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Why *Musella lasiocarpa* (Musaceae) is Used in Southwest China to Feed Pigs

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Introduction

This study seeks to understand the usage of *Musella lasiocarpa* as pig fodder in southwest China by investigating its cultivation, consumption quantities, and nutrient composition. A previous report on the ethnobotany and conservation status of *Musella lasiocarpa* highlighted the importance of this plant for its multiple uses and services (Liu et al. 2003). The research presented here, which is a follow up effort to the previous study, is a step toward a more comprehensive exploration of the cultivation potential of *Musella lasiocarpa* for food and fodder in an expanded geographic area.

Musella lasiocarpa (Franch.) C. Y. Wu ex H. W. Li (Fig. 1), with synonyms of *Musa lasiocarpa* Franch. and *Ensete lasiocarpum* (Franch.) E. E. Cheesman, is a species of a monotypic genus in the Musaceae family. It is endemic to the watersheds of the Upper Yangtze River and its branches between Yunnan and Sichuan provinces in southwest China (Wu and Kress 2000). Wild populations of *Musella* are found around cliffs in northern Yunnan and southern Sichuan. This plant is adapted to broad ecological conditions; it is able to withstand dry, cold, and mountainous environments.

The literature on uses of *Musella lasiocarpa* focuses on practices by Han Chinese communities and reports that it is primarily used as fodder and, to a lesser extent, in the human diet. Aside from fodder and food, our previous research in the communities of Yunnan's minority cultural groups shows that *Musella* is valuable for soil and water erosion control, weaving material, medicine, wine–brewing, and as a source plant for honey during the winter season (Long 1997; Liu et al. 2003). Recently, some horticulturalists from the United States, United Kingdom, European Union, and Japan have taken an interest in the commercial development of this resource as an ornamental. While the chemical composition of *Musella* previously has been documented (Qin et al. 2000; Yang et al. 2001), no studies have reported on its nutrient content or extent of use. Given this lack of research, coupled with *Musella's* extensive use in southwest China and broad ecological adaptation, we investigated its cultivation, quantities consumed as pig fodder, and nutrient composition in order to understand the rationale for its usage and development potential.

Methods

Survey and Study Sites

Fieldwork was conducted in southwest China between 2003 and 2006 using participatory rural

appraisal (PRA) methods in communities where *Musella lasiocarpa* has a long history of being cultivated. This includes the central Yunnan prefectures Chuxiong, Dali, Lijiang, Kunming, Yuxi, and Honghe. We further selected four townships in Chuxiong and Kunming as our case study sites: Qianjin, Tanhua, Xiaohe, and Hongtudi. The cultural groups in the communities studied include Han, 14 branches of Yi, and one branch of Miao (referred to as Hmong in countries outside of China). The Yi branches that cultivate *Musella* include the Axi, Azhepo, Ganyi, Lipu, Luoluopu, Luolupo, Naluo, Nasu, Naisupo, Niesupo, Nuosu, Sani, Taliu, and Talusu; the Miao branch includes the Ameng, also known as the Dahuamiao. We interviewed 213 informants (10% of the total population) from 144 households (representing 38% of total households) at the case study sites to gather data on the *Musella*'s cultivation systems and the amount fed to pigs annually per household compared with other fodder. Our informants include 66% Han, 28% Yi, and 6% Miao.

The elevation of the study sites ranges from 1,570 to 2,637meters (m) above sea level and the annual rainfall fluctuates between 1,200millimeters (mm) and 1,800mm. Locals primarily follow traditional dry–land agriculture practices where they grow wheat, barley, buckwheat, corn, and other upland crops, including *Musella*. Some farmers manage a few areas of rice paddy fields. Pigs are valued as the most important domestic animal. Other livestock kept by local communities include goats, cattle, and buffalo.

Nutrient Composition

We collected *Musella lasiocarpa* individuals from Hongqiang community of Chuxiong Prefecture in November 2004 to examine the content of protein, starch, fat, other carbohydrates, and vitamin C. Plants were separated into six parts including root, rhizome, pseudostem, leaf (blade and petiole), inflorescence, and fruit. Samples were randomly selected from five *Musella* individuals and were sliced into small pieces and dried indoors for nutritional composition analysis.

The Association of Official Analytical Chemists (AOAC) methods were used to analyze protein (method 984.13; AOAC 1990), fat (method 920.39; AOAC 1990), starch, and other carbohydrate (method 32.2.05; AOAC 1997) content of the samples. The vitamin C content of the samples was determined by dichlophenol indophenols' titration (AOAC 1984). Mineral content was analyzed by dry–ashing 3grams (g) of lyophilized and milled *Musella* samples in a muffle furnace at 500°C, and dissolving the remains in nitric acid (HNO_3) and hydrogen chloride (HCl) (AOAC 1990). Calcium (Ca), magnesium (Mg), iron (Fe), and zinc (Zn) were determined by atomic absorption, potassium (K) was determined by emission spectrometry, and phosphorus (P) was determined by a spectrophotometric ammonium molybdate method.

Results

Musella lasiocarpa is an important component of the cultivation systems at the study sites. It is cultivated primarily on the edges of terraced uplands and marginal land (70% of *Musella*'s cultivation area) and, to a lesser extent, in home gardens (15%) and plantations (15%). Approximately 45% of cultivated *Musella* grows in agro–forestry systems, 40% grows in intercropped systems, and 15% grows in monoculture systems.

Within agro–forestry systems, *Musella* grows with fruit trees and crops that commonly are cultivated in Yunnan including peach, pear, persimmon, walnut, apple, chestnut, maize, wheat, potato, rape seeds, cabbage, pea, radish, carrot, and allium. The composition in terms of area within these systems is approximately 10% *Musella*, 25% fruit trees, and 65% other crops. The palm *Trachycarpus fortunei* also is found in some systems. An important management characteristic of these agro–forestry systems is their associated bee–keeping practice. Chinese bees (*Apis cerana cerana*; Fabricius) are kept in boxes between terraces to pollinate the system's vegetation. The management of *Musella* is valuable for its lack of irrigation and chemical input needs because it requires no fertilizer, pesticides, or herbicides.

In the study sites, almost every household cultivates *Musella* in an area varying from 10square meters (m^2) to 2,000m^2, depending on the land held by the household and the number of pigs raised. Both males and females are active in the cultivation and harvest of *Musella*. However, females appear to be more knowledgeable about harvest times and cultivation amounts and areas. While locals primarily grow *Musella* for subsistence use, it is increasingly being commercialized on a small scale as an ornamental for gardens in southwest China. We estimate that approximately 132,000square kilometers (km^2) of territory

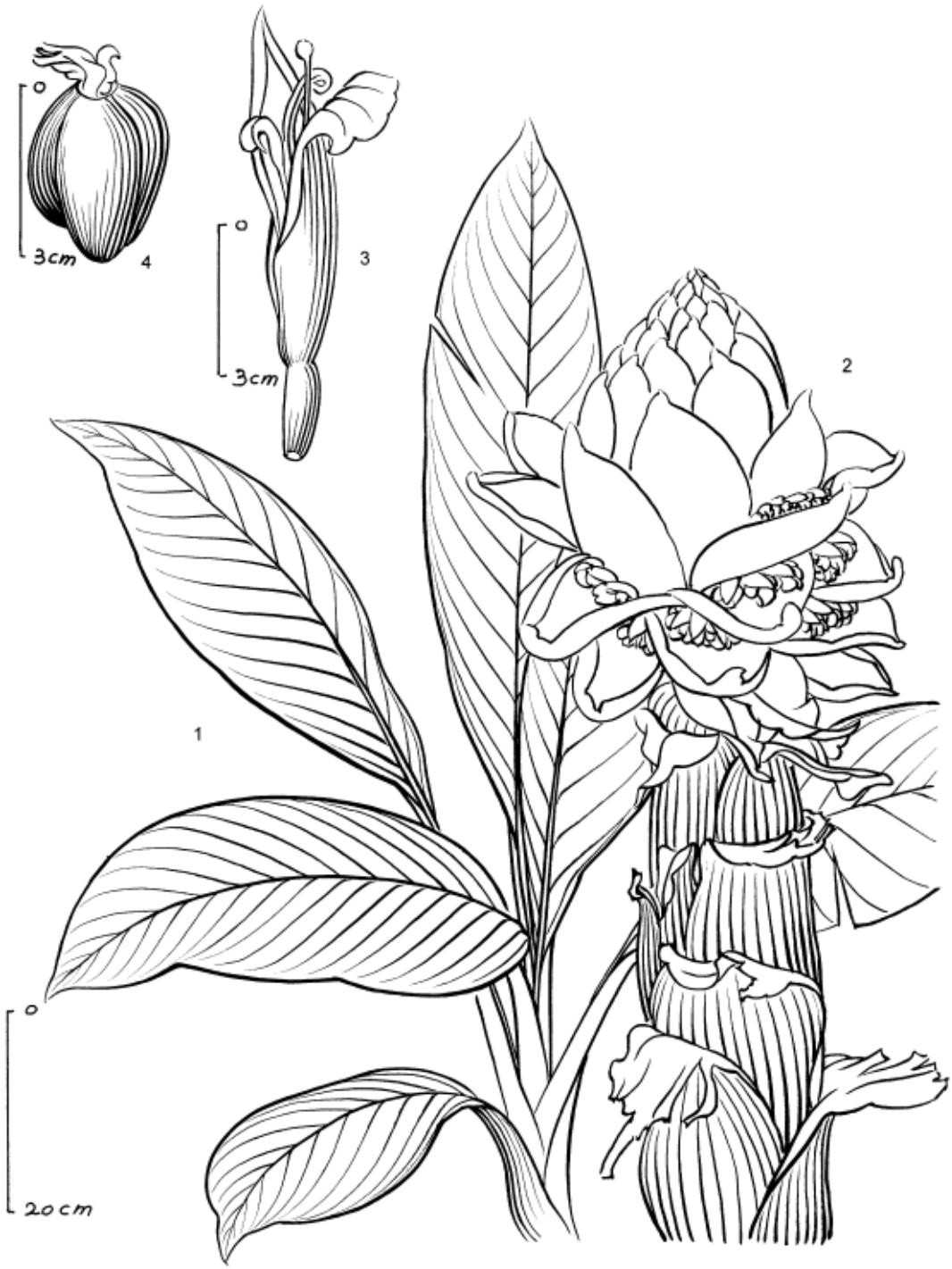

Fig. 1. *Musella lasiocarpa* (Franch.) C. Y. Wu ex H. W. Li 1 = Plant; 2 = Inflorescence; 3 = Male Flower; 4 = Ovary.

Table 1. Nutrient composition of *Musella lasiocarpa* (from dry materials).

Category	Protein (%)	Starch (%)	Fat (%)	Other Carbohydrates(%)	Vitamin C (mg/100g)
Root	3.81	2.11	1.40	6.90	0
Rhizome	3.58	42.59	0.44	9.39	0
Pseudostem	3.92	53.91	0.51	7.31	1.20
Leaf	17.25	0.00	2.84	13.13	9.33
Inflorescence	11.42	0.00	3.36	13.29	2.33
Fruit	11.98	2.21	1.66	5.42	0

throughout central Yunnan is distributed with *Musella* plantations, with over 10 million cultivators. Among the approximately 10 million cultivators, 8 million are Han, 1.7 million are Yi, and 300,000 are Miao. Locals living near wild populations of *Musella* harvest it for fodder and cultivation material. Our research found little evidence to support which cultural group domesticated this species.

All informants interviewed indicated that the use of *Musella* as pig fodder improves the growth of their animals. The whole plant can be used as fodder, either raw or after being cooked. The pseudostem, leaf, and inflorescence are the primary feeding materials; occasionally the rhizome, fruits, and roots are used also. Pigs are the only animals in the study sites that are fed *Musella*. Results from our survey on the amount of feedstuff consumed by pigs reveal that *Musella* is a significant pig fodder in all communities interviewed, with a mean weight of annual usage per household ranging from 1,443.7kilograms (kg) to 2,261.6kg. This represents 9% to 16% of total pig fodder. Our informants indicated that they use the largest amount of *Musella* in the winter, the season when the inflorescences of most *Musella* individuals emerge, because of the plant's increased nutritional value and the shortage of other fodders during this time. Other plant material used as pig fodder in the case sites includes buckwheat and leaves of sugar beet, mustard, radish, and sweet potato. The data indicate that the proportion of different pig fodder used by households shows slight variation between cultural groups and localities, with Yi communities using the greatest amount of *Musella*.

Data on the nutrient composition of *Musella* (Table 1) show it to be a significant source of protein, fat, carbohydrates, vitamin C, and starch. *Musella* leaves contain the greatest content of protein followed by the fruits and inflorescences of the plant. The leaves also contain the greatest content of vitamin C and its pseudostem and rhizome contain the greatest amount of starch. Analysis of the mineral composition of *Musella* shows that it is a significant provider of K, comprising 3.16% of the combined dry weight of the pseudostem, leaf, and inflorescence.

Conclusion

Musella lasiocarpa can be recognized as an important forage crop in central Yunnan because of the significant proportion it represents of total fodder consumed by pigs and its availability during the winter when there is a shortage of other fodders. Our results support that *Musella*'s rich nutrient composition is responsible for its wide cultivation by farmers in central Yunnan. In order to optimize the nutritional value of *Musella*, we recommend the whole plant be used to compensate for the nutrient content variation in different plant parts. For example, the lack of starch in the protein–containing leaves is compensated for by the starch content of the pseudostem. Further research is needed to address the nutritional variation our informants reported due to seasons and preparation methods. In addition, our research supports that *Musella*–based agro–forestry systems are multi–productive and their multi–storied vegetative structure protects the soil. Given *Musella*'s nutrient composition and broad adaptation to different ecological conditions, it is an appealing crop to be incorporated into agro–forestry systems globally, particularly in Himalayan and Southeast Asian countries. This can be achieved through extension organizations and farmer–to–farmer exchange systems.

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