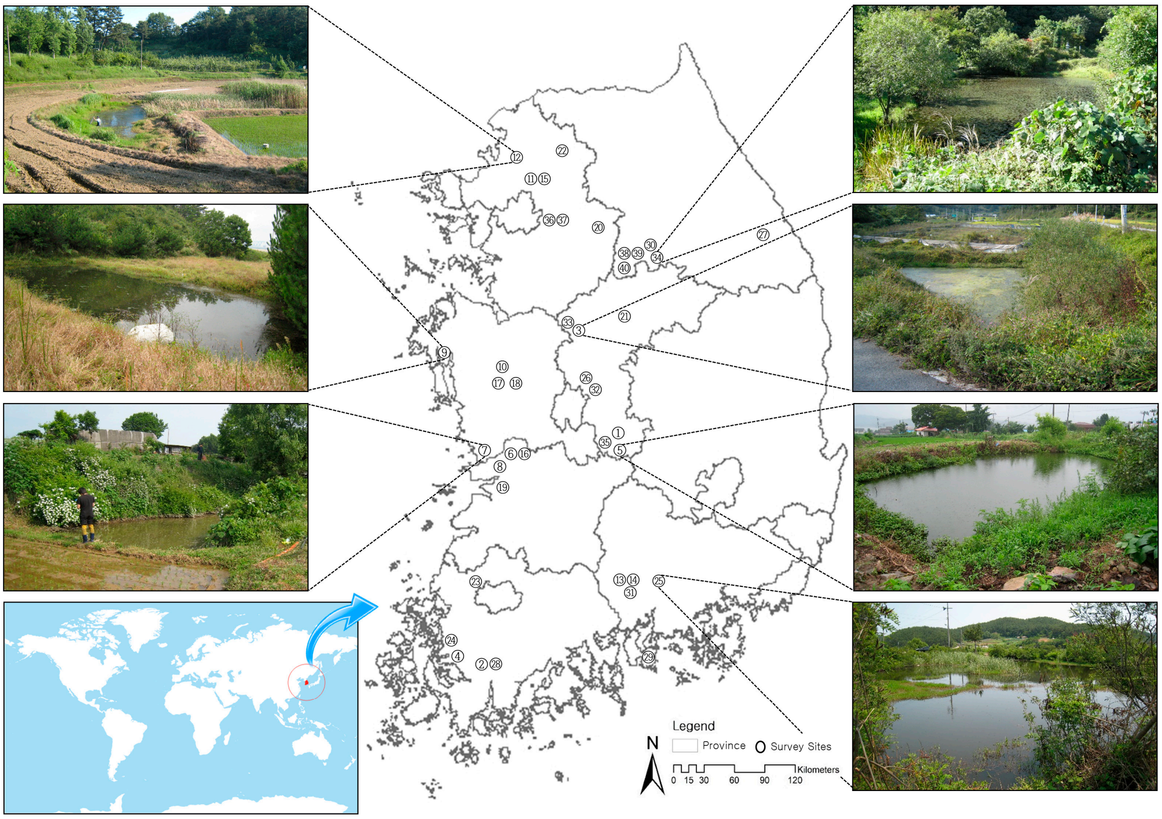

Figure 1. Map of locations of the 40 study sites, with photographs of selected sites.

For the survey, plants were identified and recorded using illustrated reference books [44,45]. Survey times were across two sessions held in May (spring) and September (autumn) 2012 because it was a general plant survey of the four seasons in Korea [9,10,25,39]. Braun-Blanquet survey method was employed for the field survey. Three quadrats (2×2 m^2) were installed at each site [46]. Some sites did not have enough space, so quadrats measuring 1×4 m^2 (equal area with a different shape) were installed. The species noted were classified into families and species, using established plant taxonomical classification.

2.2. Analysis of Use Patterns of Plant Resources in Traditional Medicine

As a basis for evaluating the use patterns of the investigated plants in TM, 5500 data items relating to medicinal herbs were retrieved from the Korea Traditional Knowledge Portal (KTKP), which is maintained by the Korean Intellectual Property Office (KIPO) [47]. The KTKP classifies all available information on medicinal herbs into applicable plant parts, efficacy, diseases, taste perceptions, and affected organs. This information mainly comprises data organized according to Ungok Herbology [48], which uses Dongui Bogam as its main reference [49]. In order to catalog and classify the data, the inventory was sorted to reflect the use patterns in TM, efficacy, and the number of indications. Furthermore, the data were classified according to the plant parts used and the functional organs in the human body to which the use applied. The plant parts noted were assigned the status of whole plant, aerial part, root, leaf, fruit, seed, flower, stem, bark and epidermis, branch, or other parts, based on the information available on the KTKP [47], while the affected organs in the human body were assigned as the liver, lung, spleen, stomach, heart, large intestine, kidney, bladder, small intestine, and gall bladder; and frequencies of mention of these organs were identified.

A correlation analysis was conducted to probe the relationship for the pond wetlands between basic information (e.g., land size, legacy, water depth, water usage, and altitude), the number of plant species, and the number of species for which there was TK. The statistical analysis used SPSS 19.0.

3. Results and Discussion

3.1. Characteristics of Plant Resource Distribution at the Study Sites

In total, 305 taxa, comprising 92 families, were identified in May 2012, consisting on average of 22.3 families, 34.3 genera, 30.1 species, 6.1 varieties, 0.2 forms, and 0.1 subspecies (Site 1). In September 2012, in total, 319 taxa were identified, consisting on average of 22.0 families, 35.7 genera, 34.2 species, 5.1 varieties, 0.2 forms, and 0.1 subspecies (Site 1).

Across the 40 study sites, on average per pond, 36.38 species (22.25 families) were observed in May and 39.58 species (21.95 families) were observed in September. Overall, 61.23 species (31.13 families) were observed during the study period. The results showed that approximately 17 species appeared more often in the September survey than in the May survey. The total, minimum, maximum, and mean counts for each taxonomic level are shown in Table 1. In total, 457 plant taxa belonging to 108 families were identified at the 40 study sites, indicating that pond wetlands are significant regions for diverse vegetation. The results revealed that pond wetlands had similar plant species than detention ponds, mountain wetlands, reservoirs, and lakes in studies that investigated different wetlands [39,48,49], although pond wetlands were smaller size than these other resources [39,50–56].

Table 1. Taxonomic classification at the 40 study sites.

Classification		Family	Genera	Species	Variety	Forma	Subspecies	Taxa
May	Min.	11	17	15	2	0	0	17
	Max.	35	52	48	10	1	1	56
	Mean	22.3	34.3	30.1	6.1	0.2	0.1	36.4
	Total	92	220	226	36	2	1	305
September	Min.	10	15	14	0	0	0	16
	Max.	39	68	67	12	1	1	80
	Mean	22.0	35.7	34.2	5.1	0.2	0.1	39.6
	Total	95	236	273	41	4	1	319
Total	Min.	15	30	24	4	0	0	31
	Max.	47	89	89	18	1	1	105
	Mean	31.1	54.0	51.5	9.3	0.3	0.2	61.2
	Total	108	309	392	59	5	1	457

The distribution of cultivars that emerged in the entire study site was 53 types (11.6%) of chrysanthemum and 46 types (10.1%) in the rice family, with similar distributions in both the May and September surveys, followed in advent rate by legume, Rosaceae, Sedgeaceae, Nodalaceae, lily, stone porridge, and honeybee. This is the same pattern that is found in the general wetland survey in Korea and can thus be regarded as a representative advent pattern for wetland plants in Korea [10,39,57–59].

Ecotourism in Korea attracts many visitors to the demilitarized zone (DMZ), Suncheon Bay, and Ramsar wetlands. However, these are observation-centered learning centers where preservation is prioritized. Therefore, pond-type wetlands where more than 60 species of plants can be collected and used annually can provide an attractive location for ecological experiences. For this reason, pond-type wetlands are important resources that can be used for field trips [60]. Field trips to wetlands focus on finding plants and learning their life history. From this point of view, plant species in pond-type wetlands are viewed as providing important learning contexts [61]. If TK, the focus of this study, is used in education, it offers an opportunity to develop contents that link history, tradition, ecology, biology, and medicine. The high vegetation density found in this study suggests that these study sites can be considered valuable spaces for ecological experiential learning.

3.2. Taxonomic Classification of Plants Used in Traditional Medicine

Using the KTKP, this study obtained information on 457 taxa and analyzed their use patterns in TM (Table 2 and Table S2). The information accessed applied to use patterns in TM for 206 (67.5%) of the 305 taxa identified in May and for 236 (74.0%) of the 319 taxa identified in September. In total, 314 (68.8%) of the 457 taxa were linked to accessed use patterns in TM (Table 2). Although only about 20% of the total 10,187 plant taxa that have been identified in Korea contribute to TK [62], this study showed that about 70% of the plants identified while surveying the pond wetlands have contributed to TK. This high differential was probably because the plants in this study were identified in farmlands close to human habitats, and thus, details on their use patterns were available.

Table 2. Plant taxa and number of reported uses in traditional medicine (TM).

Classification		Family	Genera	Species	Variety	Forma	Subspecies	Taxa
May	TM	85	176	180	24	1	1	206
	None	40	79	86	12	1	0	99
September	TM	87	189	199	33	3	1	236
	None	34	70	74	8	1	0	83
Total	TM	100	237	149	45	3	1	314
	None	50	110	127	14	2	0	143

The average number of individual advent species in 40 sites was 36.4 in one site in May, and on average 28.0 taxa (77.5%) of those species had a connection to TK. In September, 39.6 species were found as a survey average, and 77.9% of them were species used within TK. The total number of species investigated in the two surveys was 61.2 taxa in one target area, of which 46.6 taxa, or 76.0%, were found to be species used in traditional Korean folk medicine. This study evaluated whether the number of medicinal plant species was related to the number of survey plant species, using correlation analysis (Table 3). This study then evaluated whether the growth environment (e.g., size and water depth) affected the number of observed plant species, through correlation analysis (Table 3). In general, reports indicate that more plant species are found in larger and deeper wetlands [56]. The analysis results of this study showed that the number of advent species in wetland plants was not significantly related to size, water depth, altitude, construction, or usage. The results suggest that a small wetland may have as many plant species as a large wetland.

Table 3. Correlation analysis for growth environment and number of species.

	Ssz	Tsz	Alt	Depmn	Depmx	His	Nwud	NMs	NSs	NTs	MMs	MSs
Tsz	0.981 **											
Alt	0.054	0.032										
Depmn	0.578 **	0.587 **	−0.043									
Depmx	0.692 **	0.701 **	−0.031	0.946 **								
His	−0.211	−0.221	0.089	−0.039	−0.051							
Nwud	0.663 **	0.634 **	−0.084	0.785 **	0.838 **	−0.056						
NMs	0.309	0.363 *	−0.118	0.304	0.307	0.101	0.295					
NSs	0.014	−0.011	0.160	−0.083	−0.068	0.264	−0.206	0.321 *				
NTs	0.183	0.196	0.034	0.169	0.189	0.273	0.107	0.745 **	0.707 **			
MMs	0.211	0.261	−0.066	0.238	0.235	0.183	0.215	0.966 **	0.389 *	0.757 **		
MSs	−0.059	−0.081	0.162	−0.107	−0.098	0.312 *	−0.236	0.304	0.974 **	0.727 **	0.382 *	
MTs	0.062	0.072	0.067	0.110	0.119	0.360 *	0.017	0.654 **	0.740 **	0.963 **	0.716 **	0.793 **

** Correlation is significant at the 0.01 level. * Correlation is significant at the 0.05 level. Ssz: water surface size; Tsz: total size; Alt: altitude; Depmn: average depth; Depmx: maximum depth; His: history; Nwud: number of days per year using water; NMs: number of surveyed species in May; NSs: number of surveyed species in September; NTs: total number of surveyed species; MMs: number of surveyed TM species in May; MSs: number of surveyed TM species in September; MTs: total number of surveyed TM species.

TM in East Asia, including Korea, with a history of more than 3000 years, was used to treat all diseases until the 19th century [63–66]. In this historical sense, Korean TK may have discovered and recorded the efficacy of these common plants in treating disease. Another reason for the discovery that 76% of the plants surveyed have been used in TM is that local people may easily locate these plants. In fact, until recently, people in rural areas have used these plants to treat mild diseases such as cough, indigestion, and fever [67].

In addition, 69% of Koreans report that they have experienced the use of traditional medicine [68]. Education that focuses on TM and ecology using plants that can be commonly observed where people live invokes their interest.

Since the sites in this study are mainly used for wetland experience education, the use patterns of aquatic wetland plants in TM need to be assessed carefully. In total, 35 wetland plants were identified, of which 22 (62.9%) are found to have use patterns in TM: *Potamogeton distinctus*, *Potamogeton cristatus*, *Spirodela polyrhiza*, *Lemna paucicostata*, *Trapa japonica*, *Monochoria korsakowii*, *Leersia japonica*, *Zizania latifolia*, *Typha orientalis*, *Typha angustata*, *Scirpus tabernaemontani*, *Scirpus triqueter*, *Nelumbo nucifera*, *Nymphaea tetragona* var. *angusta*, *Nymphoides peltata*, *Nymphoides indica*, *Ottelia alismoides*, *Acorus calamus* var. *angustatus*, *Sagittaria trifolia*, *Alisma plantago-aquatica* var. *orientale*, *Alisma canaliculatum*, and *Sagittaria trifolia* var. *edulis*. Teaching with the 22 aquatic wetland plant taxa would thus require development of learning content; since the families Compositae, Leguminosae, Rosaceae, and Gramineae made up a large proportion of these plants, these families can become the focus of learning and experiences. Based on the previous experience of the authors of this study, vegetation education can be improved using annual plants and hemicryptophytes that are quite abundant. Education focused on aquatic plants can be provided in terms of the structure of wetlands, building an effective basis for understanding wetland ecology. Recent studies have shown an increase of wetland plants in ecological learning, so learning content must be developed that describes these plants, even without TK [9,69].

3.3. Plant Parts and Plant Resources

Analysis of the 314 pond wetland plant taxa that connected with use patterns in TM was conducted, considering the information obtained from the KTKP describing which plant part was used (Figure 2). Of the 314 taxa, 304 contained information about the plant part used, and the total number of used parts was 342, corresponding to a mean of 1.13 active parts per taxon.

The most commonly used part was the aerial part (104 taxa, 30.4%), followed by the root (80 taxa, 23.4%), leaf (28 taxa, 8.2%), fruit (22 taxa, 6.4%), and whole plant (18 taxa, 5.3%). These results are consistent with the analysis of folk plants in the inland area of Chungnam Province [70,71].

The roots of 98 taxa had recorded uses, including 18 taxa where the part used was the entire plant, corresponding to about one-third of the range of uses noted. Roots have been widely used in TM because they contain higher levels of bioactive and other compounds [25,70,71]. *Achyranthes japonica* roots have been widely used in treating neuralgia and arthritis, on Ulleungdo Island and in the inland area of Chungnam Province [25,70]. The medicinal name of *A. japonica* in KTKP was useulgyeong; its roots are used and act on the liver and kidney. According to the information provided, it is effective in ganggeungol (strengthening muscles and bones), baenong (draining pus), bogansin (protection of the liver and kidney), saneohyeol (unraveling blood clot), soongjong (detoxification effect), and jitong (pain killing effect). Its use is effective to counter gyeongpye (amenorrhea), nansan (dystocia), sajiguryeon (muscle shrinking disease of arms and legs), sanhuhyeoreoboktong (postnatal abdominal pain due to blood clot), ongjong (swelling symptoms caused by poor blood circulation), yoseulgoltong (pain in the bones of the waist and the knee), imbyeongnyohyeol (hematuria), jiltasonsang (various symptoms caused by external trauma), and hubi (throat swelling symptoms).

Fruits of 22 taxa were used, of which the majority came from trees, including *Staphylea bumalda*, *Styrax obassia*, *Trapa japonica*, *Melia azedarach* var. *japonica*, *Ligustrum obtusifolium*, *Morus bombycis*, *Akebia quinata*, *Corylus heterophylla* var. *thunbergii*, *Sorbus alnifolia*, *Crataegus pinnatifida*, *Chaenomeles lagenaria*, *Quercus aliena*, and *Quercus acutissima*. In addition, analysis showed use of the fruits of *Persicaria lapathifolia* of Polygonaceae, *Persicaria hydropiper*, and *Persicaria sieboldii*. These three Persicaria generic plant fruits were found to be mainly used for antipyretic treatment. Wild fruits may be a food source [72], are an important source of vitamins [73], and can be used to treat various diseases [74]. Fruits contain bioactive compounds that can be used as medicine [75–81]. In the past, the fruits of *Trapa japonica*, a wetland plant, were used in making porridge for food [47]. Moreover, *Diospyros kaki* and *Akebia quinata* have been important sources of sweetening in the past when fruits were not commonly available.

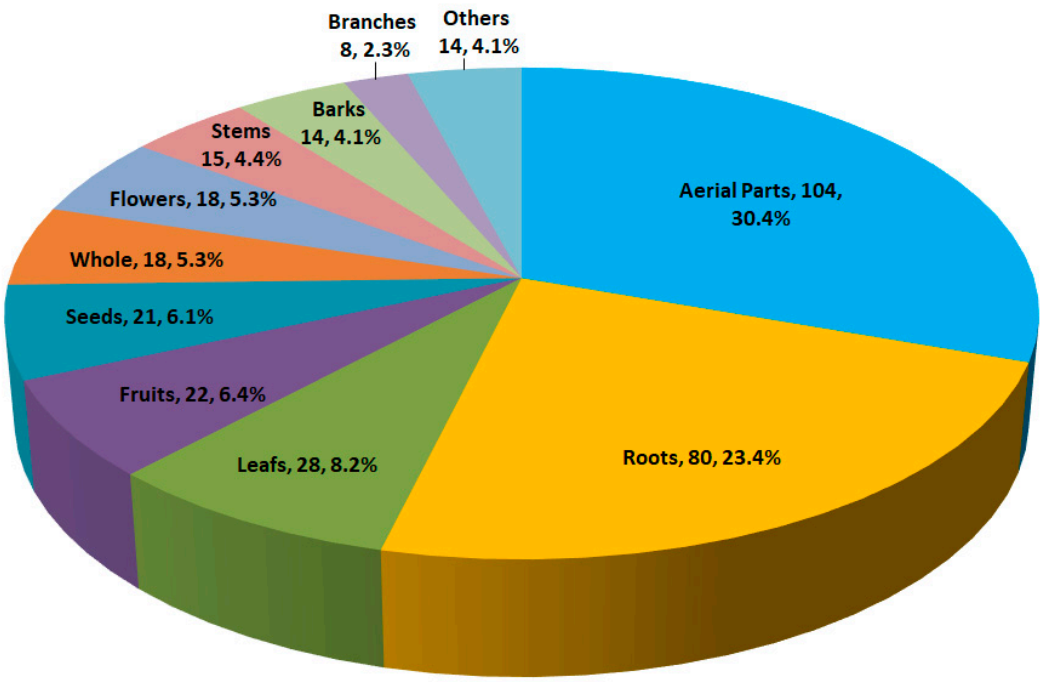

Figure 2. Plant parts utilized in traditional medicine, as percentages of 304 plants.

In addition, the analysis found plants where the seeds were used, including *Melandryum firmum*, *Brassica juncea* var. *integrifolia*, *Capsella bursa-pastoris*, *Draba nemorosa* var. *hebecarpa*, *Ipomoea purpurea*, and *Pharbitis nil*. TM using the seeds of wild plants mainly uses the oils extracted from them [82,83]. Extracting oil from seeds has an extensive record in TK, and in addition to medicinal use, oils have functioned as fuels and chemical materials [84]. However, it is possible that seeds are used less frequently than other plant parts because it is difficult to collect them when the period of their production is short.

Plants from which the bark or epidermis have been used include *Fraxinus rhynchophylla*, *Betula platyphylla* var. *japonica*, *Celtis sinensis*, *Magnolia obovata*, *Albizia julibrissin*, *Ailanthus altissima*, *Hibiscus syriacus*, and *Acanthopanax sessiliflorus*. Consider than in order to use bark, it first takes years or decades for a plant to become a tree. Bark has been used often because substances beneficial to humans are heavily accumulated in it. In fact, bark has been a useful traditional medical component in many parts of the world [85–87].

Plants where the flowers have been used include *Rhododendron yedoense* var. *poukhanense*, *Iris nertschinskia*, *Impatiens balsamina*, *Styrax japonica*, *Chrysanthemum boreale*, *Chrysanthemum indicum*, *Nymphaea tetragona* var. *angusta*, *Robinia pseudoacacia*, *Impatiens textori*, *Camellia japonica*, *Lagerstroemia indica*, *Calystegia sepium* var. *Americana*, *Lonicera maackii*, *Callistephus chinensis*, and *Hosta longipes*. Flowers generally produce a pleasant scent [88]. Flowers have also been used for food and decorative materials due to their beauty, rather than their medicinal purposes [89,90]. Moreover, many flowers have nectar, so that insects such as bees and butterflies are drawn to them [91–95]. However, the period of flower blossoms is short. Therefore, flowers are used less often than roots and leaves. People generally enjoy flowers, and flowers draw high educational interest. Therefore, education around plant flowers using connections to chemistry, insects, medicine, and tradition is attractive, and chemical components can be studied at the same time.

Other plant parts utilized have been ashes after burning for *Chenopodium album* var. *centrorubrum*, and *Equisetum arvense*, heartwood for *Cercis chinensis*, and the stamen for *Nelumbo nucifera*.

3.4. Affected Organs for Plant Resources

For the plants considered from the pond wetlands, information was found in the KTKP on target organs in the human body for the 314 taxa that showed use patterns in TM, as analyzed here (Figure 3, Table S3). Out of the 314 taxa, for 210 there was information on affected organs, and the total number of target organs was 494, corresponding to a mean of 2.35 organs per taxon. Specifically, the most frequent target organ was the liver, for 123 taxa, followed by the lungs for 82 taxa, spleen for 57 taxa, stomach for 57 taxa, heart for 45 taxa, large intestine for 43 taxa, kidney for 40 taxa, bladder for 23 taxa, small intestine for 16 taxa, and gall bladder for 8 taxa. Traditional Chinese Medicine (TCM) classifies the range of operating human organs into 11 categories, including pericardium, which is one more than the 10 categories examined by this study [96]. Moreover, TCM classifies the 11 organs as Zhongs (heart, liver, spleen, lungs, and kidneys) and Fus (bladder, gall bladder, stomach, small intestine, large intestine, and pericardium). The analysis in this study did not include the TCM information on the pericardium. The relationships and interactions between Zhongs and Fus include complex philosophical approaches to concepts such as the universe, the earth, nature, and time [97]. Thus, advance study and preparation are required in developing educational content for the relationships of target organs in terms of Zhongs and Fus.

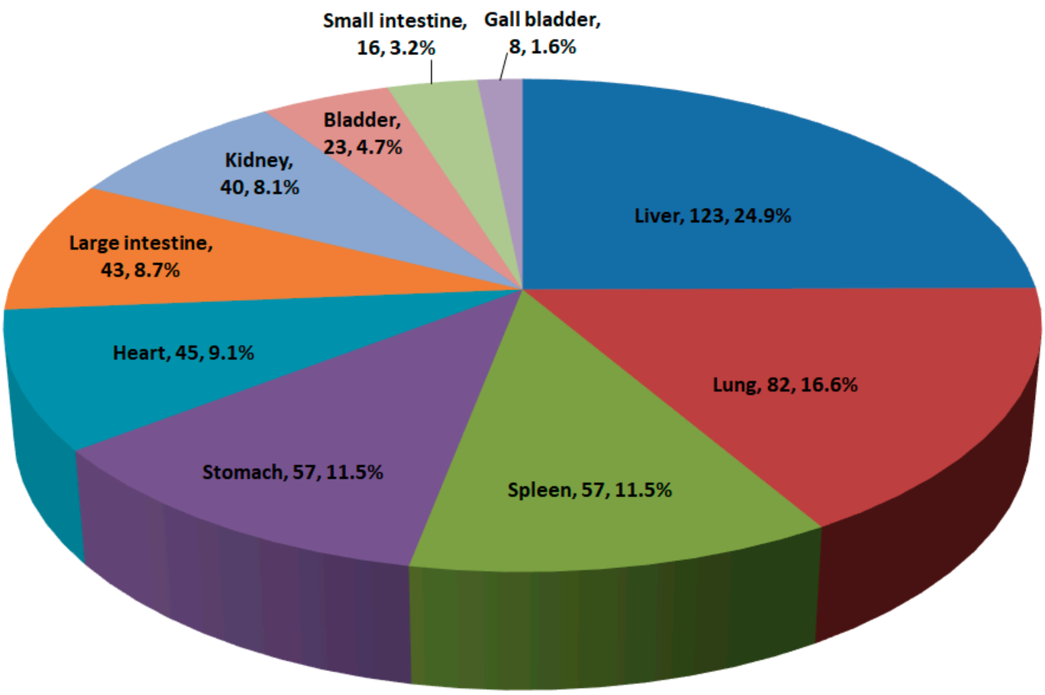

Figure 3. Affected organs reported in traditional medicine, as percentages of 201 plants.

The taxa with the highest number of affected organs were *Commelina communis*, which was reported to act on six organs, including the liver, large intestine, small intestine, spleen, kidney, and heart. Information on how to use this plant is also contained in TCM [98]. Moreover, the KTKP reported that this plant had four efficacies and was effective in treating 13 symptoms [47]. *Commelina communis* is classified as UPL (an obligate upland plant) according to the classification of wetland plants [99]. However, since it is frequently observed in general wetland surveys conducted in South Korea, it can be selected as an educational wetland species [100].

The information describing which part of each plant is efficacious is provided in the supplementary. However, since use patterns found in TM for 104 out of the 314 plant taxa had no information on target organs; these need to be studied systematically, while the information for the remaining 210 plant taxa needs to be verified and elucidated based on modern medicine.

3.5. Sustainable Use of Pond Wetlands by TM Education

Out of 314 taxa, 307 had information about 596 types of effects, and the total number of effects was 1120, corresponding to a mean of 3.89 effects per taxon. The effect types seen with the highest frequency were antipyretic, detoxification, anti-inflammatory, eyesight improvement, hemostasis, diuretic, disinfestation, removal of pathogen from blood, pain killing, improving blood circulation, antirheumatic, and anticoughing. Out of the reports on the 314 taxa, those for 290 taxa contained information about 771 types of efficacy, and the number of total indications was 1921, corresponding to a mean of 6.62 indications per taxon. The indications named in the highest proportions were various symptoms caused by external trauma; hematemesis; shigellosis; jaundice; vaginal bleeding symptom due to uterine hemorrhage; edema; collective terms for symptoms of swelling and pain in the throat; bloody stools; symptoms with reduced urine amounts; difficulty in urination; stopped urination due to blockage; pains in arms and legs; swelling and pain in the eyes and inflamed eyes; bleeding caused by reasons other than injury like nose bleeding; bloody urination symptoms; injury from a viper bite; scrofula at the back of the neck, the back of ears, armpits, or the groin; lump in the breast; erysipelas; and carbuncle. This body of information is vast. The amount of information is so large so that it is difficult to describe in detail what kinds of species are available. Therefore, an additional set of specialized explanations will need to be developed for educational textbooks.

Of the pond wetland plants considered here, 314 taxa in which TM use patterns could be identified were subjected to analysis of related information summarized in the KTKP on their efficacy and indications. In total, for 307 taxa there was information on 596 types of effects, corresponding to a mean of 3.89 types of effect per taxon. In terms of the indications for use, 290 taxa with 771 indications were identified, corresponding to a mean of 6.62 treatment indications per taxon. There were 210 taxa for which the information included affected organs. On average, 61 species were surveyed per site and traditional use information for 46 species among them was confirmed. Contents regarding the effects, indications, and affected organs reached 500 items for one wetland site.

Education has now become an important value in people's travels [101,102], and rural, cultural heritage, education, health, and ecotourism approaches continue to evolve [34,37,103,104]. Moreover, a travel niche focused on medicinal herbs and ecology is emerging [105–107]. Therefore, the pond wetlands in rural areas, the main target space of this study, may have very important value that can be utilized for rural tourism, ecological tourism, and educational tourism connecting wetlands, ecology, plants, TK, and medicine. Additionally, if the TM results of pond-type wetlands are used for education, the perception that the space has high biodiversity can be improved. This improvement in public awareness will help the sustainable conservation of the space where water is not needed.

4. Conclusions

Many plants have uses for a variety of purposes, including food, farming, and crafting, and in TM have they considerable historical significance. With increasing farm tours in Korea, educational materials around agricultural tourism are beginning to be developed. For the study, plants in pond wetlands were investigated, and their use patterns in TM were analyzed with the aim of applying this knowledge in education.

This paper provides the results of a survey of the plants commonly found at 40 pond wetlands in rural areas of Korea and it assessed the TM use of these plants. Altogether, 68.8% of the surveyed plants around pond wetlands have been used in TM. Up to 500 content items related to TK can be generated at a single pond wetland. The content developed from the present analysis offers potential in the development of educational data for ecological experiences in agricultural villages. By increasing recognition of the value of pond wetlands in agricultural villages that no longer utilize these in farming, the conservation significance of pond wetlands can improve, providing support for national biodiversity and various ecosystem services.

Although results of the present study showed various effects and indications for pond wetland plants, the terms describing their interactions can be too difficult for direct adoption into education content development, and reference materials for the education of the general public or students are lacking; hence, a systematic organization of such information and materials is needed to make these concepts accessible.

For these reasons, this study has limitations, as follows. It is difficult to provide additional explanations for the causal relationships among plants, ecology, chemical components, action sites, effects, and efficacies. Moreover, education can be more effective by making available information on the medical definitions of affected organs in TM and Western medicine. This study suggests that TM information could be used in the educational content for rural and ecological tourism. However, this study could not extend to the wide range of information available for direct use in such education. Therefore, it is necessary to develop plant education content using this result in follow-up studies.

Supplementary Materials: The following are available online at http://www.mdpi.com/2071-1050/12/15/5963/s1, Table S1: Land and water conditions of the 40 survey sites, Table S2: The plant survey and classification as medicinal plants for the 40 study sites, Table S3: The list of 314 traditional medicinal plants for use in ecological experiences.

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