

Vietnam Northwest Ethnic Minority Farmers' traditional Cultivation Practices of Curcuminoid -rich Turmeric

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Abstract

*Turmeric (*Curcuma longa* L.) is a culturally spice and medicinal crop cultivated in the Northern Mountain region of Vietnam by various ethnic minority communities. They utilize turmeric extensively in traditional rituals, ceremonies, textiles, and cuisine, deeply integrating it into their cultural heritage. In the Northwest mountainous areas, natural conditions are favorable for medicinal plants in general and turmeric in particular to grow. The average annual temperature is about 25°C which is much lower than that of the Northern delta. The land in the Northwest is gradually eroding due to the slope and ethnic minorities do not practice modern farming methods, but interestingly turmeric appears to be suitable for this barren soil condition. This study investigated the traditional cultivation practices of curcuminoid -rich turmeric of ethnic minorities in the Northwest mountainous region of Vietnam and evaluated the outstanding quality of turmeric rhizomes cultivated by ethnic minority farmers across the Lai Chau and Bac Kan provinces. Chemical analysis revealed significant variations in total curcuminoid content. The findings suggest that the traditional turmeric landraces grown in the Northern Mountains by ethnic minorities with specific practice of Vietnam could be a valuable source of natural curcuminoid compounds with potential applications in functional foods and biotherapeutic products. Leveraging the cultural significance and unique phytochemical attributes of this traditional turmeric could help promote the sustainable development and preservation of the ethnic minority communities' agricultural heritage in the Northern Mountain region of Vietnam.*

Keywords: Vietnam Ethnic Turmeric, Vietnam Minority Farmers, Traditional Cultivation Practices, High Curcuminoid Turmeric.

INTRODUCTION

Turmeric (*Curcuma longa* L.) is a popular but important spice and medicinal crop cultivated in Vietnam. It is widely used in traditional rituals, ceremonies, and spiritual practices of many ethnic groups in the Northern Mountains, such as the Hmong, Dao, Thai, and Muong people (Huu Tien Nguyen *et al*, 2020). It is commonly used to dye fabrics, clothes, and handicrafts produced by these ethnic minority communities, adding cultural significance to their traditional textiles and crafts. In traditional medicine practices, turmeric is used to treat a variety of ailments, as it is believed to have therapeutic properties (Surjit R. *et al*, 2023) (Debjit Bhowmik *et al*, 2009). A very interesting feature of the turmeric plant is that it is immune to pests, so during the growing process, pesticides are often not used.

Ethnic minority communities in East Asia, particularly in mountainous regions, have traditionally grown and relied on turmeric as a major crop. It holds deep cultural and spiritual significance, widely used in traditional ceremonies, rituals, and folk medicine practices. The crop is often seen as a symbol of health, prosperity, and purification, and is therefore deeply embedded in the cultural and spiritual beliefs of these communities. In traditional medicine and healing, turmeric, particularly the active compound curcumin, has long been used in traditional medicine systems across Asia, including Ayurvedic and traditional Chinese medicine, using it to treat a wide range of ailments, from skin conditions to inflammation and digestive issues. One of the main and superior characteristics of the turmeric plant is a relatively hardy crop that can thrive in these marginal environments, making it a suitable and sustainable option for ethnic minority farmers. The crop can be grown

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for both household consumption and as a cash crop, contributing to the overall economic and nutritional well-being of these communities. Ethnic minority communities in East Asia have developed traditional farming techniques and extensive knowledge about turmeric cultivation, which have been passed down through generations (Iris F. F. Benzie and Sissi Wachtel-Galor. 2011).

In the Northwest Mountain of Vietnam, the ethnic minority farmers use traditional cultivation methods, that differ from commercial turmeric production, which is often based on sustainable and environmentally-friendly methods. These practices influence the accumulation of bioactive compounds like curcuminoids in turmeric. Besides that, the mountain's climate and soil may lead to distinct phytochemical profiles compared to turmeric grown in other regions. There, in the Northern Mountains have a cooler, more temperate climate compared to other parts of Vietnam. Variations in temperature, precipitation, and sunlight exposure can influence the biosynthesis and accumulation of different curcuminoids in the turmeric plant. The mountainous terrain and geology of the Northern regions likely result in distinct soil mineral profiles. which is gradually eroding due to the slope and ethnic minorities do not practice modern farming methods, but turmeric appears to be suitable for this barren soil condition Besides, the availability of specific organic matter, and pH levels in the soil can affect the plant's ability to produce and store different curcuminoid compounds. Ethnic minority communities in the Northwest Mountains may cultivate unique turmeric cultivars or landraces that have adapted to the local environment. The distinct geographic, climatic, and cultural factors of the Northern Mountain region likely contribute to turmeric grown there developing a unique curcuminoid composition compared to turmeric from other parts of Vietnam or the world. This could have interesting implications for the medicinal and culinary properties of this regionally specific turmeric. Nguyen Thi Kieu Oanh *et al.* in 2021 collected samples from 3 main groups: northern (Lang Son), center (Nghe An), and southern highland (Lam Dong), the results showed that turmeric from Lang Son represented the highest amount of curcumin (110.3 ± 50.0 ug/mg), demethoxycurcumin (46.7 ± 22.1 ug/mg) and bisdemethoxycurcumin (29.1 ± 10.4 ug/mg). Similarly, in the case of turmeric from Nepal, curcumin content was found to be high in the samples cultivated in the southern region compared with the opposing geographical part. A sample from Chitwan belonging to Himalaya Mountain, was found to have about 165 mg/g of curcumin while the sample from Kalikot was found to have about 79 mg/g of curcumin in the turmeric extract (Amrit Poudel *et al.* 2019).

This study investigated the cultivation conditions and the curcuminoid profiles of turmeric planted in the delta (Hung Yen province), midland (Bac Kan province) and mountainous (Lai Chau provinces) regions of the Northwest. Chemical analysis revealed significant variations in total curcuminoid content among the ethnic turmeric landraces and the popular one. Cultivation practices, environmental factors, and genetic diversity are likely to contribute to the observed differences in curcuminoid profiles. The findings suggest that traditional turmeric landraces in the Northwest Mountains could be a valuable source of natural curcuminoid compounds with potential applications in medicine, functional foods, and cosmetics. The results could contribute scientific approach in the sustainable development and preservation of the ethnic minority communities' agricultural heritage in the Northern Mountain region of Vietnam.

MATERIAL AND METHOD

Turmeric Sampling

Ethnic turmeric rhizomes were collected from ethnic families of Lai Chau, Bac Kan and Hung Yen provinces from April 2022 to March 2023.

Survey of Turmeric Cultivation Conditions

Qualitative Survey: Ethnographic field observations and in-depth interviews were conducted with members of minority communities involved in turmeric farming in Bac Kan and Lai Chau provinces.

A total of 17 families of ethnic peoples participated in the survey, where 7 in Bac Kan and 10 in Lai Chau.

The survey was conducted from April 2022 to March 2023. The questionnaire included history, traditional technique, cultural and spirit believe and income from turmeric planting.

Soil's and water's analysis

Soil's samples were collected according to the standard method of TCVN 7538-6:2010

pH (KCl) were analyzed according to TCVN 5979:2007.

TDS and pH measurement of irrigation water were carried out in accord with national technical regulation on water quality for irrigated agriculture (QCVN 39:2011/BTNMT).

Analyze of Turmeric's Curcuminoid Profile

Extraction of total curcuminoid: Turmeric rhizomes were sliced, dried at 50°C for 3 days, and then powdered passed from sieve no. 60. 50 mg of the dried, powdered rhizomes were combined with 1.5 mL of 80% ethanol solution. This mixture was refluxed for 5 hours at room temperature in the dark. The mixture was then centrifuged at 5000 g for 15 minutes and filtered through a 0.25 µm membrane.

Determination of total curcuminoid

Standard curve: Stock solution of curcuminoid standard was prepared from 10mg of curcuminoid dissolved in 96% ethanol, then make up the volume to the 25ml mark. Dilute the stock standard curcumin solution 100 times and scan the absorbance at different wavelengths from 400nm to 500nm to determine the maximum absorption wavelength. From the stock standard solution, preparing a series of standard curcumin solutions in methanol, a standard curve was created to show the relationship between curcuminoid solution concentrations and absorbance.

Total curcuminoid measurement: Accurately weighing about 2-3 g of the test sample and it was diluted with 96% ethanol. Measurements of samples were performed using UV – VIS spectroscopy at maximum absorption wavelength of 420 nm. The curcuminoid content in the test sample was calculated according to the following formula:

$$C_t = \frac{C_{dc} \cdot V \cdot K_t}{m_t}$$

Where C_t was curcuminoid concentration in the sample (µg/g); C_{dc} : curcuminoid concentration from the standard curve (µg/mL); K_t : dilution factor, V : diluted solvent (mL); m_t : weight of the sample (g)

Determination of curcuminoid composition

Curcuminoid composition (curcumin, DMC, BMC) were measured by HPLC – PDA Shimadzu (FIRI.F.004). with PDA detection at 424 nm. The mobile phases were Acetonitrile: H₂O (95:5) and H₃PO₄ 0,1% at the flow rate of 1mL/min. The column temperature was 35°C. The total injection volume was set to 10 µL (Jangle R. D. and Thorat B. N. 2013)

RESULTS AND DISCUSSION

Ethnic Turmeric Cultivation Conditions

Qualitative survey

Open-ended questions has been used to encourage participants to share their unique experiences, perspectives, and insights on turmeric cultivation. The survey was carried out with simple Q&A, which is presented in Table 1.

Table 1. Survey on turmeric’s traditional farming practice of ethnic minority people

Key theme	Question	Answer	Number of answers
3. History	Q1.1. How has turmeric cultivation and usage play role over time in your minority community?	The crop holds deep cultural significance	17/17
		It is used in traditional medicines and ceremonies	17/17
	Q1.2. What are some of the unique characteristics of turmeric cultivation? How do these methods differ from modern or mainstream farming practices?	Turmeric is predominantly grown using traditional, small-scale farming methods.	14/17
		For families’ use: It is mostly grown around the house to get roots and leaves	17/17
		For selling: Turmeric is planted at high, well-drained plots of land i.e. at forests, land can be prepared to grow turmeric under the forest canopy	12/17
	2.Traditional techniques	Q2.1. Describe the process of turmeric cultivation in your village, from planting to harvesting.	Farmers rely on manual labor and organic fertilizers rather than mechanization or chemical inputs.
Turmeric is usually planted in the Winter – Spring crop, and harvested sporadically from October to March of the following year, depending on land use needs. When the turmeric plant stops growing young leaves, the old leaves begin to dry at the edges, turning pale yellow. When you dig up the turmeric root and see that the tuber’s skin is dark yellow (the skin is glossy, the tuber’s tip is also dark yellow), it is time to harvest.			15/17
Q2.2. What are the key in turmeric planting?		Turmeric is healthy and rarely susceptible to pests, so do not use chemical pesticides. Be careful of root rot caused by waterlogging. Therefore, it is necessary to open drainage ditches during the rainy season.	10/17
Q2.3 What factors do you consider when deciding how to cultivate turmeric?		Soil, time, no labor care	17/17
Q2.4 What are the biggest challenges or issues you face in turmeric cultivation?		Limited access to quality planting materials and technical knowledge on improved cultivation techniques. Difficulties in transporting and marketing turmeric products due to remote locations and underdeveloped infrastructure.	13/17
Q2.5 Can you describe any traditional remarks or practices you use to plant the turmeric		Crop rotation and intercropping with other vegetables are common practices.	12/17
		Susceptibility to crop diseases and pests, with limited pest management options.	15/17
3.Cultural or spiritual beliefs	Q3.1. How it has been passed down through generation	Women play a crucial role in turmeric cultivation and post-harvest processing.	17/17
	Q3.2 Can you share any cultural or spiritual beliefs or practices that influence the way you cultivate turmeric?	The crop holds deep cultural significance and is used in traditional medicines and ceremonies.	17/17
		It is often used in various traditional rituals and folk medicines, where it symbolizes health, prosperity, and protection against evil spirits.	17/17
	Q3.3 In your opinion, what are the most important benefits or values that turmeric cultivation brings to your community?	Turmeric cultivation provides an important source of income and food security for ethnic minority households.	17/17
It is often utilized in traditional medicine and cooking,		17/17	
4.Income from turmeric planting	Q4.1. Does turmeric create job for ethnic people	The turmeric starch production model has helped increase income as a part-time job	12/17
		Crops help eliminate hunger and reduce poverty, shifting agricultural structure in a	9/17

		positive direction	
		The selling price is 4,000 to 5,000 VND per kg (as in December 2024)	17/17

The survey followed the key themes of history, traditional technique and cultural or spiritual beliefs related to the role of turmeric cultivation and usage in ethnic minority communities in Vietnam. For ethnic minorities in the mountainous regions of the Northwest Vietnam, turmeric is a crop that holds immense cultural significance. It is deeply woven into traditional medicines and ceremonial practices passed down through generations. Turmeric cultivation often involves small-scale, labor-intensive farming methods, with the crop grown around homes for family use or in well-drained plots of land for commercial purposes. The cultivation process relies heavily on manual labor and organic fertilizers, with planting and harvesting timed to specific seasons. Key factors considered by farmers include soil conditions, preventing waterlogging while managing pests and diseases is kept naturally. However, ethnic minority communities face challenges such as limited access to quality planting materials and technical knowledge, as well as difficulties in transporting and marketing their turmeric products due to remote locations and underdeveloped infrastructure. Despite these obstacles, turmeric cultivation remains an integral part of the cultural fabric of these communities. Women play a crucial role in the process, which is deeply rooted in traditional rituals and folk medicines. Beyond its cultural significance, turmeric provides an important source of income and food security for ethnic minority households, who also incorporate it into their traditional medicinal and culinary practices. Besides, turmeric cultivation provides valuable part-time employment and income opportunities for the surveyed ethnic minority communities. Growing turmeric has had a positive impact on food security and poverty reduction for many of these families. The current turmeric market price of 4,000-5,000 VND/kg appears to be favorable for the farmers. Overall, the survey findings suggest that turmeric production is an important source of supplementary income and livelihood support for these ethnic minority communities in the target provinces.

Soil's and water's analysis

The provinces of Lai Chau, Bac Kan in Northern Vietnam present unique geographical and environmental characteristics that play a crucial role in shaping the cultivation practices and agricultural output of these regions. Each province exhibits distinct features in terms of latitude, longitude, temperature patterns, soil composition, and irrigation water quality, contributing to the diversity and richness of their agricultural landscapes. The diverse climatic conditions, soil compositions, and water quality parameters in these regions significantly influence the agricultural practices and crop yields.

Soil and climate conditions for growing turmeric are presented in the following table. Growing area of ethnic turmeric was with lower average temperature (21°C), with higher pHKCL (4.6; 4.5). It suggested that growing conditions in ethnic people's areas played as an important factor for curcuminoid accumulation in turmeric. A similar study on secondary metabolites of saffron indicated that soil type, altitude, temperature, irrigation water affected the accumulation of compounds in saffron plants used as medicinal and pharmaceutical raw materials and food additives (Mykhailenko et al. 2020).

Table 2. Geographical condition of turmeric's plating area in Lai Chau, Bac Kan and Hung Yen

		Lai Chau (Phong Tho)	Bac Kan (Na Ri)	Hung Yen (Khoai Chau)	
Geographical		Northern Lai Chau, 22025' to 22051' North latitude, 103008' to 103036' East longitude	East Bac Kan, 21055' to 22030' North latitude, 1050 58' to 106018' East longitude	West Hung Yen, 205216' to 20430' North latitude, 1055859 58' to 1056018' East longitude	
Average temperature		Warm season, from March to September with average temperature of around 27°C. Cool season is from October to February with average temperature of around 21°C.	Warm season from March to October with average temperature of around 29°C. Cool season is from October to February with average temperature of around 21°C.	Warm season from April to November with average temperature of around 31°C. Cool season from December to March with average temperature of around 26°C.	
Soil	Composition	Soil mixed with clay		Soil mixed with clay/ sand	
	Soil pH (KCl)	4.6	4.5	4.3	
Irrigation water		pH	TDS ppm	pH	TDS ppm
		6.8	1600	6.3	1705

By delving into the geographical nuances and environmental contrasts of Lai Chau, Bac Kan, and Hung Yen, we gain a deeper appreciation for the intricate interplay between nature and agriculture in Northern Vietnam. These insights can inform strategies for enhancing crop productivity, preserving soil health, and promoting environmental sustainability in the region, especially economically development of ethnic turmeric plants, devising plans for purchasing, connecting production and preparation, turning turmeric into a key crop and an economic source for ethnic minority people in the northern mountains of Vietnam.

Ethnic Turmeric Yields High Curcuminoid Content

Turmeric’s Curcuminoid Profile

Turmeric as a recognizable spice consisting of the dried rhizome of *Curcuma longa* L., a plant native to tropical South Asia with a long history of traditional medicinal uses, especially for its medicinal properties and its anti-inflammatory. The biological activity of turmeric is mainly due to curcuminoids, polyphenolic compounds that make up about 3% of the dry weight of the rhizome (Meghan B Skiba et al., 2018). Curcuminoid of ethnic turmeric (turmeric collected from Lai Chau and Bac Kan provinces) were different from that of the popular turmeric (collected from Hung Yen province) in term of content and composition profile. Ethnic turmeric contained 6.04 and 7.94% of curcuminoid which was extremely higher (8 to 11 times) than the curcuminoid content in popular one (0.73%), (Table 3).

Table 3. Total curcuminoid analyzed in rhizome obtained from Lai Chau (Northwest Mountain) Bac Kan (Midland) and Hung Yen (Delta)

Composition	Lai Chau	Bac Kan	Hung Yen
Total Curcuminoid (% dw)	7.94±0.07	6.04±0.05	0.73±0.07
Curcuminoid ratio	~11 (10.8)	~8 (8.3)	1

With the specific cultivation conditions of ethnic minorities in the mountains of Northwest Vietnam, combined with the typical climate, ethnic turmeric contains 2 to 3 times more curcuminoids than turmeric grown in the plains

The distinctiveness of the curcuminoid profile in ethnic turmeric can be attributed to the specific cultivation practices of the indigenous communities in the mountainous regions of Northwest Vietnam. The combination of unique soil compositions, climatic conditions, and cultivation techniques practiced by ethnic minorities contributes to the enhanced accumulation of curcuminoids in the turmeric grown in these areas. Additionally, the study suggests that ethnic turmeric contains 2 to 3 times more curcuminoids than turmeric cultivated in flat plains due to these specialized conditions.

This research underscores the importance of recognizing and preserving the diversity of turmeric varieties, particularly those with exceptional curcuminoid content like the ethnic turmeric from the mountains of Northwest Vietnam. By understanding the factors that influence the bioactive compounds in turmeric, we can further explore the potential health benefits and therapeutic applications of this remarkable spice.

The medicinal economy of ethnic minorities towards sustainable development towards net zero - Ethnic herbal medicines bring prosperity

Vietnam's Northwest region is focusing on developing herbal spice agriculture through sustainable practices aimed at achieving net-zero emissions by 2050. This involves integrating agricultural mitigation actions as part of the country's national strategy, which emphasizes the importance of preserving natural capital to ensure long-term economic development. Turmeric is increasingly recognized in sustainable agriculture practices in the northern mountainous regions of Vietnam. These areas are transitioning toward environmentally friendly farming methods, focusing on carbon absorption and contributing to net-zero emissions goals.

Overall, the medicinal economy of ethnic minorities in Vietnam's Northwest is playing a key role in the country's transition towards sustainable development and net-zero emissions by 2050, leveraging traditional knowledge and practices in herbal spice agriculture.

CONCLUSION

The traditional cultivation practices adopted by the minority farmers in the Northwest region of Vietnam have unveiled the remarkable potential of producing curcuminoid-rich turmeric with significantly higher levels of bioactive compounds compared to conventional varieties, which is 2 to 3 times higher. Through centuries-old farming techniques, coupled with the region's unique climate and soil conditions, these indigenous communities have been able to cultivate turmeric that boasts extraordinary health-promoting properties.

The exceptional curcuminoid content found in the turmeric grown by Vietnam's Northwest minority farmers not only underscores the richness of the country's agricultural diversity but also highlights the invaluable knowledge and wisdom passed down through generations. By continuing to uphold and preserve these traditional cultivation practices, we can ensure the sustainability and conservation of this precious heritage.

Furthermore, the exploration of curcuminoid-rich turmeric varieties opens up exciting possibilities for the fields of medicine, nutrition, and wellness. The potent anti-inflammatory and medicinal properties of curcuminoids make them a valuable resource for addressing various health concerns and promoting overall well-being.

In conclusion, the cultivation of curcuminoid-rich turmeric by Vietnam's Northwest minority farmers serves as a testament to the harmonious relationship between humans, nature, and traditional wisdom. By recognizing and supporting these indigenous practices, we can not only harness the full potential of this extraordinary spice but also honor and preserve the cultural heritage and environmental stewardship of these communities for generations to come.

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