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**Use of Inn (*Dipterocarpus Tuberculatus*) Leaves and Its Potential for
Plastic Reduction: Case study in Nay Pyi Taw Union Territory**

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**Use of Inn (*Dipterocarpus Tuberculatus*) leaves and its potential for plastic reduction:
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Dr. Ei Ei Swe Hlaing, Assistant Director, Forest Research Institute

Abstract

Dipterocarpus tuberculatus Roxb. Occurs Indaing forest of Myanmar distributed in Ayeyarwady, Sagaing, Magway and Mandalay regions, Kayin, Kayah, Chin, Yakhine and Shan states and Nay Pyi Taw Union Territory. Inn (*Dipterocarpus tuberculatus* Roxb) leaves is widely used for roofing and wrapping flowers and local food like vegetables, meat and so on. This study examines the production and use of Inn-leaves in 18 selected markets of Nay Pyi Taw Union Territory, potential of reduction of plastic by using it and perceptions of consumers for accepting Inn-leaves to wrap the food. Data were collected from 472 respondents consists of 24 collectors, 293 sellers and 100 consumers. It is estimated that total annual production of Inn-leaves is about 57 million leaves while total annual use is about 39 million. Hence, annual plastic reduction is likely to be 3 million kg for (14x28) plastic bag, 2 million kg for (12x24) plastic bag and 2 thousand kg for plastic (9x18) bag. Study shows that 83 respondents like Inn-leaves for wrapping food because of good health affect to consumers, nontoxic and durable nature, fragrance and flavor, environmentally friendly and reduce plastic. Despite its natural properties and durability, 27 respondents dislike it because of impossibility to wrap the liquid food items and inconvenience to hold and carry by hand. We should pay attention to conservation of Indaing forest because of its importance for daily family income (30,000 to 50000 kyats a day) and wrapping local foods which reduce excessive use of plastic.

Key words: Indaing forest, wrapping, family income, plastic bag, conservation

ပြည်ထောင်စုနယ်မြေ နေပြည်တော်အတွင်း အင်ဖက်ထုတ်ယူမှု၊ အသုံးပြုမှုနှင့် ပလတ်စတစ်လျှော့ချနိုင်မှု အလားအလာအား လေ့လာခြင်း

ဒေါက်တာအိအိဆွေလှိုင်၊ လက်ထောက်ညွှန်ကြားရေးမှူး၊ သစ်တောသုတေသနဌာန

စာတမ်းအကျဉ်း

မြန်မာနိုင်ငံတွင် အင်ပင်ပေါက်ရောက်သည့် အင်တိုင်းတောများကို ဧရာဝတီတိုင်းဒေသကြီး၊ စစ်ကိုင်းတိုင်းဒေသကြီး၊ နေပြည်တော်ကောင်စီနယ်မြေ၊ မကွေးတိုင်းဒေသကြီး၊ မန္တလေးတိုင်းဒေသကြီး၊ ချင်းပြည်နယ်၊ ကယားပြည်နယ်၊ ရခိုင်ပြည်နယ်နှင့် ရှမ်းပြည်နယ်မြောက်ပိုင်းနှင့် အရှေ့ပိုင်းတို့တွင် တွေ့ရှိရပါသည်။ အင်ပင်မှရရှိသည့် အင်ရွက်ကို အမိုးအကာအဖြစ်လည်းကောင်း၊ အစားအစာများထုပ်ပိုးရာတွင် လည်းကောင်း အသုံးပြုကြပါသည်။ ယခုစာတမ်းသည် ပြည်ထောင်စုနယ်မြေ၊ နေပြည်တော်အတွင်း အင်ဖက်ထုတ်ယူမှုနှင့် အသုံးပြုမှု၊ အင်ဖက် စုဆောင်းမှုမှ မိသားစုဝင်ငွေရရှိမှု၊ အင်ဖက်အသုံးပြုမှုကြောင့် ပလတ်စတစ်လျှော့ချနိုင်မှု အလားအလာနှင့် အင်ဖက်အသုံးပြုမှုနှင့် စပ်လျဉ်း၍ စားသုံးသူများ၏အမြင် ကို လေ့လာတင်ပြထားခြင်းဖြစ်ပါသည်။

ဈေးကြီး၊ ဈေးလေး (၃၆) ဈေးအနက် ဈေးကြီး (၅၀%) နှင့် ဈေးလေး (၅၀%) ကို ကျပမ်းရွေးချယ်ခဲ့ပြီး အဆိုပါဈေးများမှ အင်ဖက်စုဆောင်းသူ (၂၄) ဦး၊ အင်ဖက် အသုံးပြုသူဈေးသည် (၂၉၃) ဦး နှင့် ဈေးဝယ် (၁၁၀) ဦး စုစုပေါင်း (၄၇၂) ဦးအား မေးခွန်းများ မေးမြန်းခဲ့ပါသည်။ လေ့လာမှုအရ ပြည်ထောင်စုနယ်မြေ၊ နေပြည်တော်အတွင်း တစ်နှစ်လျှင် အင်ဖက်အရေအတွက် (၅၆.၆) သန်းခန့် ထုတ်ယူခဲ့ပြီး ဈေးများမှ သုံးစွဲသည့် အင်ဖက်အရေအတွက်မှာ တစ်နှစ်လျှင် (၃၉) သန်း ခန့်ဖြစ်ပါသည်။ သို့ဖြစ်၍ အင်ဖက်သုံးစွဲမှုကြောင့် တစ်နှစ်လျှင် ပလတ်စတစ်အိတ် လျှော့ချနိုင်မှုမှာ (၉" x ၁၈" အိတ်အရွယ်ဖြင့် ကီလိုဂရမ် ၃ သိန်းခန့်၊ ၁၂" x ၂၄" အိတ် အရွယ်ဖြင့် ကီလိုဂရမ် ၁ သိန်းခန့်၊ ၁၂" x ၂၄" အိတ်အရွယ်ဖြင့် ကီလိုဂရမ် ၂ သောင်းခန့်) အသီးသီးလျှော့ချနိုင်သည့် အလားအလာရှိကြောင်း တွေ့ရှိရပါသည်။

ဈေးဝယ်သူ (၈၃%) အနေဖြင့် အင်ဖက်ဖြင့် အစားအစာများ ထုပ်ပိုးခြင်းသည် ရောဂါ ကင်းစေခြင်း၊ တာရှည်ခံခြင်း၊ ဖက်နံ့သင်းခြင်း၊ သဘာဝပစ္စည်းဖြစ်ခြင်းနှင့် ပလတ်စတစ်လျှော့ချနိုင်ခြင်း တို့ကြောင့် ကြိုက်နှစ်သက်ပြီး (၂၇%) မှာ အရည်ပါသည့် အစားအစာများထုတ်ပိုး၍ မရခြင်းနှင့် သယ်ယူ ရန် ခက်ခဲခြင်းများကြောင့် ကြိုက်နှစ်သက်မှုမရှိကြောင်း တွေ့ရပါသည်။ အင်ပင်များ ပေါက်ရောက်မှုသည် အင်ဖက်စုဆောင်းသူများအတွက် မိသားစု နေ့စဉ်ဝင်ငွေ (၃၀,၀၀၀ ကျပ်မှ ၅၀,၀၀၀ ကျပ်) လိုအပ်ချက်ကို ဖြည့်ဆည်းပေးသကဲ့သို့ ပလတ်စတစ် အလွန်အကျွံသုံးစွဲမှုကို လျှော့ချစေနိုင်သည့် ဈေးသည်အများစု၏ ထုပ်ပိုးမှုလိုအပ်ချက်ကိုလည်း ပံ့ပိုးပေးလျက်ရှိသဖြင့် အင်တိုင်းတောများ ရေရှည် တည်တံ့စေရေးကို အလေးထားဆောင်ရွက်သင့်ပါသည်။

Use of Inn (*Dipterocarpus Tuberculatus* Roxb.) Leaves and Its Potential for Plastic Reduction: Case study in Nay Pyi Taw Union Territory

1. Introduction

In many developing countries, there is an old tradition of using a variety of plant leaves as food packaging. They have cultural, environmental significance and socio-economic importance (Hounsou et al., 2022). In response to global issues of plastic waste pollution which pose threat to ecosystem and human health, several studies such as Mensah et al (2012), Korea (2019), Pratama and Junianto (2021), Hounsou et al (2022), Quetchehou et al (2022), Jaffna et al (2024), Mvuma and Alexander (2023), Kalina et al (2024), Tirpude and Singh (2024) has been explored and proved alternative ways of packaging food with environmental friendly materials from plant leaves and sheaths. Hounsou et al (2022) reported 220 plant species from botanical families which is widely used for food packaging in Africa, Asia and South America. Varieties of plant leaves employed as plates and packaging material in India include e.g. the leaf of lotus *Nelumbo nucifera*, *Tectona grandis*, *Shorea robusta*, the leaf of banana *Musa paradisica*, *Ficus religiosa* and *Ficus bengalensis* (Bangyan) Similarly, Indonesia use banana leaves, teak leaves and corn leaves while Thirilinka use the leaf of lotus, Coconut, Teak, Jack fruit and Banyan. Malaysia also used bamboo leaves in the culture of wrapping cooked rice. Based on previous studies, it can be concluded that plant leaves are attractive alternatives for plastic that has low costs, positive impact on the environment and consumers, availability, biodegradability and reduced carbon footprint. Some studies emphasized the culture of packaging traditional snacks or cooked food to preserve for future generation while some studies go further development of plant leaves especially banana leaves in terms of mechanical properties, biodegradability and design development. However, there is limited market study on plant leaves for wrapping raw items.

Like in other South East Asia countries, Myanmar also has a long history of using plant leaves for the basic needs of local communities depending on the region although there is limited documentation. For instance, Pauk leaf *Butea monosperma* is used for packaging traditional cooked foods in some parts of Sagain region, *Musa pardisiaca* (Banana) and *D. tuberculatus* (Inn) in most of parts of the country. *D. Tubercalutus*, which is locally called Inn tree provides not only timber but also non-timber forest products in terms of resin, leaves and mushroom which appear under the Inn leaves. Its dry leaves, locally known as “Inn phet” is mainly used for roofing in rural areas (e.g. Hpa-an Township; Myanaung Township) while fresh leaves are used for wrapping local foods like meat, vegetable, flower and so on. Despite their importance, they have not been systematically exploited and have remained under value.

The native range of *D. tuberculatus* is Bangladesh to Indo-China. Yi Yi Han et al (2009) stated that it is found in upper and lower Myanmar chiefly along the valleys of the Chindwin, Ayeyarwady and Sittaung rivers; from Myitkyina southwards, through Katha, Myittha, Shan States, Minbu, Magway, Pyay, Hinthada, Yezin, Tatkon, Taungoo, Yangon, Moattama and Kyaukphyu. According to the inventory data of Forest Department of Myanmar in 2019, it is widely distributed in 24 Districts of Ayeyarwady Division, Chin State, Kayah State, Magway Division, Mandalay Division, Nay Pyi Taw Council Region, Rakhine State, Sagain Division and Shan State as shown in Figure (1). There are about 28.37 million of Inn species in the production working circle of these state and region are given in the Table (1). It can also be found not only in Reserved Forest Area but also in land at the disposal of the government. Some studies such as Khaing et al. (2019) highlighted composition and structure of seasonally Dry Forest in Myanmar including Low Indaing and High Indaing. Additionally,

Than et al. (2024) assessed the total carbon storage of *D. tuberculatus* in per ha. In part of the timber utilization of Inn (*Dipterocarpus tuberculatus*), some studies such as Yi Yi Han et al. (2009) and Lwin Lwin Aung (2006) have been carried out to provide information on morphological characteristic of reproductive and vegetative organs and anatomical characteristic of wood of stems and leaves. However, the production and use of Inn (*D. tuberculatus*) leaves is not well documented.

The objectives of this study were therefore (i) to examines the production and use of the fresh leaves in the of markets of Nay Pyi Taw Union Territory, (ii) to explore the potential of plastic reduction plastic by using Inn-leaves and (iii) to understand the perceptions of consumers for accepting Inn-leaves to wrap the food.

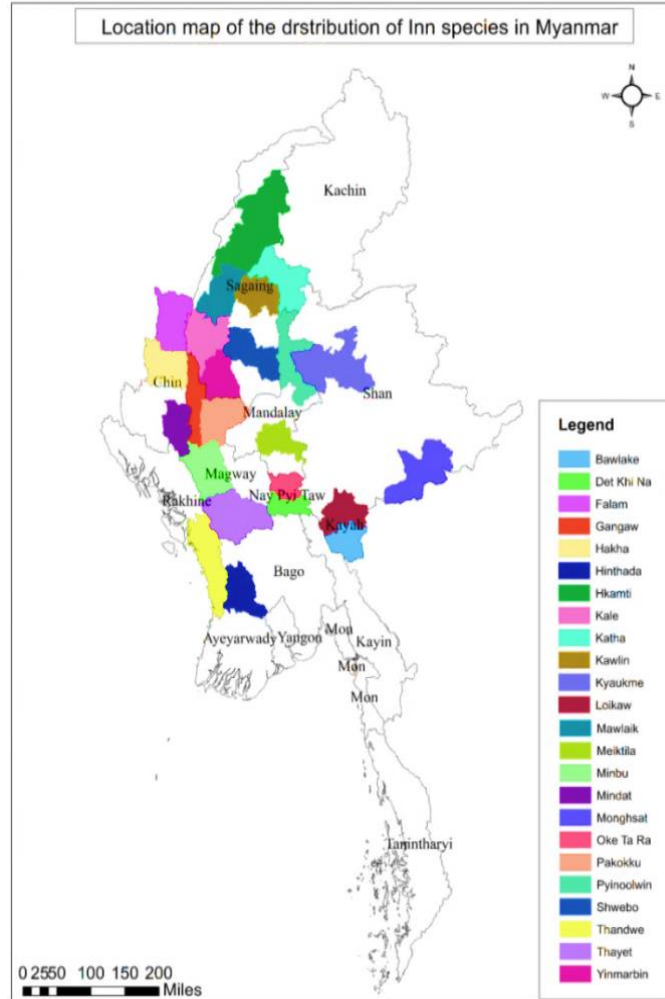


Figure 1 Location map of the distribution of Inn species in Myanmar

Table 1. Number of Inn species in States and Regions of Myanmar

State/Region	District	No. of tree
Ayeyarwady	Hinthada	169,200
Chin	Falam	1,134,000
	Hakha	1,969,200
	Mindat	1,742,400
Kayah	Bawlake	928,800
	Loikaw	115,200

State/Region	District	No. of tree
Magway	Gangaw	1,440,000
	Minbu	154,800
	Pakokku	198,000
	Thayet	363,600
Mandalay	Meikhtila	1,213,200
	PyinOoLwin	511,200
Naypyitaw	Dekhina	133,200
Rakhine	Thandwe	3,600
Sagaing	Hkamti	4,042,800
	Kalay	1,558,800
	Katha	309,600
	Kawlin	525,600
	Mawlaik	1,958,400
	Shwe Bo	1,083,600
	Tamu	230,400
	Yinmarbin	1,944,000
Shan(E)	Monghsat	108,000
Shan(N)	Kyaukme	6,534,000
Grand Total		28,371,600

Source; Planning and Statics Division, Forest Department (2024)

2. Methodology

2.1 Study Area

The study was carried out in 18 local markets of Nay Pyi Taw Union Territory. According to the collected data from Market Department of Naypyitaw City Development Committee in 2024, there are about 36 markets in Nay Pyi Taw which include 8 large markets and 28 small markets which is categorized by number of shoppers. For this study, 50 % of large markets and 50 % of small markets were randomly selected depending on accessibility. Small markets include Shwe Kyar Pin, Aung Zabu, Kyidaunggan, Lane Pyinmana, Shwe Thazin, Yuzana, Ingyin, Gandama, Ingyin, Ywa Taw, Yezin, Ngushwewar, Sin Phyu Shin and Alar markets located in Detkhinathiri, Zabuthiri, Pobbathiri, Zayar Thiri, Pyinama and Laeway Townships respectively while large markets include Aharathuka market, Thapyaygone market, Pobbathiri market and Laeway market located in Pyinmana, Zabuthiri, Pobbathiria and Lewé Townships respectively. In small markets, the minimum number of sellers is about 275 in Lan Pyinmana market while the maximum number is about 760 in Ingyin market. As for large markets, the largest one is Myoma market (about 2,073) followed by Aharathuka market (2,070) and Thapyaygone market (1,360) (Market Department of Nay Pyi Taw City, 2024). Among the sampled markets, Aung Zabu and Lan Pyinmana are five-days market. The location of sampled market is as shown in the Figure (2).

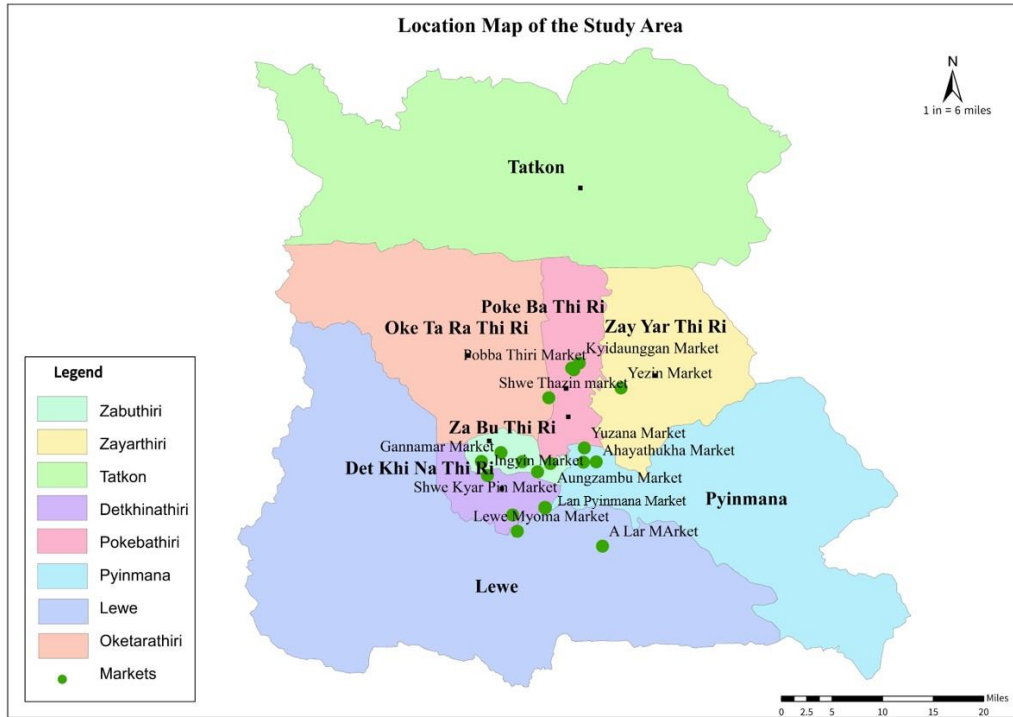


Figure 2. Location map of the study area in Nay Pyi Taw Union Territory

2.2 Data collection and analysis

Firstly, we identified and conducted semi-structured interview with Inn-leaves collectors of each market to obtain information on number of the leaves they harvest, income from selling them, how they collect the leaves, the place where they collect and price of selling. To predict the time series data of production and prices of Inn-leaves in Nay Pyi Taw Union Territory, three markets were purposely selected depending on availability of collectors who has been harvested the leaves more than 30 or 20 years. Secondly, we collected total number of sellers from each sampled markets according to the data from markets office and direct observation. Then, we selected 30% of sellers who use Inn-leaves for wrapping flowers, food (Motephat) and vegetables using stratified random sampling. Additionally, we asked the 5 consumers from small markets and 10 consumers from large markets to reveal their future opinions for utilization of Inn-leaves. Data were collected from June 2024 to January 2025. The data collected were processed with Excel. An estimate of trends of production and price of Inn-leaves in 30 years, 20 years, 10 years and current were analyzed using simple linear regression analysis following a guide to Rapid Market Appraisal (2012).

3. Results and Discussions

3.1 Production and Use of Inn-leaves for packaging

3.1.1 Harvesting practices of Inn-leaves

According to the informants, collectors harvest Inn-leaves throughout the year using hand-harvesting. The average height of the tree is from 1 - 20 feet and they can collect 2-5 leaves a tree. The best season for picking Inn-leaves is from April to September because of its availability. In summer, local residents have to go and walk along the gully to look for the trees which have more young leaves. The leaves collected by collectors are purchased by the sellers from the markets of Nay Pyi Taw city. The daily collection per person is around 1,000 to 1500 leaves. Therefore, it can earn about 7,000 kyats to 20,000 kyats for individual collector;

30,000-50,000 kyats for family collectors (some household collect both household heads of men and women). It is likely to be small-scale family production for local market.

Table 2 No. of sample respondents and collected data

No.	Respondents	Types of data collected	No. of sample respondents
1.	Inn-leaves collectors	Demographic data; no. of collected leaves per month; place of collecting leaves; income; harvesting techniques, size of trees	24
2.	Sellers	Reasons of using leaves; no. of use of leaves per month; availability; size of leaves compared to plastic, where they buy, price of leaves	293
3.	Consumers	Reasons of using leaves; Perception of acceptance and plastic reduction	110

Source: Field Survey (2024)

After picking the leaves, they strip the sheaths using by pencil knife to remove the layers of the sheath and tie them into countable bundles for selling respective local markets (Figure 3). It is locally called “**Phet Paing**”. It takes about 2-3 hours to arrive the forest where they collect. Most of the respondents use motorbike to go and pick the leaves but a few of them use on foot. There is no local regulation for harvesting the leaves. It is open access and everybody can pick the leaves. According to the interview, it can be indicated that harvesting practice may not harm the plant population or environment. This is because local residents pick only 2-5 leaves from a tree and they never pick new shoots. After 3-4 days, these new shoots become mature size (about 1-3 feet) for wrapping materials. The following table shows the demographic characteristic of collectors including income contribution from selling Inn-leaves are given in the Table (3). Collectors are resource poor households and harvesting Inn-leaves is main livelihood for 75 % of respondents.



Figure 3 Left: Carrying bundles of Inn-leaves by motorbike; Right: Women carrying and selling leaves to markets

Table 3 Demographic characteristics of Inn-leaves collectors

	Frequency	Percentage
Age of the collectors		
30-40 years	9	38
40-50 years	10	42
50-60 years	5	20
Year of experience of collecting Leaves		
1-10 years	6	25
10-20 years	13	54
20-30 years	5	21
Annual gross income from selling leaves (kyats)		
<500 million	19	79
500 - 1000 million		
1000 - 1500 million		
1500 - 2000 million	5	21
Number of collectors who have alternative income	6	25
Number of collectors who depend on selling leaves	18	75

Source: Field survey (2024)

3.1.2 Production of Inn-leaves

Among the 18 markets we selected for the study, 10 markets including Yezin, Gandama, Lane Pyinmana, Lewe, Pobbathiri, Ywa Taw, Yuzana, Thapyaygone, Myoma, Aharathukha have its own collectors who directly sell Inn-leaves to the sellers whereas remaining 8 markets including Alar, Sin Phyu Shin, Ngu Shwe War, Ingyin, Shwe Thazin, Kyidaunggan, Aung Zabu and Shwe Kyar Pin have no collectors. They bought it from Aharathukha market and the average annual use is relatively small compared to other markets. **It may be related to small number of sellers and types of vegetables and food, it is not easy to buy Inn-leaves.** The number of sellers who used Inn-leaves for wrapping varies widely, with a maximum of 198 shoppers to minimum of 10 consists of 70% flowers sellers, 20 % of motephathae and 10 % of vegetable sellers. According to interview and our observation during market survey, the average number of leaves used by the sellers who sell flowers, traditional food particularly for motephat and vegetables is about 70 to 500 leaves, 80-150 leaves and 60 to 100 leaves a day respectively.

Aharathuka market has not only local collectors but also wholesalers who distribute the leaves to other markets and users. They use the service of middlemen to collect Inn-leaves from collectors particularly from Thargaya, Taungu and Yetarshe. According to interview with 19 local collectors and 5 wholesalers who supply Inn-leaves and 293 shoppers who use Inn-leaves, the estimated annual production is around 56.6 million leaves while estimated annual use is around 39 million in Nay Pyi Taw Union Territory as shown in Table (4). The total number of Inn-leaves used for all sellers in a market range from 2 million to 38.9 million. The highest production is found in Aharathuka market which is about 50.5 million leaves whereas the highest use is found in Thapyaygone market which is about 8.76 million leaves.

Table 4 Annual production and use of Inn-leaves

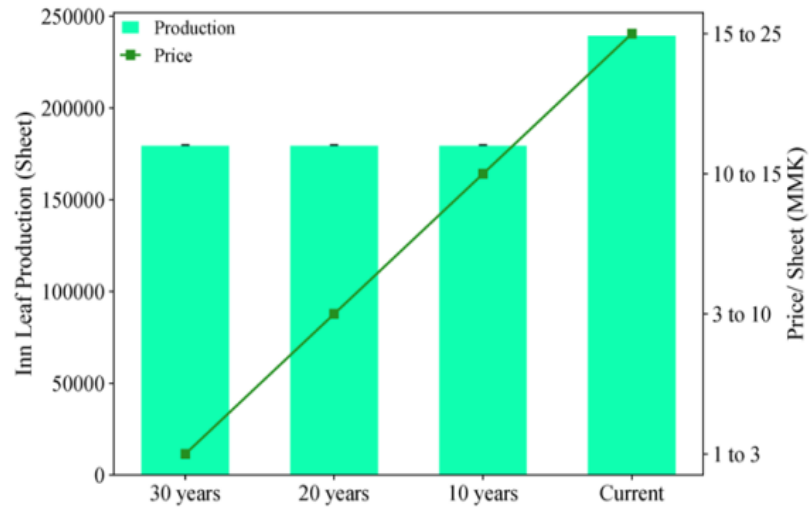
Name of the market	Annual production of Inn-leaves	Annual use of Inn-leaves
Aharathuka market	50,508,000	6,161,562
Thapyaygone market	1,620,000	8,646,205
Myoma market	1,476,000	3,639,916
Yuzana market	972,000	2,152,080
Ywa Taw market	648,000	3,132,000
Pobbathiri market	486,000	1,800,900
Lewe market	324,000	828,000
Lan Pyinmana market	324,000	3,077,625
Gandama market	162,000	421,200
Yezin market	162,000	1,969,800
Shwe Kyar Pin market	0	1,042,100
Aung Zabu market	0	1,243,620
Kyidaunggan market	0	1,986,072
Shwe Thazin market	0	1,134,642
Ingyin market	0	916,370
Ngu Shwe War market	0	349,920
Sin Phyu Shin market	0	264,000
Alar market	0	259,200
Total	56,682,000	39,025,212

Source: Field survey (2024)

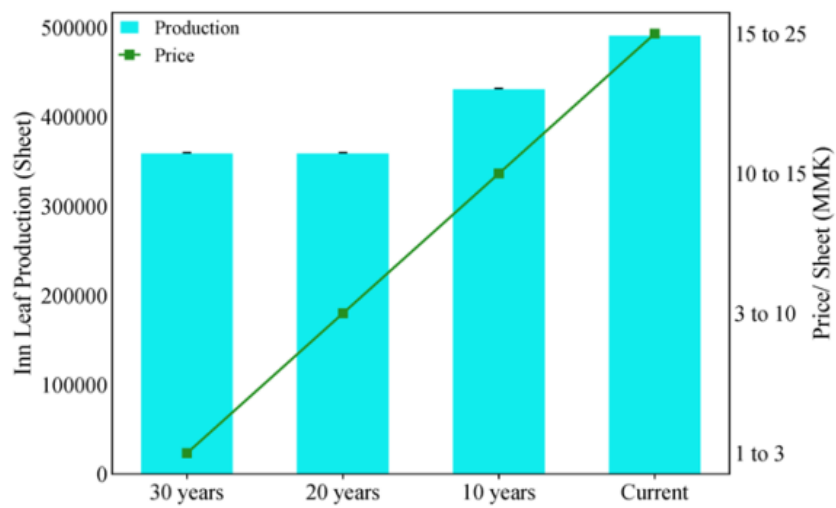
The average annual production per market is about 3.15 million leaves while average annual use is 2.16 million leaves.

3.1.3 Trend Analysis of production and price of Inn-leaves

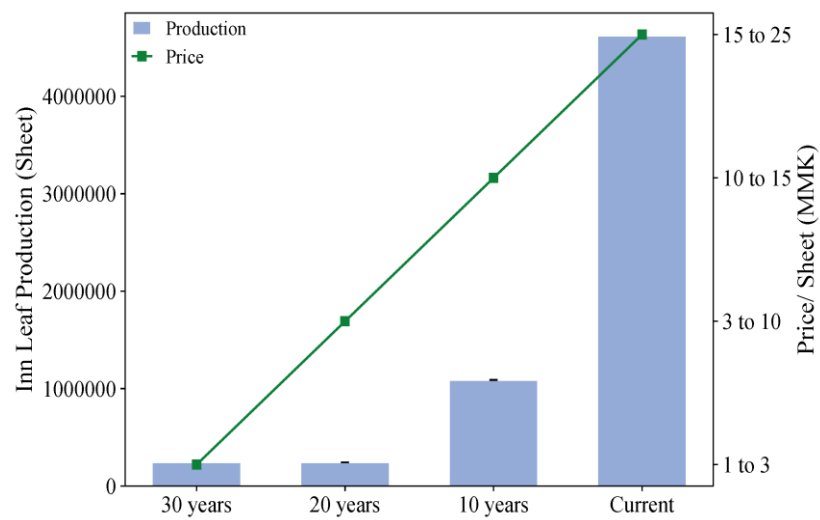
Based on a combination of secondary and primary information, we gathered information on trends in prices and market growth for Inn-leaves in three markets namely Yezin Market (a), Thapyaygone Market (b), and Aharathukha Market (c) based on the availability of collectors who has been harvested the leaves more than 30 or 20 years. Among the selected three markets, Yezin market is located before the Nay Pyi Taw city development and there are about 20 sellers who used Inn-leaves for wrapping in the market. The overall production of Inn-leaves is relatively stable because there is no changes in market demand and consumer preference. As for Aharathukha and Thapyaygone markets which were upgraded as large markets after Nay Pyi Taw city development, production of Inn-Leaves has increased about 2-3 times of previous production as demand increased. Aharathuka market became wholesale that distribute Inn-leaves not only to Nay Pyi Taw city areas but also other regions e.g. Shan state. Last 30 years or 20 years ago, collectors harvest Inn-leaves as subsistence scale using on foot. After urban development, they use motorbike in collecting leaves as collection area is far away (about 20-30 miles) from their home. The price is slightly fluctuate based on the season and location of the markets. For instance, prices may drop during April-September when supply is high and increase in summer season when supply is low. The current price is 15 to 25 kyats per leaf in general, however, the price in summer is as high as about 30-40 kyats in some markets.



(a) Yezin Market



(b) Myoma market



(c) Aharathuka market

Figure 4 Trend in prices and market growth of Inn-leaves

3.2 Potential of reduction of plastic bags

According to Kalina et al (2024), packaging material is responsible for 50 % of plastic produce around the world. Since ancient time, different plant materials are used in packing and serving food. Inn-leaves are one of the NTFP produce collected from the forest by local residents and it has a long tradition of use in food packaging. Compared to plastic bags, Inn-leaf is relatively cheap to be used in natural packaging because it costs 15-25 kyats depending on the market whereas it costs about 250 kyats for a large size plastic bag 9"x18", 150 kyats for middle size (12"x4") and 100 kyats for small size (14"x 28"). The sellers indicated that they use Inn-leaves because of its cool effects to food, vegetables and flowers compared to plastics rather than its low costs. Table (5) shows annual use of Inn-leaves per market and its potential for plastic reduction. According to our measurement, 100 Inn-leaves is equal to 210 kyathar (2viss) whereas 100 of large, medium and small size of plastic bags are equal to 74 kyatthar, 32 kyatthar and 20 kyatthar respectively. Based on that calculation, 100 of Inn-leaves is nearly equal to 284 plastic bags of large size; 656 of medium size and 1,050 of small size. Hence, annual plastic reduction by using Inn-leaves in Nay Pyi Taw Union Territory is about 3 million kg for (14x28) plastic bag, 2 million kg for (12x24) plastic bag and 1 thousand kg for plastic (9x18) bag. Our study supports the previous finding of Kalina et al (2024) that biodegradable packaging material will be productive solution to maize plastic pollution.

Table 5 Annual use of Inn-leaves and its potential for plastic reduction

Name of Market	Annual use of Inn-leaves	Potential of Plastic Reduction		
		9x18 Size	12x24 Size	14x28 Size
Aharathuka Market	6,161,562	64,696,401	40419847	17498837
Thapyaygone Market	8,646,205	90,785,153	56719105	24555222
Myoma Market	3,639,916	38,219,118	23877849	10337361
Yuzana Market	2,152,080	22,596,840	14117645	6111907
Ywa Taw Market	3,132,000	32,886,000	20545920	8894880
Pobbathiri Market	1,800,900	18,909,450	11813904	5114556
Laeway Market	828,000	8,694,000	5431680	2351520
Lane Pyinmana Market	3,077,625	32,315,062	20189220	8740455
Gandama Market	421,200	4,422,600	2763072	1196208
Yezin Market	1,969,800	20,682,900	12921888	5594232
Shwe Kyar Pin Market	1,042,100	10,942,050	6836176	2959564
Aung Zabu Market	1,243,620	13,058,010	8158147	3531881
Kyitaungkan Market	1,986,072	20,853,756	13028632	5640444
Shwe Thazin Market	1,134,642	11,913,741	7443251	3222383
Ingyin Market	916,370	9,621,885	6011387	2602491
Ngu Shwe War Market	349,920	3,674,160	2255475	993773
Sin Phyu Shin Market	264,000	2,772,000	1731840	749760
Alar Market	259,200	2,721,600	1700352	736128
Total	3,9025,212	409,764,727	255,965,390	110,831,602
		20,488,236	7,998,918	1,497,724
		327,812	127,983	23,964

3.3 Consumer perception of using Inn-leaves

We documented users' preference of Inn-leaves on using packaging for food, vegetables and flowers. The 110 consumers comprised 24 (22%) males and 86 (78%) females. Among the consumers, 83 respondents (75%) like Inn-leaves for wrapping food, vegetables and flowers because of good health affect to consumers, non-toxic and durable nature, environmentally friendly, biodegradability, their fragrance and flavor as shown in Table (6). Remaining 27 (25%) respondents' especially young ladies under age 30 dislike it because of impossibility to wrap the liquid food items and inconvenience to hold and carry by hand. Although they don't prefer to use, they are aware of good health effect of Inn-leaves compared to plastics. The sellers indicated that they use Inn-leaves because of its cool effects to food, vegetables and flowers compared to plastics.

Table 6 Consumer attitudes on preference of Inn-leaves

No.	Reason of using Inn-leaves	Frequency	Percentage (%)
1.	Good health affect to consumers	44	53
2.	Non-toxic and durable nature	26	31
3.	Environmentally friendly	4	5
4.	Biodegradability	6	7
5.	Fragrance and flavor	3	4

Source: Field survey (2024)

4. Conclusions

It is estimated that more than 56.6 million of Inn-leaves are harvested annually in Nay Pyi Taw Union Territory while sellers from the markets used around 39 million of leaves (70 % of production). The higher the number of sellers who sell flowers and traditional food items the higher the use of Inn-leaves. Study reported that current production of Inn-Leaves has increased about 2-3 times compared to production of last 30, 20 and 10 years ago. However, the price is steadily increased and it is slightly fluated based on the season and location of the markets. The current price is 15 to 25 kyats per leaf in general, however, the price in summer is as high as about 30-40 kyats in some markets. As the annual use of Inn-leaves is around 40 million, annual plastic reduction is likely to be 3 million kg for the size of 14"x28" plastic bag, 2 million kg for the size of 12"x24" plastic bag and 2 thousand kg for the size of 9"x18" plastic bag. Our study supports the previous research finding that biodegradable packaging material will be productive solution to maize plastic pollution. Among the consumers, 83 respondents (75%) like Inn-leaves as wrapping material because of good health affect to consumers, non-toxic and durable nature, environmentally friendly, biodegradability, their fragrance and flavor. Due to the resource availability, consumers' preference and family daily income which can earn about 25,000-30,000 kyats, it can be concluded that the culture of using Inn-leaves would continue in Nay Pyi Taw Union Territory. We should pay attention to conservation of Indaing forest because of its socio-economic, cultural and environmental importance. School children should be educated and motivated to realize the importance of plastic waste and benefits of plant leaves.

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