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Improving the community's herbal raw material quality control

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Abstract - A model national master plan on the development of Thai herbs No. 1, 2017-2021, aims to develop Thai herbs for economic stability driven by innovation (Value-Based Economy), with a comprehensive plan for the development of Thai herbs from the beginning of production, during the production, and distribution process. The development of herbal raw materials to have international quality, marketing promotion, and promoting the use of herbs and Thai traditional medicine are one of the main strategies for driving the country. It is necessary to rely on techniques and research methods to cover every step from agriculturist selection, species selection, planting process, harvesting process, and post-harvest storage, including analysis of the content of medicinally active substances in order to be developed into the best quality herbal products. The objectives of the research include 1) to transfer the knowledge of growing herbal plants in organic farming, 2) to encourage the production process of herbal raw materials to have quality and standards (Thai Herbal Pharmacopoeia), and 3) to assess the agriculturist's satisfaction towards herb production. *Andrographis paniculata* (Burm.f.) Nees and *Curcuma longa* L. were encouraged to the 20 agriculturists' target group in Ban Kota Village, Phra That Subdistrict, Na Dun District, Maha Sarakham Province, who voluntarily participated in this project. Planting experiments were conducted from May 2016 to January 2017. The data were collected by analyzing medicinal active substances and using community satisfaction questionnaires. The results showed that the content of curcuminoids in *Curcuma longa* was approximately 5.56% of dry weight. And the andrographolide content in *Andrographis paniculata* was about 6.62% of dry weight, which is consistent and higher than the standard requirements for Thai herbs. It is a result of growers having knowledge

and understanding of the quality control process of herbal raw materials. Take into consideration the factors that make the product safe with good agricultural practices, good harvesting practices, as well as producers, places, equipment, and management, thus making high-quality herbal raw materials. The growers were the most satisfied with the herb yield at 98 percent. At present, the aforementioned grower's group has registered as "Ban Kota Organic Herb Growers Community Enterprise" with Walai Rukhavej Botanical Research Institute as a knowledge provider on the process knowledge and sale in the community. In 2020, the group entered into a memorandum of understanding (MOU) with Pharmcare Pharmaceutical Factory, Faculty of Pharmacy, Mahasarakham University to sell quality herbal raw materials to the factory in the form of medicinal powders, including *Andrographis paniculata* (Burm.f.) Wall. ex Nees., *Curcuma longa* L., *Cissus quadrangularis* L., *Zingiber cassumunar* Roxb., and *Thunbergia laurifolia* Lindl.

Keywords: *Andrographis paniculata* (Burm.f.) Nees, *Curcuma longa* L., medicinal active substances

1. Introduction and significance

Since 2004, the government policy announced Thailand as an international Medical Hub. The strategic plan supports four areas of operation, consisting of medical treatment, health promotion, Thai traditional and alternative medicine, and health products and Thai herbs to meet standards, which is consistent with the National Master Plan on The Development of Thai Herbs No. 1 (2017 – 2021), which aims to develop Thai herbs toward value-based economic stability and necessitates a comprehensive research methodology for herbal raw materials. To develop quality herbal goods in the form of Thai Traditional Medicine, Phytopharmaceuticals, Dietary supplements, Cosmeceuticals, and other products. Through the master plan, the government's strategy has promoted stakeholders in the herbal business. As a result, the herbal market is experiencing exponential expansion around $91.8 billion in total. The countries with the highest market value of herbs are Japan, Korea, China, France, Germany, and countries in Asia, with the value of using and exporting Thai herbs in the dietary supplement group totaling more than 80 billion baht, and products in the spa group having a value of approximately 10 billion baht, the traditional medicine group according to the wisdom of traditional Thai medicine with a total value of approximately 10 billion baht (National Medicine Committee, 2006)

The epidemic Covid-19 is considered a major factor that has prompted the use of medicinal plants to initially treat and alleviate the symptoms of the disease in recent years, as well as the increase in the country's aging population, resulting in the increasing popularity of herbal medicines especially *Andrographis paniculata* (Burm.f.) Nees. It has been used well to treat COVID-19 symptoms. Since 1999, *Andrographis paniculata* is added to the traditional Thai medication list by the Ministry of Health and has been classified with the following indications: bacillary dysentery, pharyngotonsillitis, and to treat the common cold symptoms including sore throat, weariness, muscular aches, etc. There are also many medicinal plants that are effective in treating disease symptoms such as Turmeric (*Curcuma longa* L.) which is used to cure dyspepsia.

Therefore, the promotion of planting medicinal plants and traditional Thai medicine is one of the national strategies that must be developed, rehabilitated, and seriously pushed to appreciate the value and being an invaluable alternative medicine in today's society. It can be seen from the trend of using natural products which tends to increase. The awareness of health care before illness, or during illness has caused many Thai people to turn to herbal remedies. And modern medicine substances derived from chemical synthesis are expensive and have a high potential for side effects, and the cost of treating illnesses is too high. Each year, Thailand loses a lot of money to import drugs from abroad for use in the Thai health care system. The significance of importing modern medicines for humans from abroad for the year 2020 has reached a total of 145,624.8 million baht. While the value of modern medicines for animals has reached a total of 9,719.04 million baht (Chokcharoenrat & Sangchontharn, 2005). For the aforementioned reason, farmers must be encouraged to have knowledge and understanding in growing quality medicinal plants in order for medicinal plants to have high levels of active medicinal substances according to the standard. Both medicinal plants in this research are highly safe and are listed on the National List of Essential Medicines for industrially developed herbal medicines and also generate additional income for local farmers and communities.

2. Objective

1. To impart knowledge in growing medicinal plants organically to farmers.

2. To promote the production of herbal raw materials to meet quality and standards (Thai Herbal Pharmacopoeia).

3. To assess the satisfaction of farmers towards their herbal products.

3. Processing duration

Fiscal Year 2016-2017

4. Target group

Ban Kota Organic Herb Growers Community Enterprise, Phra That Subdistrict, Nadun district, Maha Sarakham province.

5. Project implementations/activities/assessment methods

Quality control of medicinal raw materials in the community, the scope of the study, and methods are as follows.

5.1 The target groups for this project are the 20 agriculturists in Ban Kota Organic Herb Growers Community Enterprise, Phra That Subdistrict, Nadun district, Maha Sarakham province, who voluntarily participated in this project.

5.2 Planning and preparation by the research team in collaboration with the agriculturists in Ban Kota Organic Herb Growers Community Enterprise, and Phra That Subdistrict Administrative Organization, attended a meeting to clarify the project's objectives, and jointly to analysed the performance of the past year, whether the herbal products was sufficient to meet the market demand, sales revenue in the past year, how the quality of the raw materials was, are there any shortcomings that need to be improved, and determine the types of herbs planted, and planting locations, and clearly divide the responsibilities of the project.

5.3 Training workshops to educate about standards and quality control of raw materials with steps as follows:

5.3.1 The upstream phase is the preparation and selection of quality herb varieties, such as Turmeric cultivars that are mature, aged about 8 months or more which were bred from a group of organic herb growers in Hua Dong Sub-district, Na Dun District, Maha Sarakham Province, and including area preparation for planting and water systems.

5.3.2 The midstream phase includes planting operations, plant caring, harvesting, and post-harvest processing, all of which must meet the medicinal raw material standard requirements.

5.3.3 The downstream phase includes the preliminary processing of herbal raw materials such as washing, slicing, chopping, and drying. Baking under appropriate temperature, coarse grinding, fine grinding, powder sieving, and packaging before delivery to determine the concentration of active medicinal substances.

Currently, medicinal plants are used in a variety of ways. Whether in the form of a decoction, powder, or in extract form, the chemical components of each medicinal plant are different. Therefore, the process of controlling the quality of herbal raw materials quality herbal raw materials must be put in place to follow the high standard requirements in every step, and consistency. Must not be contaminated with microorganisms, aflatoxin, arsenic, and heavy metal pesticide. In order to obtain high-quality raw materials, there must be a good selection of herb species and variety, methods of reproduction, zoning, caring, age and method of harvesting, proper post-harvest operations, packaging, storage, and quantitative detection of active compound, including processing into quality herbal products. Consequently, each process of creating herbal raw materials is crucial and intricate. If the raw materials fulfill the standards and consistency throughout all growing plots, It naturally leads to product confidence. This educational training has selected safe medicinal plants that also have a clear clinical research report. Bringing the *Andrographis paniculata* (Burm.f.) Nees, and *Curcuma longa* L. to encourage farmers who participate in the project to grow in their area. When *Andrographis paniculata*

is about 120 days or 4 months, it is the fully grown period and starts to bloom until about 50% of the flowers bloom, which is the highest period to have active medicinal compounds, and harvested by uprooting the whole plant and then chopping the discarded roots. While *Curcuma longa* is harvested while the plant is in a dormant period, at the age of 8 months by collecting the rhizomes. During harvesting, it is important to be careful of contamination by weeds or other poisonous plants, soil, or sand, and harvest when there is no rain to minimize contamination. As for post-harvest processing, drying, packaging, and storage of raw materials, the group members followed the procedures under the strict supervision of the Staff from the Walai Rukhavej Botanical Research Institute, Mahasarakham University, before delivering raw materials to the Farm Care pharmaceuticals factory, Faculty of Pharmacy, Mahasarakham University, to be studied in the laboratory as a quality control herbs to meet consumer safety standards and be effective in treating diseases.

Figure 1. 120-days of Andrographis paniculata (Burm.f.) Nees

Members of the herb growers group have brought raw materials to be processed into products, including turmeric capsules, and *Andrographis paniculata* capsules. The production process at the Herb Production and Processing Building Laboratory at the Na Dun Operation Station, Walai Rukkhavej Botanical Research Institute, and the products are used for trial among members and distributed cheaply in community stores.

4. Inspection is an assessment of satisfaction, knowledge, and understanding. and the utilization of community towards project implementation activities, divided into 5 areas of assessment: 1) Speakers, 2) facilities of the venue, date and time of the event, 3) service of the research team and staff, 4) knowledge and understanding of herbal raw material quality control, and 5) utilization. At this stage, internship students in Biology from Ubon Ratchathani Rajabhat University have helped to evaluate and publicize the community to use of herbal products for health care in treating basic symptoms such as fever, cough, sore throat, and diarrhea using Andrographis paniculata capsules. while if there is colic, distension, indigestion, acid reflux, or stomach disease It is recommended to use turmeric capsules instead of modern medicines, etc.

Figure 2. Andrographis Capsules and Turmeric Capsules

5. Conclusion stage: It was found that the group of organic herb growers in the community had knowledge and understanding about the planted herbs, both species growth, planting process, maintenance, and harvesting, and has been trained in both quality control techniques for herbal raw materials and cleaning, there is a knowledge management process by exchanging knowledge through doing (Learning by doing), or learning by action (Action learning), Focus on the process of taking lessons in the 3R system (3-Review), consisting of Before action review, During action review, and After action review, with Record practical data in every production process so that it can be used to verify production methods that will lead to the production of quality herbal raw materials.

Figure 3. Ban Kota Community Enterprises Group Herbal Products

6. Summarize the results of operations and important issues from the implementation of the project/activity

6.1 Quality control of medicinal raw materials

The quality control of medicinal raw materials are divided into two species control as followed:

6.1.1 *Curcuma longa* L. (Turmeric)

The turmeric powder was obtained from the organic farms of the participating farmers and was analyzed at the laboratory of the Faculty of Pharmacy, Mahasarakham University, The analysis results are as follows:

6.1.1.1 Standard curve of curcumin

1) Standard curve of curcumin using the 1 mg curcumin standard material dissolved in ethanol 1 ml, and diluted to five different concentrations ranging from 1 to 0.0625 mg/ml, and HPLC analysis revealed an R^2 value = 0.9994 (R^2 is the correlation coefficient, which indicates how much the x variable influences the y variable. If it approaches 1, indicates that there is a high correlation. From the equation, Y = 3E+07x – 407298 (3E+07 = $3x10^7$; X = concentration, Y = area under the graph) as shown in table 1 and figure 4.

Table 1. The correlation between curcumin concentration (Conc.) and area under the graph (AUC) of curcumin is based on HPLC analysis.

Chemical compound	Concentration (mg/ml)	Area under the graph
Curcumin	1	26,398,367
	0.5	13,178,596
	0.25	5,890,346
	0.125	2,935,407
	0.0625	150,2981

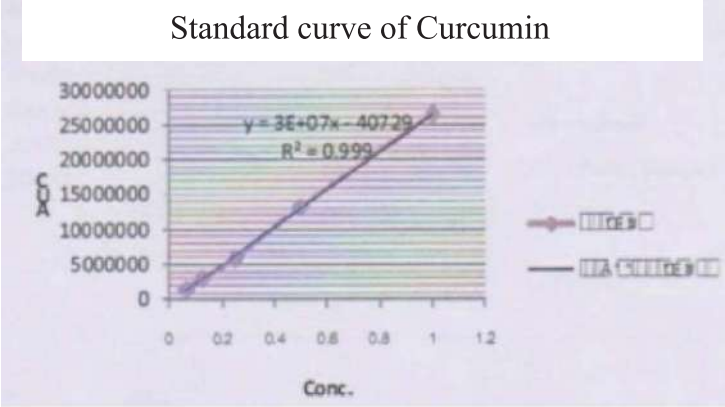


Figure 4. Standard curve of curcumin

6.1.2 *Andrographis paniculata*

6.1.2.1 Standard curve of andrographolide

1) The standard curve of andrographolide by using 1 mg of andrographolide dissolved in 1 ml of ethanol, diluted to five various concentrations ranging from 0.5 to 0.03125 mg/ml, and then evaluated by HPLC analysis, determined that the value $R^2 = 0.9987$, from the equation $Y = 1E+07x + 41955$ ($1E+07 = 3x10^7$; X = concentration, Y = area under the graph) as shown in Table 2 and Figure 5.

Table 2. The correlation between andrographolide concentration (Conc.) and subgraph area (AUC) is based on the HPLC analysis.

Chemical compound	concentration (mg/ml)	Area under the graph (dots)
Andrographolide	0.5	5,786,734.667
	0.25	2,774,898.667
	0.125	1,557,234.333
	0.0625	765,825
	0.03125	382,282.3333

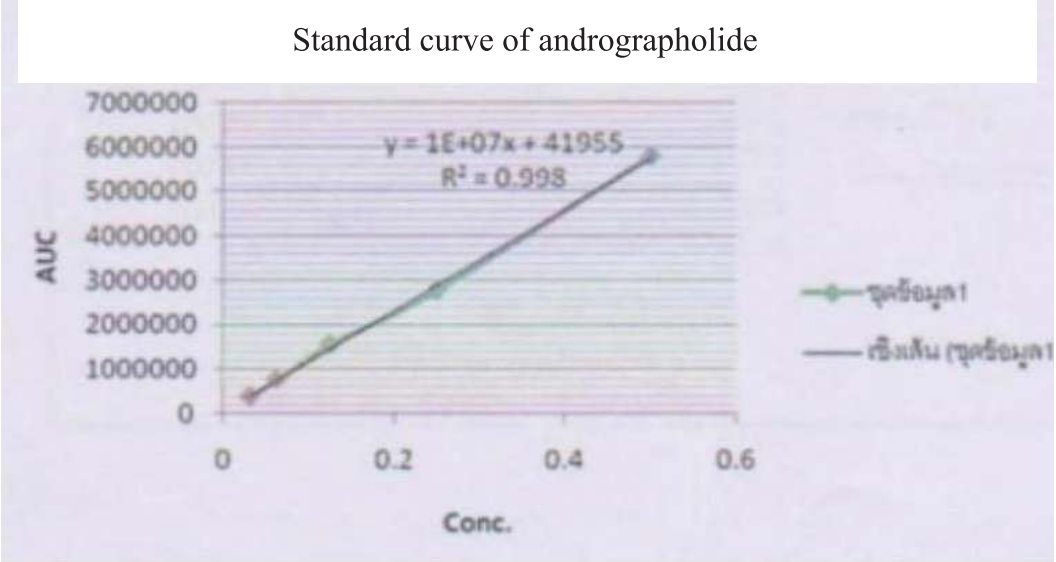
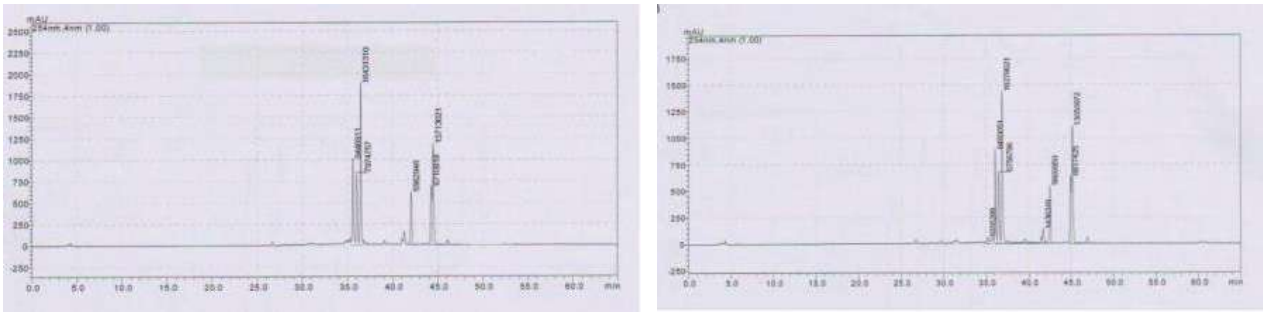


Figure 5. Standard curve of andrographolide

2. Result of the measurement of the active compound from herbs

2.1 Curcumin content in turmeric

Analyzing the absorbance of the active compounds from HPLC examination, the mean area under the curcumin peak in the HPLC chromatogram of turmeric extract of plot 1 was 1,657,919 and the second plot is 16,686,864. When substituted from the equation, then calculates the amount of curcumin found in turmeric 100 mg, it is found that the curcumin content is 5.54 and 5.58 mg respectively. The chromatogram is shown in Figure 6 and Table 3.



Plot 1 Plot 2

Figure 6. HPLC chromatograms of turmeric in both plots

Table 3. Analysis of curcumin content in turmeric

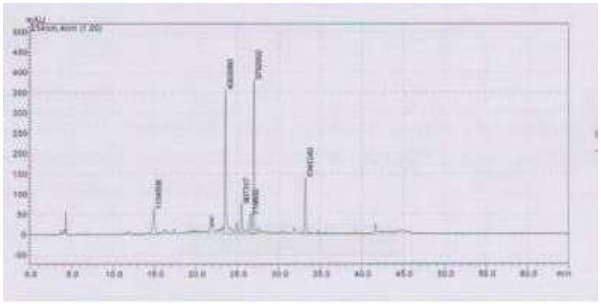
Herb	Plots	Area under curve (AUC)	Concentrations determined using formulas	250 mg of chemical is contained in the powder	Substance content In powder 100 mg	S.D.	Compared to standard substances
Tur-meric	plot 1	1,657,919	0.55	13.85	5.54	0.04	Curcumin
	plot 2	16,686,864.67	0.56	13.94	5.58	0.15	Curcumin

S.D. = standard deviation

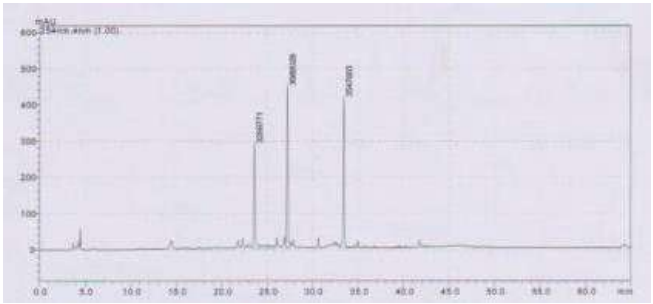
The results of the HPLC analysis of curcumin content in turmeric herbs are shown in Table 3: Turmeric is extracted with sonication for 30 minutes, then filtered through a millipore filter, injected with 20 microliters of HPLC volume, and the curcumin content in turmeric extract is compared to the standard graph. Then, the content of curcumin in turmeric extract was compared with the standard curve. It was found that turmeric in plot 2 contained slightly more curcumin than in plot 1, with curcumin contents of 5.58 and 5.54 percent respectively, without significant differences.

2.2 Analysis of andrographolide content in *Andrographis paniculata*

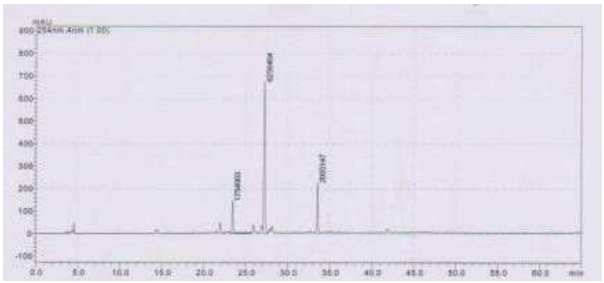
When evaluating the amount of andrographolide in *Andrographis paniculata* with HPLC, the area below the graph's peak was typical. The number of andrographolides in plot 1 is 3,943,726; the number in plot 2 is 4,068,799; the number in plot 3 is 6,655,324.33. When substituting the values in the equation to calculate the amount of andrographolide found in Andrographis paniculata 100 mg. The andrographolides contents were 3.90, 4.03, and 6.62 respectively. The characteristics of HPLC chromatograms were shown in Figure 7 and Table 4.



Plot 1



Plot 2



Plot 3

Figure 7. HPLC chromatogram of andrographolide

Table 4. Analysis of andrographolide content in *Andrographis paniculata* extracts

Quantitative analysis of the Andrographolide content in *Andrographis paniculata.*							
Herb	**Plots**	**Area under curve (AUC)**	**Concentrations determined using formulas**	**250 mg of chemical is contained in the powder**	**Substance content In powder 100 mg**	**S.D.**	**Compared to standard substances**
Andrographis paniculata	plot 1	3,943,726	0.39	9.75	3.90	0.17	Andrographolide
	plot 2	4,068,799	0.40	10.07	4.03	0.079	Andrographolide
	plot 3	6,657,324.33	0.66	16.54	6.62	0.35	Andrographolide

S.D. = standard deviation

From Table 4, the results of the analysis of *Andrographis paniculata* content in *Andrographis paniculata* obtained from HPLC analysis revealed that when the *Andrographis paniculata* was extracted by sonication for 30 minutes, then filtered through a millipore filter and injected with 20 microliters of HPLC, and analyzed for the andrographolide content in the solution. *Andrographis paniculata* extract was compared with the standard graph. It was found that plots with the most important amount of substances were plot 3 with the andrographolide 6.62%, followed by plots 2 and plot 1, with 4.03% and 3.9% respectively.

By encouraging local communities to use herbal medicines instead of modern medicines when they first get sick, it was found that the members of the enterprise group had more knowledge and understanding of the quality control process of turmeric and *Andrographis paniculata* measured by the satisfaction assessment form, their knowledge, understanding, and utilization of the herb, taking into account factors that contribute to product quality, and safety, from good agricultural processes, good harvesting processes, and planting herbs in an organic way. Therefore, confidence in the quality of the product is measured by the amount of active medicinal substances and their actual use when colic, indigestion, and stomach disease occur. The community uses turmeric capsules to replace modern medicines. And use *Andrographis paniculata* capsules when symptoms of fever, cough, or sore throat, which could be assessed from the number of production and income from sales per month.

3. Evaluation results of community satisfaction towards their herbal products.

Evaluation results of satisfaction in the use of herbal products for the benefit of the community on herbal products It was found that 98 percent of organic herbal growers had the highest satisfaction with herbal products, while another 2 percent commented that the intake of turmeric capsules or *Andrographis paniculata* 4–5 capsules at once is tough to swallow.

7. Discussion of performance/Concise synthesis and recommendations

Quality control of medicinal raw materials. The turmeric and *Andrographis paniculata* were extracted with sonication for 30 minutes, then filtered through a millipore filter, and injected with 20 microliters of HPLC. The curcumin content in the turmeric extract was 5.56%. In this analysis, only the content of curcumin is analyzed, which is 1 in 3 of the chemicals that are constituents of the total curcuminoids in turmeric. (curcuminoids include curcumin, demethoxycurcumin, and bisdemethoxycurcumin). Curcumin typically comprises two-thirds of the total curcuminoid content. According to the requirements of the Thai Herbal Pharmacopoeia, turmeric raw materials for the production of medicines must contain curcuminoids not less than 5%. Although this study did not analyze the total curcuminoid content, only the results obtained from studies of single curcumin content were greater than that of curcuminoids accordingly to the standards prescribed in Thai Herbal Pharmacopoeia. Therefore, if analyze the volume of curcuminoids there may be quite greater than the standard.

While *Andrographis paniculata* contained andrographolide about 6.62% (Gangathip, 1997) The results of the study were consistent with the quality control guidelines for herbal products. It was found that the major substances found in the aboveground part were several types of diterpene lactones, including Andrographolide (AP_1), Neoandrographolide (AP_4), Deoxyandrographolide, 14-Deoxy-11,12-didehydroandrographolide (AP_3). Good *Andrographis paniculata* raw materials should have total lactone not less than 6% by weight[3]. This analysis is a specific analysis of only the amount of andrographolide, which is one of the total lactones. Therefore, if analyze the volume of total lactone there may be quite greater than the standard.

The research results appear like this due to the members of the group have knowledge and understanding of quality control processes for both species of medicinal raw materials. Taking into account the factors that make the product safe. From good cultivation processes, good harvesting processes, and organic farming. Including producers, premises, tools, equipment, and good management, thereby making medicinal raw materials of high quality.

2. Turmeric capsules are used by local communities for primary illnesses such as colic, indigestion, and gastritis. While *Andrographis paniculata* capsules are used when fever, cough, or sore throat occurs. By evaluating the use from the number of production, and income from sales per month.

Since turmeric and *Andrographis paniculata* are herbs that are highly safe and are listed on the National List of Essential Medicines, herbal medicines have been developed. Based on research evidence, turmeric is effective in the treatment of dyspepsia (Pratanthurarak, 2003). While the Andrographolide in *Andrographis paniculata* is effective in the treatment of pharyngotonsillitis, and bacilliary dysentery, including relieving symptoms of common cold[3], which is in line with the policy of the Ministry of Public Health that focuses on campaigning for the use of herbal medicines to reduce

the importation of medicines from abroad. In addition, it also helped increase the career of growing herbs for farmers in the country as well.

3. Ban Kota Organic Herb Growers Community Enterprise had the highest satisfaction with herbal products, 98 percent. The production process for turmeric and Andrographis paniculata capsules was not extracted to extract only the active ingredients. Therefore, when having an illness, the number of capsules eaten once must be increased more than usual, to make it effective in treating the illness. The results of this research are in line with and achieve the objectives.

8. The synthesis of the study

- Partnership

Currently, the group of enterprises has formed a network of alliances and partnerships in making a community model for community-based health tourism under the name "Hello Nadun", which consists of Ban Go Ta Community Enterprise Group, Ban Dong Noi Community, and Nong Khu Sub-district Community.

- Mutual benefits

The community enterprise group earns income from selling quality herbal raw materials to Farm Care Pharmaceutical Factory, Faculty of Pharmacy, Mahasarakham University, to be developed into quality pharmaceutical products.

- Knowledge sharing and academic works

There is joint learning between the community and the research team, there is an exchange of knowledge together, and the results of the study can be published in academics.

- Assessable society impact

The community enterprise group earns its income from the sale of herbal raw materials and the health tour program "Hello Nadun" as shown in Figure 8.

Figure 8. Community Health Tourism, Nadun District, Maha Sarakham Province

9. Benefits

1. Target audience or stakeholder level (Stakeholder) has expanded the target group from the original there were 10 families interested in participating in the project, and currently, it has increased to 20 families (the average stakeholder is 4 people per family, a total of about 80 people).

2. There is a network of partners at the organizational level in the community and outside the area, to exchange of knowledge with a group of organic herb growers

in Nong Khu Sub-district, Na Dun District, Maha Sarakham Province. The Phra That Subdistrict Administrative Organization, and Nong Khu Subdistrict Administrative Organization, Na Dun District, Maha Sarakham Province provide support for the medicinal plant budget to members who are interested in participating in the project.

3. Commercially, Farm Care Pharmaceutical Factory, Faculty of Pharmacy Mahasarakham University, buys raw materials from members on an average of 50,000-100,000 baht per year.

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