The utilisation of IJAH analytics in determining the main superior medicinal plant derivatives as an effort for equitable community welfare and regional development

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The first steps in improving the welfare of farmers and driving regional development are the determination of the main superior medicinal plants and precise market segmentation. North Sumatra Province is the third-highest province in Indonesia that uses traditional medicine, although it has not been able to increase the value of farmers' welfare. The medicinal plant industry cannot thrive because the products of medicinal plants and the demands of the market are not in harmony. This research was therefore conducted to determine the main superior medicinal plants and their derivatives according to market needs to create an equitable distribution of community welfare and regional development. The study employed quantitative and qualitative analyses with location quotient (LQ), shift-share (SS), IJAH analytics and descriptive analytical methods. The results of the LQ and SS analyses revealed that there were four main superior plants (*Zingiber officinale, Kaempferia galangal, Ammomum cardamomum,* and *Morinda citrifolia*). According to the outcome of the IJAH Analytics, three of the four main superior medicinal plants (*Z. officinale, K. galangal,* and *M. citrifolia*) can treat 615,625 patients with 57 type and 17 different diseases group. The determination of the main superior medicinal plant derivatives and knowing the presence of disease sufferers are potential consumers that will increase economic transactions for farmers, the primary and secondary industries of medicinal plants. Increased economic activity results in more demand for derivatives of medicinal plants, which raises the value of Farmer Exchange Rate (FER). It also raises investment value, increases labour absorption, facilitates easier access to capital, facilitates market segmentation and clarifies consumer characteristics, all of which support equitable welfare distribution and successful regional development.

Keywords: Agro-industry, bio-pharmaceutical plants, disease, TMSB/TMBB, welfare distribution.

Due to its use of natural resources and perception as being safer than chemical and conventional drug utilisation, the use of herbal medicine has gained attention on a global scale (Upton 2016). A derivative of medicinal plants is herbal medicine. The production of medicinal plants and herbs, results from farming in the horticulture sub-sector. This type of farming is competitive, market-driven, and capable of meeting the demands of both domestic and international markets (Salim and Munadi 2017). The economics of business stakeholders, farmers, and society at large can benefit from derivatives from medicinal plants, which will support the success of local development (Volenzo and Odiyo 2020). The herbal agro-industry uses medical plant derivatives, modifying their form to boost the added value of agricultural output. According to the study conducted by Lu et al. (2020), there has been international interest in and support for medicinal plant derivatives.

Through the creation of regulatory profiles and the quality of medical plant derivatives, the developed countries of the European Union devote attention to the development of medicinal plant derivatives. A law passed by the European Medicines Agency that protects consumers and offers unrestricted chances for the development of medicinal plant derivatives establishes regulations. In Europe and the United States, one in three cancer patients reported that they used plant-based remedies to speed up their recovery (Ben-Arye et al. 2016;

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Roosta et al. 2017). The traditional medicine sector is supported by the governments of China and India. The "Outline of the Development of Modernization of Chinese Medicine for 2002–2010" programme was established to carry out the Chinese government's assistance. As a result, the manufactured derivatives of medicinal plants can enter the markets of numerous developed nations in Asia, Europe, and Australia (Fleischer et al. 2017). The combination of medicinal plant derivatives with chemical medications prescribed by doctors is how the Indian government supports the development of these new products (Sharma and Pundarikakshudu 2019).

The natural resources of Indonesia are diverse and abundant in medicinal plants that can be used as raw materials for derivatives of medicinal plants (Ariandi and Khaerati 2016). Only a handful of the medicinal plants utilised by the Indonesian people are cultivated; most are still harvested from the wild. The Food and Drug Administration (FDA) of Indonesia has concluded that 15 of the 283 types of medicinal plants should be cultivated. Such medicinal plants are *Zingiber officinale, Acorus calamus, Alpinia galanga, Ammomum cardamomum, Kaempferia galanga, Morinda citrifolia, Curcuma longa, Phaleria macrocarpa, Zingiber zerumbet, Strobilanthes crispus, Curcuma xanthorrhiza, Andrographis paniculata, Curcuma aeruginosa, Aloe vera* and *Boesenbergia rotunda*. After China, India, and Nepal, Indonesia is reportedly the fourth-largest exporter of *Zingiber officinale* (Salim and Munadi 2017). In 15 provinces of 35 provinces in Indonesia, the 15 medicinal plants have been dispersed. One of them is in the province of North Sumatra (Pujiasmanto 2016).

A variety of medicinal plants are used as raw materials in the region of North Sumatra, which has a long tradition of traditional medicine. Traditional medicine is supported by a large population, a variety of ethnic groups, and underdeveloped health systems (Silalahi et al. 2016). The current circumstances demonstrate that medicinal plants have a significant economic benefit for the community when used properly (North Sumatra Provincial Health Office 2017). The development of medicinal plant production in North Sumatra varies every year and the production of medicinal plants in North Sumatra increased from 5,078,010 kg in 2019 to 11,996,224 kg in 2020 (Central Bureau of Statistics of North Sumatra 2021). When practically all non-oil and gas sectors underwent recession as a result of the COVID-19 pandemic, the Traditional Medicine Industry (TMI) sub-sector grew favourably, with the highest sub-sector growth of 14.96% (Ministry of Research, Technology and Higher Education 2020).

The vast variety of medicinal plant species, high production value, and fastest-growing segment of the TMI do not set the standard for the wellbeing of farmers (primary sector). This situation was evidenced by the FER of the North Sumatran horticulture subsector, which was still at less than 100 (National Planning Department 2021). Farmer exchange rate (FER) is a method of determining a farmer's degree of capability and purchasing power by comparing the price indexes that farmers pay and get. The welfare of farmers is indicated by the FER value being greater than 100, which denotes favourable terms of trade for agricultural products concerning the consumption of goods and services as well as production costs (Central Bureau of Statistics of North Sumatra 2020). According to Keumala and Zainuddin (2018), an FER value greater than 100 is an indicator of an equitable distribution of welfare among farmers. The importance of the horticulture sub-sector to the district/city economy will change as the value of medicinal plants changes, and this will also have a positive impact on the welfare of farmers and the growth of the medicinal plant industry (Nurrochmat et al. 2017). If this change occurs, it will affect farmers' exchange rates by more than 100 (Faqih et al. 2020).

Traditional Medicine Small Business (TMSB) and Traditional Medicine Micro Business (TMMB) are primary industries, and the TMI is a secondary industry. Due to the mismatch between market demand and the

products produced, primary and secondary industries that engage in value-added activities by producing medicinal plant derivatives receive relatively low profits (Ratag et al. 2016). According to Bejarano et al. (2020), the primary and secondary industries were unable to endure for an extended period and did not have a substantial impact on regional development because of the incompatibility of the medicinal plant derivatives produced. It takes derivatives of medicinal plants, particularly those from North Sumatra Province, to raise the value of FER above 100. The superior medicinal plants produced must be known before identifying the derivatives of such plants. The identification of superior medicinal plants was done by research into which diseases (chronic and acute) can be treated. Following these results, the follow-up was modified to account for the presence of the diseases in the province of North Sumatra.

The aim of this research was to determine the main superior medicinal plants and their derivatives according to market needs to achieve equal welfare distribution and regional development.

Materials and methods

Sources of data

Secondary data were used in the study. There were four sources of secondary data:

1. The first set of data involved the production of 15 medicinal plants that were cultivated sustainably, according to data collected between 2016 and 2020 by the Department of Agriculture for Food Crops and Horticulture of North Sumatra Province and the Central Bureau of Statistics of North Sumatra Province.
2. The second set of data, collected between 2016 and 2020 by the North Sumatra Provincial Health Office, shows the diseases that in-patients and out-patients at 179 hospitals in the province of North Sumatra experienced.
3. The third set of information came from the IJAH Analytics application (Pratama 2019).
4. The fourth set of data emanated from research articles (journals and books).

Data analysis

Both quantitative and qualitative data analyses were performed. A quantitative analysis was carried out for the initial set of data. The second, third, and fourth sets of data all underwent qualitative examination. Quantitative analysis was carried out using location quotient (LQ) and shift-share (SS) methods. Qualitative analysis was conducted with the IJAH analytics application and descriptive analysis.

A. *Location quotient (LQ)* was employed to establish whether or not medicinal plants were based in the regencies/cities of the North Sumatra Province. The LQ method was carried out by calculating the comparison of the donation of medicinal plants of type X with the contribution of all medicinal plants in the district/city (Bangun 2017). The LQ formula is as follows, Bangun (2018):

$$LQ = \frac{(Kij/Kj)}{Kin/Kn}$$

Description:

K_{ij} = total production of a medicinal plant (X) in 2020 in a district
K_j = total production of all medicinal plants in 2020 in a district
K_{in} = total production of medicinal plant (X) in 2020 in Indonesia
K_n = total production of all medicinal plants in 2020 in the province

LQ > 1: base commodities (commodities that have a significant effect on the total production of medicinal plants)
LQ < 1: non-base commodities (commodities that have no significant effect on the total production of medicinal plants)

B. *Shift-share (SS)* was used to estimate the economic potential of a region. It was estimated through the priority setting of medicinal plant bases with top priority. The SS method was carried out by comparing the amount of production of medicinal plants in district/city X in 2020 and 2016 with the production of provincial medicinal plants in 2020 and year 2016 (Bangun 2018). The general form of the equation of the shift-share analysis and its components is as (Knudsen, 2000):

$\Delta K_{ij} = PPW + PP$

Description:

1. ΔK_{ij} = a value that indicates whether the medicinal plant is classified as a top, second or third priority
2. PPW = PPW_{ij} / Y_{ij}
   PPW_{ij} = $(r_i - Y_{ij}) \times R_i$
   r_i = $(Y'_{ij} - Y_{ij}) / Y_{ij}$
   Y'_{ij} = total production of medicinal plants in 2020 in district X
   Y_{ij} = total production of medicinal plants in 2016 in district X
   R_i = $(Y'_i - Y_i) / Y_i$
   Y'_i = Total production in 2020 of medicinal plants in the province
   Y_i = Total production in 2016 of medicinal plants in the province
3. PP = PP_{ij} / Y_{ij}
   PP_{ij} = $(R_i - Y_{ij}) \times Ra$
   Ra = $(Y' - Y) / Y$
   Y' = Total production in 2020 for all medicinal plants in the province
   Y = Total production in 2016 for all medicinal plants in the province

PPW and PP are prioritised to be superior medicinal plants, if:

PPW (+) and PP (+), then prioritised to be the main superior medicinal plants
PPW (-) and PP (+), then prioritised to be the second superior medicinal plants
PPW (-) and PP (-), then prioritised to be the third superior medicinal plants

C. IJAH analytics application was utilised to determine the number of metabolites present in the primary superior medicinal plants. IJAH analytics, a network pharmacology-based online tool, is used to identify the types of compounds produced by medicinal plants, proteins targeted at the human body, and types of curable diseases. The results of the analysis will provide the best possible substances for the treatment and prevention of certain diseases (Pratama 2019). The IJAH analytics results are adjusted according to the disease and potentially treatable patients. Disease and patient data were obtained from the North Sumatera Provincial Health Office.

D. Descriptive analysis (literature study): this approach was used to combine research on the equitable distribution of welfare and regional development with the outcomes of conformity between IJAH analytics and the North Sumatra Provincial Health Office.

Results

The examination of the LQ value > 1 and the SS values, specifically PP and PPW, were used to determine the primary superior medicinal plants. Medicinal plants with minimum positive PP and PPW values in five out of the 33 districts/cities in North Sumatra Province were prioritised to be the main seeds. Four different types of medical plants: *Zingiber officinale, Kaempferia galangal, Ammomum cardamomum* and *Morinda citrifolia* were identified as the primary superior medicinal plants among the 15 varieties of medicinal plants produced by the province of North Sumatra. Based on the results of IJAH Analytics and conformity with patient data from the North Sumatra Health Office, it is known that three of the four main superior medicinal plants of North Sumatra (*Z. officinale, K. galangal* and *M. citrifolia*) have the potential to cure 54 types and 17 groups of diseases (Table 1). IJAH analytics does not have a database related to secondary metabolites contained in *A. cardamom*, so there is no disease that has the potential to be cured in the

people of the province of North Sumatra. The North Sumatra Provincial Health Office report lists both chronic and acute disorders as curable diseases. Table 2 shows the content of secondary metabolites of plants and their relationship to proteins present in the human body, Table 3 shows the relationship between proteins and potentially curable diseases, Table 4 shows the potential for curable diseases and their prevalence and Table 5 shows the potential number of patients which can be cured.

Information on patients was gathered from patient history records from 179 hospitals in the North Sumatra Province between 2016 and 2020. Patients with acute and chronic diseases require both in-patient and out-patient care (North Sumatra Health Office 2020). According to the data that were gathered, North Sumatra Province had 615,625 patients who were potential customers for the medicinal plants *Z. officinale, K. galangal* and *M. citrifolia*. Table 6 shows specifics about the disease kind and the number of individuals who have a chance to be cured.

Table 1: LQ and SS analyses of medicinal plants in North Sumatra Province

Districts/cities	Value		Type of plant			
			Z. officinale	*A. cardamomum*	*K. galangal*	*M. citrifolia*
Kab. Nias	LQ			68.97	4.26	
	SS	PP		0.60	0.31	
		PPW		31.92	8.53	
Mandailing Natal	LQ			2.92	1.83	10.45
	SS	PP		0.60	0.31	0.57
		PPW		0.22	1.02	2.79
Tapanuli Tengah	LQ					668.98
	SS	PP				0.57
		PPW				85.96
Tapanuli Utara	LQ				1.08	
	SS	PP			0.31	
		PPW			0.60	
Toba Samosir	LQ		1.21			
	SS	PP	0.11			
		PPW	0.03			
Asahan	LQ				12.04	
	SS	PP			0.31	
		PPW			0.89	
Dairi	LQ		1.27	19.82		
		PP	0.11	0.60		
		PPW		0.43		
			0.33			
Karo	LQ		1.43			
	SS	PP	0.11			
		PPW	3.94			
Deli Serdang	LQ				2.31	
	SS	PP			0.31	
		PPW			0.93	
Langkat	LQ					9.95
	SS	PP				0.57
		PPW				3.59
Humbang Hasundutan	LQ				4.19	61.90
	SS	PP			0.31	0.57
		PPW			2.37	32.81

Table 1 continued

Districts/cities	Value		Type of plant			
			Z. officinale	*A. cardamomum*	*K. galangal*	*M. citrifolia*
Pakpak Barat	LQ		1.40	6.22		
	SS	PP	0.11	0.60		
		PPW	4.37	1.24		
Samosir	LQ		1.78			
	SS	PP	0.11			
		PPW	0.59			
Tanjung Balai	LQ			5.39		106.85
	SS	PP		0.60		0.57
		PPW		0.77		54.21
Medan	LQ				9.91	
	SS	PP			0.31	
		PPW			2.28	
Padang Sidempuan	LQ				7.74	84.42
	SS	PP			0.31	0.57
		PPW			0.58	16.31

LQ: location quotient; SS: shift-share

Table 2: Relationship of Secondary Metabolism of Main Superior Medicinal Plants with proteins in the human body based on IJAH Analytics

Medicinal Plants	Ijah Analytic Information		
	Secondary Metabolite		Protein
Zingiber officinale	1.	1-Propanol	P61626|LYSC_HUMAN
			O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
	2.	Camphor	P30518|V2R_HUMAN
			P16885|PLCG2_HUMAN
			P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
			Q16620|NTRK2_HUMAN
	3.	Safrole	P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
	4.	3-carene	P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
	5.	Eucalyptol|	O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			Q16620|NTRK2_HUMAN
			P16885|PLCG2_HUMAN
	6.	(1s)-(-)-camphor	P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
	7.	532929-69-4|null	O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
	8.	532929-73-0|null	O43316|PAX4_HUMAN
			Q8NBP7|PCSK9_HUMAN
			Q6XZB0|LIPI_HUMAN
			P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			P02649|APOE_HUMAN
			O60602|TLR5_HUMAN
			Q5SW96|ARH_HUMAN
			Q6Q788|APOA5_HUMAN
			P01130|LDLR_HUMAN
			P01588|EPO_HUMAN

Table 2 continued

Medicinal Plants	Ijah Analytic Information		
		Secondary Metabolite	Protein
	9.	beta.-sesquiphellandrene	P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
			P08908|5HT1A_HUMAN
	10.	76060-35-0|1-(4-hydroxy-3-methoxyphenyl)dec-1-ene-3,5-dione	P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
	11.	Nerol	P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			P01130|LDLR_HUMAN
			Q8NBP7|PCSK9_HUMAN
			P01588|EPO_HUMAN
			Q6XZB0|LIPI_HUMAN
			O60602|TLR5_HUMAN
			P02649|APOE_HUMAN
			Q5SW96|ARH_HUMAN
			Q6Q788|APOA5_HUMAN
			O43316|PAX4_HUMAN
	12.	Shogaol	P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
	13.	Citral	P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
	14.	(-)-germacrene d	P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN|
			O43316|PAX4_HUMAN
	15.	71641-23-1|null	O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
	16.	Nerolidol	O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
	17.	(+)-alpha-curcumene	P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			P16885|PLCG2_HUMAN
	18.	Beta-sitosterol	O60343|TBCD4_HUMAN
			O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			P49810|PSN2_HUMAN
	19.	Methylglyoxal	O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			P01588|EPO_HUMAN
			O60602|TLR5_HUMAN
	20.	2-nonanone	P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
	22.	Gingerenone a	P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
	23.	Alpha-phellandrene	O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN|
	24.	Alpha-phellandrene	P3051-nonanol18|V2R_HUMAN
			O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN

Table 2 continued

Medicinal Plants	Ijah Analytic Information		
		Secondary Metabolite	Protein
	25.	(+)-cyclosativene	O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			O60602|TLR5_HUMAN
			P01588|EPO_HUMAN
	26.	|1-(4-hydroxy-3-methoxyphenyl)oct-4-en-3-one|	P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
	27.	53172-04-6|null	P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN|
	28.	53172-05-7|null	P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
	29.	8-shogaol	O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
	30.	8-gingerol	O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
	31.	10-gingerol	P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
	32.	Terpinen-4-ol	Q16620|NTRK2_HUMAN
			P16410|CTLA4_HUMAN
			Q6Q788|APOA5_HUMAN
			P01130|LDLR_HUMAN
			O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			Q8NBP7|PCSK9_HUMAN
			P01588|EPO_HUMAN
			Q5SW96|ARH_HUMAN
			Q6XZB0|LIPI_HUMAN
			O60602|TLR5_HUMAN
			P02649|APOE_HUMAN
	33.	6]-dehydroshogaol|	O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			Q6XZB0|LIPI_HUMAN
			P01130|LDLR_HUMAN
			O60602|TLR5_HUMAN
			Q8NBP7|PCSK9_HUMAN
			Q5SW96|ARH_HUMAN
			P02649|APOE_HUMAN
			Q6Q788|APOA5_HUMAN
			P01588|EPO_HUMAN
	34.	212137-56-9|null	O43316|PAX4_HUMAN|
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
	35.	Beta-bisabolene	P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			P08908|5HT1A_HUMAN
	36.	D-limonene	P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
	37.	|(-)-alpha-copaene	O43316|PAX4_HUMAN
			O60602|TLR5_HUMAN|
			P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			P01588|EPO_HUMAN

Table 2 continued

Medicinal Plants	Ijah Analytic Information		
		Secondary Metabolite	Protein
	38.	(-)-alpha-cedrene	O60602|TLR5_HUMAN
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
			P01588|EPO_HUMAN
	39.	3-methylbutanal	O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
	40.	|Alpha-farnesene	P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
	41.	Zingiberenol	P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN|
	42.	8-paradol	O43316|PAX4_HMAN
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
	43.	748159-34-4|nul	P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
	44.	748159-33-3|null	O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
	45.	532929-70-7|null	P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
			P01588|EPO_HUMAN
			O60602|TLR5_HUMAN
	46.	Beta-phellandrene	O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
	47.	Neral	P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN|
	48.	36437-95-3|null	P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
	49.	Alpha-terpineol	Q16620|NTRK2_HUMAN
			O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
	50.	Alpha-muurolene	O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
	51.	10-shogaol	P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
	52.	Citral	P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
			Q6XZB0|LIPI_HUMAN
			Q6Q788|APOA5_HUMAN
	53.	Octanal	P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
	54.	Paradol	
	55.	Alpha-pinene	P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
			Q16620|NTRK2_HUMAN

Table 2 continued

Medicinal Plants	Ijah Analytic Information		
		Secondary Metabolite	Protein
	56.	139341-65-4|null	Q6XZB0|LIPI_HUMAN
			Q6Q788|APOA5_HUMAN
			P30518|V2R_HUMAN
			O60602|TLR5_HUMAN
			P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
			P01130|LDLR_HUMAN
			P02649|APOE_HUMAN
			P01588|EPO_HUMAN
			Q8NBP7|PCSK9_HUMAN
			Q5SW96|ARH_HUMAN
	57.	Sesquithujene	P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
	58.	6-gingerol	P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
	59.	Gingerdione	O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
	60.	Sabinene	P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
	61.	[4]-gingerdiacetate	P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
			Q6Q788|APOA5_HUMAN
			Q8NBP7|PCSK9_HUMAN|
			Q6XZB0|LIPI_HUMAN
			P02649|APOE_HUMAN
			Q5SW96|ARH_HUMAN
			P01588|EPO_HUMAN
			O60602|TLR5_HUMAN
			P01130|LDLR_HUMAN|
	62.	189128-20-9|null	O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			Q8NBP7|PCSK9_HUMAN
			O60602|TLR5_HUMAN
			P01588|EPO_HUMAN
			P01130|LDLR_HUMAN
			Q6XZB0|LIPI_HUMAN
	63.	Camphene	P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
			Q16620|NTRK2_HUMAN
			P16410|CTLA4_HUMAN
			P16885|PLCG2_HUMAN|
	64.	532929-72-9|null	P16410|CTLA4_HUMAN|
			P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
			P01588|EPO_HUMAN
			O60602|TLR5_HUMAN
	65.	532929-71-8|null	P16410|CTLA4_HUMAN|
			O60602|TLR5_HUMAN
			O43316|PAX4_HUMAN
			P30518|V2R_HUMAN|
			P01588|EPO_HUMAN
	66.	Citronellol	P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
			P01588|EPO_HUMAN
			O60602|TLR5_HUMAN

Table 2 continued

Medicinal Plants	Ijah Analytic Information		
		Secondary Metabolite	Protein
	67.	Geraniol	P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			Q16620|NTRK2_HUMAN
			O43316|PAX4_HUMAN
	68.	Terpinolene	
	69.	alpha.-linalool|	P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
	70.	748159-32-2|null	O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
	71.	P-cymene	Q16620|NTRK2_HUMAN
			P01130|LDLR_HUMAN
			O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			P02649|APOE_HUMAN
			Q8NBP7|PCSK9_HUMAN
			Q6XZB0|LIPI_HUMAN
			Q6Q788|APOA5_HUMAN
			O60602|TLR5_HUMAN
			P01588|EPO_HUMAN
			Q5SW96|ARH_HUMAN
	72.	Linalool	O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
			P02649|APOE_HUMAN
			P30518|V2R_HUMAN
			Q6Q788|APOA5_HUMAN
			Q5SW96|ARH_HUMAN
			Q6XZB0|LIPI_HUMAN
			P01130|LDLR_HUMAN
			Q8NBP7|PCSK9_HUMAN
			O60602|TLR5_HUMAN
			P16885|PLCG2_HUMAN
			P01588|EPO_HUMAN
	73.	128700-99-2|null	P01588|EPO_HUMAN
			P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
			O60602|TLR5_HUMAN
			P30518|V2R_HUMAN
	74.	(z)-.beta.-santalol|	P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
	75.	Propionaldehyde	P30518|V2R_HUMAN
			O43316|PAX4_HUMAN|
			P16410|CTLA4_HUMAN
	76.	Tricyclene	P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
	77.	39029-41-9|null	O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN

Table 2 continued

Medicinal Plants	Ijah Analytic Information		
		Secondary Metabolite	Protein
	78.	Zingiberene	P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
			P08908|5HT1A_HUMAN
			O43316|PAX4_HUMAN
			Q5SW96|ARH_HUMAN
			Q6Q788|APOA5_HUMAN
			P02649|APOE_HUMAN
			Q6XZB0|LIPI_HUMAN
			O60602|TLR5_HUMAN
			P01588|EPO_HUMAN
			Q8NBP7|PCSK9_HUMAN
			P01130|LDLR_HUMAN
	79.	39728-61-5|null	O43316|PAX4_HUMAN
			P16410|CTLA4_HUMAN
			P30518|V2R_HUMAN
	80.	79067-86-0|null	P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
	81.	863780-79-4|null	O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
	82.	Nonane	O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			Q6Q788|APOA5_HUMAN
			O60602|TLR5_HUMAN
			Q5SW96|ARH_HUMAN
			P01130|LDLR_HUMAN
			Q6XZB0|LIPI_HUMAN
			P02649|APOE_HUMAN
			P01588|EPO_HUMAN
			Q8NBP7|PCSK9_HUMAN
	83.	Isoborneol	
	84.	Allyl methyl sulfide	P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
			Q6Q788|APOA5_HUMAN
			Q6XZB0|LIPI_HUMAN
	85.	2-undecanone	P01588|EPO_HUMAN
			P30518|V2R_HUMAN
			O43316|PAX4_HUMAN
			P01130|LDLR_HUMAN
			P16410|CTLA4_HUMAN
			O60602|TLR5_HUMAN
			Q8NBP7|PCSK9_HUMAN
			Q5SW96|ARH_HUMAN
			Q6XZB0|LIPI_HUMAN
			P02649|APOE_HUMAN
			Q6Q788|APOA5_HUMAN
	86.	Beta-cadinene	P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
	87.	4-methyl-2-pentanone	P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN
	88.	Octane	P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			O43316|PAX4_HUMAN|
	89.	36062-05-2|null	O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN|

Table 2 continued

Medicinal Plants	Ijah Analytic Information	
	Secondary Metabolite	**Protein**
	90. (+)-alpha-pinene|	O43316|PAX4_HUMAN
		P30518|V2R_HUMAN
		P16410|CTLA4_HUMAN
	91. Gingerdiol	P30518|V2R_HUMAN
		O43316|PAX4_HUMAN
		P16410|CTLA4_HUMAN
	92. (4)-gingerol	O43316|PAX4_HUMAN
		P16410|CTLA4_HUMAN
		P30518|V2R_HUMAN
	93. 748159-49-1|null	16410|CTLA4_HUMAN|
		O43316|PAX4_HUMAN
		P30518|V2R_HUMAN
	94. 53254-77-6|null	O43316|PAX4_HUMAN
		P30518|V2R_HUMAN
		P16410|CTLA4_HUMAN
	95. Trans-12-shogaol	P30518|V2R_HUMAN
		P16410|CTLA4_HUMAN
		O43316|PAX4_HUMAN
		P01588|EPO_HUMAN|
		O60602|TLR5_HUMAN
	96. 748159-27-5|null	P30518|V2R_HUMAN
		O43316|PAX4_HUMAN
		P16410|CTLA4_HUMAN
		O60602|TLR5_HUMAN|
		P01588|EPO_HUMAN
	97. 863780-91-0|null	P30518|V2R_HUMAN
		P16410|CTLA4_HUMAN
		O43316|PAX4_HUMAN
	98. 1-dehydro-10-gingerdione	P30518|V2R_HUMAN
		Q5SW96|ARH_HUMAN
		P16410|CTLA4_HUMAN
		O43316|PAX4_HUMAN
		P01130|LDLR_HUMAN
		Q6XZB0|LIPI_HUMAN
		P02649|APOE_HUMAN
		O60602|TLR5_HUMAN
		Q8NBP7|PCSK9_HUMAN
		Q6Q788|APOA5_HUMAN
		P01588|EPO_HUMAN
	99. Curcumene	P30518|V2R_HUMAN
		P16410|CTLA4_HUMAN|
		O43316|PAX4_HUMAN
		P20309|ACM3_HUMAN
		P53985|MOT1_HUMAN
		Q99720|SGMR1_HUMAN
		P16885|PLCG2_HUMAN
	100. 6-methyl-5-hepten-2-one	P30518|V2R_HUMAN
		O43316|PAX4_HUMAN
		P16410|CTLA4_HUMAN
	101. 6-gingesulfonic acid	P30518|V2R_HUMAN
		O43316|PAX4_HUMAN
		P16410|CTLA4_HUMAN
	102. Beta-pinene	Q16620|NTRK2_HUMAN
		P16410|CTLA4_HUMAN
		P30518|V2R_HUMAN
		O43316|PAX4_HUMAN
		P16885|PLCG2_HUMAN

Table 2 continued

Medicinal Plants	Ijah Analytic Information		
	Secondary Metabolite		Protein
Kaempferia galanga	1.	Kaempferol	
	2.	24393-56-4	
	3.	Beta-phellandrene	O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN|
	4.	3-caren-5-one	
	5.	Kaempferide	
	6.	4-methoxystyrene	
Morinda citrifolia	1.	Kaempferol	
	2.	Rutin	
	3.	Cytidine	O60343|TBCD4_HUMAN
	4.	18843-01-1|null	O60343|TBCD4_HUMAN
	5.	Deacetylasperulosidic acid	O60343|TBCD4_HUMAN
	6.	Daucosterol	O60343|TBCD4_HUMAN
	7.	942610-32-4|null	O60343|TBCD4_HUMAN
	8.	(-)-pinoresinol	
	9.	Chebi:69520	O60343|TBCD4_HUMAN
	10.	Beta-sitosterol	O60343|TBCD4_HUMAN
			O43316|PAX4_HUMAN
			P30518|V2R_HUMAN
			P16410|CTLA4_HUMAN
			P49810|PSN2_HUMAN
	11.	Asperuloside	O60343|TBCD4_HUMAN
	12.	15914-62-2|null	O60343|TBCD4_HUMAN
	13.	Clethric acid	O60343|TBCD4_HUMAN
	14.	1-hydroxyanthraquinone	
	15.	Morindone	O60343|TBCD4_HUMAN
	16.	Quercitrin	O60343|TBCD4_HUMAN
			Q13873|BMPR2_HUMAN
			P49810|PSN2_HUMAN
	17.	64070-09-3|null	O60343|TBCD4_HUMAN
	18.	Rubiadin	O60343|TBCD4_HUMAN|
	19.	Balanophonin	
	20.	1004987-19-2|null	O60343|TBCD4_HUMAN
	21.	1004987-18-1|null	O60343|TBCD4_HUMAN
	22.	1-hydroxy-2-methoxyanthraquinone	O60343|TBCD4_HUMAN
	23.	Physcion	O60343|TBCD4_HUMAN
	24.	Alizarin 1-methyl ether	O60343|TBCD4_HUMAN
	25.	366469-88-7|null	O60343|TBCD4_HUMAN
	26.	Ursolic acid	
	27.	(2r,3s,4r,5r)-2,3,4,5,6-pentahydroxyhexanal	
	28.	157744-29-1|null	O60343|TBCD4_HUMAN
	29.	Monopalmitin	O60343|TBCD4_HUMAN
	30.	497178-39-9|null	
	31.	Damnacanthol	O60343|TBCD4_HUMAN
	32.	Coniferyl aldehyde	O60343|TBCD4_HUMAN
	33.	Nordamnacanthal	O60343|TBCD4_HUMAN
	34.	Ctk0e2421	O60343|TBCD4_HUMAN
	35.	Soranjidiol	O60343|TBCD4_HUMAN
	36.	Alizarin	
	37.	9,10-anthracenedione, 1,6-dihydroxy-5-methoxy-2-(methoxymethyl)-	O60343|TBCD4_HUMAN
	38.	Rubiadin 1-methyl ether	O60343|TBCD4_HUMAN
	39.	Asperulosidic acid	
	40.	Methyl phaeophorbide	
	41.	6-hydroxyrubiadin	
	42.	Beta-hydroxypropiovanillone	O60343|TBCD4_HUMAN
	43.	Oleanolic acid	O60343|TBCD4_HUMAN
	44.	Hederagenin	O60343|TBCD4_HUMAN
	45.	Roseoside	O60343|TBCD4_HUMAN
	46.	121051-83-0|null	O60343|TBCD4_HUMAN
	47.	Yopaaoside a	O60343|TBCD4_HUMAN

Table 2 continued

Medicinal Plants	Ijah Analytic Information		
		Secondary Metabolite	Protein
	48.	Isoscopoletin	O60343|TBCD4_HUMAN
	49.	851447-05-7|null	
	50.	Isoamericanin a	O60343|TBCD4_HUMAN
	51.	Borreriagenin	O60343|TBCD4_HUMAN
	52.	9,10-anthracenedione, 1,6-dihydroxy-5-methoxy-2-methyl-	O60343|TBCD4_HUMAN
	53.	60372-13-6|null	O60343|TBCD4_HUMAN
	54.	Nicotiflorin	O60343|TBCD4_HUMAN
			P49810|PSN2_HUMAN
	55.	Phytol	
	56.	Scopoletin	O60343|TBCD4_HUMAN
	57.	Pteryxin	O60343|TBCD4_HUMAN
	58.	Barbinervic acid	O60343|TBCD4_HUMAN
	59.	Molport-039-338-633	O60343|TBCD4_HUMAN
	60.	Anthragallol 2-methyl ether	O60343|TBCD4_HUMAN
	61.	144828-18-2|null	
	62.	Rotungenic acid	
	63.	Peucedanocoumarin iii	
	64.	366469-87-6|null	O60343|TBCD4_HUMAN
	65.	Vanillil	O60343|TBCD4_HUMAN
	66.	Methyl beta-d-fructofuranoside	
	67.	Citrifolinin a	O60343|TBCD4_HUMAN

Table 3: Relationship of proteins present in the human body with diseases that have the potential to be cured by the main superior medicinal plants in North Sumatra (Presence of Patients) based on IJAH Analytics

Medicinal Plant	Ijah Analytic Information		
		Protein	Disease
Zingiber officinale	1.	P61626|LYSC_HUMAN	105200|Amyloidosis 8
	2.	O43316|PAX4_HUMAN	612227|Diabetes mellitus, ketosis-prone
			125853|Diabetes mellitus, non-insulin-dependent
			612225|Maturity-onset diabetes of the young 9
			222100|Diabetes mellitus, insulin-dependent
	3.	P30518|V2R_HUMAN	304800|Diabetes insipidus, nephrogenic, X-linked
			300539|Nephrogenic syndrome of inappropriate antidiuresis
	4.	P16410|CTLA4_HUMAN	601388|Diabetes mellitus, insulin-dependent, 12
			152700|Systemic lupus erythematosus
			609755|Celiac disease 3
			616100|Autoimmune lymphoproliferative syndrome 5
	5.	P16885|PLCG2_HUMAN	614878|Autoinflammation, antibody deficiency, and immunedysregulation PLCG2-associated
			614468|Familial cold autoinflammatory syndrome 3
	6.	Q16620|NTRK2_HUMAN	613886|Obesity, hyperphagia, and developmental delay
	7.	Q8NBP7|PCSK9_HUMAN	603776|Hypercholesterolemia, autosomal dominant, 3
	8.	Q6XZB0|LIPI_HUMAN	145750|Hypertriglyceridemia, familial
	9.	P02649|APOE_HUMAN	611771|Lipoprotein glomerulopathy
			143890|Familial hypercholesterolemia
			104310|Alzheimer disease 2
			269600|Sea-blue histiocyte disease
			107741|Hyperlipoproteinemia 3
	10	O60602|TLR5_HUMAN	601744|Systemic lupus erythematosus 1
	11.	Q5SW96|ARH_HUMAN	603813|Hypercholesterolemia, autosomal recessive
	12.	Q6Q788|APOA5_HUMAN	145750|Hypertriglyceridemia, familial
			144650|Hyperlipoproteinemia 5
	13.	P01130|LDLR_HUMAN	143890|Familial hypercholesterolemia
	14.	P01588|EPO_HUMAN	612623|Microvascular complications of diabetes 2
	15.	O60343|TBCD4_HUMAN	616087|Diabetes mellitus, non-insulin-dependent, 5
	16.	P49810|PSN2_HUMAN	606889|Alzheimer disease 4
			613697|Cardiomyopathy, dilated 1V
	17.	P08908|5HT1A_HUMAN	614674|Periodic fever, menstrual cycle-dependent
	18.	P20309|ACM3_HUMAN	100100|Prune belly syndrome

Table 3 continued

Medicinal Plant	Ijah Analytic Information		
	Protein		Disease
	19.	P53985|MOT1_HUMAN	616095|Monocarboxylate transporter 1 deficiency
			610021|Familial hyperinsulinemic hypoglycemia 7
			245340|Symptomatic deficiency in lactate transport
	20.	Q99720|SGMR1_HUMAN	614373|Amyotrophic lateral sclerosis 16, juvenile
			605726|Distal spinal muscular atrophy, autosomal recessive, 2
Kaempferia galanga	1.	O43316|PAX4_HUMAN	612227|Diabetes mellitus, ketosis-prone
			125853|Diabetes mellitus, non-insulin-dependent
			612225|Maturity-onset diabetes of the young 9
			222100|Diabetes mellitus, insulin-dependent
	2.	P30518|V2R_HUMAN	304800|Diabetes insipidus, nephrogenic, X-linked
			300539|Nephrogenic syndrome of inappropriate antidiuresis
	3.	P16410|CTLA4_HUMAN	601388|Diabetes mellitus, insulin-dependent, 12
			152700|Systemic lupus erythematosus
			609755|Celiac disease 3
			616100|Autoimmune lymphoproliferative syndrome 5
Morinda citrifolia	1.	O60343|TBCD4_HUMAN	616087|Diabetes mellitus, non-insulin-dependent, 5
	2.	O43316|PAX4_HUMAN	612227|Diabetes mellitus, ketosis-prone
			125853|Diabetes mellitus, non-insulin-dependent
			612225|Maturity-onset diabetes of the young 9
			222100|Diabetes mellitus, insulin-dependent
	3.	P30518|V2R_HUMAN	304800|Diabetes insipidus, nephrogenic, X-linked
			300539|Nephrogenic syndrome of inappropriate antidiuresis
	4.	P16410|CTLA4_HUMAN	601388|Diabetes mellitus, insulin-dependent, 12
			152700|Systemic lupus erythematosus 609755|Celiac disease 3
			616100|Autoimmune lymphoproliferative syndrome 5
	5.	O60343|TBCD4_HUMAN	616087|Diabetes mellitus, non-insulin-dependen, 5
	6.	Q13873|BMPR2_HUMAN	265450|Pulmonary venoocclusive disease 1, autosomal dominant
			178600|Pulmonary hypertension, primary, 1
	7.	P49810|PSN2_HUMAN	606889|Alzheimer disease 4
			613697|Cardiomyopath, dilated 1V
	8.	O60343|TBCD4_HUMAN	616087|Diabetes mellitus, non-insulin-dependen, 5

Table 4: Potential curable diseases and the presence of patients in North Sumatra Province

No.	Disease	Patients presences
1.	Amyloidosis 8	√
2.	Nephrogenic syndrome of inappropriate antidiuresis	x
3.	Diabetes insipidus, nephrogenic, X-linked	√
4.	Symptomatic deficiency in lactate transport	√
5.	Familial hyperinsulinemic hypoglycemia 7	√
6.	Monocarboxylate transporter 1 deficiency	x
7.	Monocarboxylate transporter 1 deficiency	√
8.	Diabetes mellitus, insulin-dependent, 12	√
9.	Celiac disease 3	x
10.	Autoimmune lymphoproliferative syndrome 5	√
11.	Alzheimer disease 4	√
12.	Cardiomyopathy, dilated 1V	√
13.	Hypertriglyceridemia, familial	x
14.	Familial hypercholesterolemia	√
15.	Prune belly syndrome	x
16.	Diabetes mellitus, non-insulin-dependent	√
17.	Diabetes mellitus, insulin-dependent	√
18.	Diabetes mellitus, ketosis-prone	√

Table 4 continued

No.	Disease	Patients presences
19.	Maturity-onset diabetes of the young 9	√
20.	Hypercholesterolemia, autosomal dominant, 3	√
21.	Microvascular complications of diabetes 2	x
22.	Hyperlipoproteinemia 3	x
23.	Alzheimer disease 2	√
24.	Sea-blue histiocyte disease	√
25.	Lipoprotein glomerulopathy	√
26.	Amyotrophic lateral sclerosis 16, juvenile	√
27.	Distal spinal muscular atrophy, autosomalrecessive, 2	√
28.	Familial cold autoinflammatory syndrome 3	x
29.	Autoinflammation, antibody deficiency, and immunedysregulation PLCG2-associated	√
30.	Periodic fever, menstrual cycle-dependent	√
31.	Hyperlipoproteinemia 5	x
32.	Hypercholesterolemia, autosomal recessive	√
33.	Systemic lupus erythematosus	√
34.	Diabetes mellitus, non-insulin-dependent, 5	√
35.	Obesity, hyperphagia, and developmental delay	√
36.	Nephrogenic syndrome of inappropriate antidiuresis	x
37.	Diabetes insipidus, nephrogenic, X-linked	√
38.	Systemic lupus erythematosus	√
39.	Diabetes mellitus, insulin-dependent, 12	√
40.	Celiac disease 3	x
41.	Autoimmune lymphoproliferative syndrome 5	x
42.	Diabetes mellitus, non-insulin-dependent	√
43.	Diabetes mellitus, insulin-dependent	√
44.	Diabetes mellitus, ketosis-prone	√
45.	Maturity-onset diabetes of the young 9	√
46.	ephrogenic syndrome of inappropriate antidiuresisN	√
47.	Diabetes mellitus, insulin-dependent, 12	√
48.	Systemic lupus erythematosus	x
49.	Celiac disease 3	x
50.	Autoimmune lymphoproliferative syndrome 5	x
51.	Alzheimer disease 4	√
52.	Cardiomyopathy, dilated 1V	√
53.	Pulmonary venoocclusive disease 1, autosomal dominant	√
54.	Pulmonary hypertension, primary,	x

Table 5: Potential number of patients with diseases that can be cured by the main superior medicinal plants in North Sumatra Province

No.	Disease	Number. of patients	Superior medicinal plants		
			Z. officinale	*K. galangal*	*M. citrifolia*
1.	Amyloidosis	2	√	x	x
2.	Diabetes	236,513	√	√	√
3.	Symptomatic deficiency in lactate transport	21	√	x	x
4.	Familial hyperinsulinemic hypoglycemia	56	√	x	x
5.	Systemic lupus erythematosus	188,941	√	√	√
6.	Alzheimer	187,312	√	x	√
7.	Cardiomyopathy	194	√	X	√
8.	Hypercholesterolemia	50	√	X	x
9.	Sea-blue histiocyte disease	35	√	X	x
10.	Lipoprotein glomerulopathy	89	√	X	x
11.	Amyotrophic lateral sclerosis, juvenile	16	√	X	x
12.	Distal spinal muscular atrophy, autosomal recessive	61	√	X	x
13.	Autoinflammation, antibody deficiency, and immunedysregulation PLCG2-associated	121	√	X	x
14.	Periodic fever, menstrual cycle-dependent	83	√	X	x
15.	Obesity, hyperphagia, and developmental delay	41	√	x	x
16.	Nephrogenic syndrome of inappropriate antidiuresis	89	x	x	√
17.	Pulmonary hypertension, primary	2,001	x	x	√
	Total patients	**615,625**			

Discussion

According to the results of the LQ and SS analyses, the province of North Sumatra has four major superior medicinal plants: *Zingiber officinale, Kaempferia galangal, Ammomum cardamomum,* and *Morinda citrifolia*. An LQ analysis was used to determine an area's internal potential, which serves as the standard for base and non-base sectors. This study is predicated on the idea that the value of all medicinal plants x in a district or city is equal to the value of all medicinal plant production in the province/region (Pratama et al. 2017). In particular, the horticulture sub-sector, which has the potential to be further developed to increase the growth of the agricultural sector in North Sumatra Province and has the opportunity to export to other regions, has a role to play as the main driver in the development of the agricultural sector (Bangun 2019). The main superior medicinal plant is a commodity from medicinal plants that have strategic value based on physical, socio-economic, and institutional considerations (mastery of technology, human resource capabilities, infrastructure, and socio-cultural conditions) to be developed in an area. Determination of the main superior medicinal plants in an area will facilitate efforts to improve the welfare of the community by creating their derivatives (Salmeron et al. 2020). To know the number of secondary metabolites of the medicinal plants' active components is necessary to produce derivatives of the primary superior medicinal plants.

Secondary metabolites are compounds found in medicinal plants that play a role in protecting the human body against physiological disorders and damage. Depending on the target protein, secondary metabolites from medicinal plants can be used to treat some diseases. To prevent harm to human cells or organ functions, secondary metabolites work to raise or improve protein

function against physiological function problems (Anggraito et al. 2018). Knowing the composition of metabolites produced by these medicinal plants will make it simple to use them as the key ingredients of a treatment (Alqethami and Aldhebiani 2020). The three most effective medicinal plants *Z. officinale, K. galangal,* and *M. citrifolia* can contain up to 50 different types of secondary metabolites, which help proteins in the body perform better (Pratama 2019). These secondary metabolites have different functions in treating patients with diseases that may be treatable.

The industry plays a role in the use of secondary metabolites to create a major superior medicinal plant derivative. North Sumatra Province has two sectors, namely primary and secondary industries. Traditional Medicine Industry (TMI) is a secondary sector, while TMSB and TMMB are primary industries that add value to superior medicinal plants. The number of potential consumers will make up the target market determines the industry's development and growth. Patients who require treatment for curing diseases are potential customers for North Sumatra's primary superior medicinal plant derivatives. Potential consumers of medicinal plant derivatives will increase the economic transactions of the primary and secondary industries of medicinal plants. If the primary and secondary industries know the exact number of potential consumers, there will be an increase in economic transactios (Gupta et al. 2016). Potential consumers are spread across regions in districts and cities and are not concentrated in urban areas (North Sumatra Provincial Health Office, 2020). Acute and chronic disease sufferers are those whose conditions may benefit from the primary superior medicinal plant derivatives. Chronic disease is defined as a degenerative condition that develops or worsens over a long period of time, typically more than 6 months (Ayub et al. 2020). Acute disease is a bodily illness or physiological imbalance that develops swiftly and lasts for a brief period (Arlati 2019).

An economic opportunity that will change the state of the primary and secondary sectors is the possibility for derivatives of the main superior medicinal plants to treat a variety of diseases experienced by the population (Purnamasari 2019). The main superior medicinal plant derivatives produced by disease trends will make it easier for farmers, in primary and secondary industries, to compete with the chemical drug industry (World Health Organization 2019; Bejarano et al. 2020). Farmers will increase the productivity of medicinal plants and land area, as a result of current demands. The price of medical plants purchased by the general public and by the primary and secondary industries of medicinal plants has increased in response to market demands (Roosta et al. 2017).

The sector that would take the lead in achieving equitable welfare has been identified as the primary superior medicinal plant derivatives (Bangun 2019). The leading sector is an initiative to boost employment, investment value, capital availability, market segmentation clarity and effective regional development (Caporale et al. 2020). How a region develops and makes use of the potential of its natural and human resources determines the effectiveness of regional development (Wahidin 2021). The identification of the primary superior medicinal plant derivatives will enable the simultaneous implementation of the concepts of equitable distribution of community welfare and accelerating economic development (Booker et al. 2016).

Conclusion

One step toward achieving an equitable distribution of welfare and regional development is the identification of the main superior medicinal plant derivatives. The findings of this study reveal that the three principal medicinal plants of North Sumatra Province (*Zingiber officinale, Kaempferia galangal,* and *Morinda citrifolia*) contain secondary metabolites that have therapeutic

effects. IJAH analytics does not have a database related to secondary metabolites contained in *A. cardamomum*, so there is no disesase that has the potential to be cured in the people of the province of North Sumatra. According to market segmentation, the main superior medicinal plant derivatives will treat 615,625 patients. The primary and secondary industries of medicinal plants will play a larger economic role as a result of the alignment of the major superior medicinal plant derivatives with the target market, which will make it simpler for farmers and the agro-industry to compete.

Author contributions

All authors contributed to the research and writing of this article.

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References

Alqethami, A., and A.Y. Aldhebiani. 2020. "Medicinal Plants Used in Jeddah, Saudi Arabia: Phytochemical Screening." *Saudi Journal of Biological Sciences* **28(1)**: 805–812. https://doi.org/10.1016/j.sjbs.2020.11.013.

Anggraito, Y.U., R. Susanti., R.S. Iswari., A. Yuniastuti., W. H. N. Lisdiana, N. A. Habibah., S. H. Bintari. 2018. "Secondary Metabolites from Plants." Faculty of Mathematics and Natural Sciences, Semarang State University.

Ariandi and Khaerati. 2016. "Identification of the Diversity Index of Medicinal Plants in the Forest Areas of Battang and West Battang Villages." *Proceedings of the National Seminar* **2(1):** 729–896. ISSN 2443–1109.

Arlati, S. 2019. "Pathophysiology of Acute Illness and Injury." *Operative Techniques and Recent Advances in Acute Care and Emergency Surgery* **2(1):** 11–42. https://doi.org/10.1007/978-3-319-95114-0_2.

Ayub, S.M.B., V.M.S.W. Marsh, and S.M.D. Reed. 2020. "An Exploration of Chronic Disease Perception, Management, and Barriers to Care in Liberian Refugees Resettled in Charlottesville, Virginia." *Journal of the National Medical Association* **112(6):** 654–667. https://doi.org/10.1016/j.jnma.2020.06.013.

Bangun, R.H. 2017. "Study of the Potential of People's Plantations in North Sumatra Province using Location Quotient and Shift Share." *Journal of Agrica* **10 (1):** http://ojs.uma.ac.id/index.php/agrica.

Bangun, R.H. 2018. "Regional Development Priority Analysis Based on Gross Regional Domestic Product Sector, Central Tapanuli Regency-North Sumatra." *Sukowati R&D Journal* **2(l):** 19–35.

Bangun, R.H. 2019. "Identification of Leading Commodities to Increase Biopharmaceutical Competitiveness in North Sumatra." *Journal of Agrica* **12 (1):** 25. https://doi.org/10.31289/agrica.v12i1.2219.

Bejarano, J.S.R., T.S. Rodrigues, C.M. Sanchez, G.K. Al, and S.M. Al. 2020. "Promoting Sustainable Businesses for Strong Local Communities: Qatar's Wild Herbal Plants Industry." *Energy Reports* **6 (8):** 80–86. https://doi.org/10.1016/j.egyr. 2020.10.058

Ben-Arye, E., N. Samuels., L.H. Goldstein., K. Mutafoglu., S. Omran., E. Schiff., H. Charalambous., T. Dweikat, I. Ghrayeb, S.G. Bar, I. Turker, A. Hassan, E. Hassan, B. Saad, O. Nimri, R. Kebudi, and M. Silbermann. 2016. "Potential Risks Associated with Traditional Herbal Medicine Use in Cancer Care: A Study of Middle Eastern Oncology Health Care Professionals." *Cancer* **122(4):** 598–610. https://doi.org/10.1002/cncr.29796.

Booker, A., D. Johnston, and M. Heinrich. 2016. "The Welfare Effects of Trade in Phytomedicines: A Multi-Disciplinary

Analysis of Turmeric Production." *World Development* **77:** 221–230. Doi:10.1016/j.worlddev.2015.08.024.

Caporale, F., J.M. Martín, M.F. Usman, and C.S. Hall. 2020. "Plant Based Sustainable Development The Expansion and Anatomy of the Medicinal Plant Secondary Processing Sector in Nepal." *Article in Sustainability*. Doi: 10.3390/su12145575.

Central Bureau of Statistics of North Sumatra. 2020. Farmer's Exchange Rate (FER). https://www.bps.go.id/pressrelease/2020/12/01/1709.

Central Bureau of Statistics of North Sumatra. 2021. Horticultural Agriculture Statistics SPH-TBF. Production of Biopharmaceutical Plants by Plant Type in North Sumatra Province 2019-2020. https://sumut.bps.go.id/statictable/2021/04/21/2326/.

Faqih, A., R. Elizabeth, and D.H. Azahari. 2020. "The Increasing of Competitiveness of Agro-Industry products Through Institutional Empowerment to Support the Achievement of Sustainable Agricultural Development." *International Journal of Energy Economics and Policy*. **10(5):** 663–671. Doi:10.32479/ijeep.10376.

Fleischer, T., Y. Su., S. J. Lin. 2017. "How do Government Regulations Influence the Ability to Practice Chinese Herbal Medicine in Western Countries." *Journal of Ethnopharmacology* **196:** 104–109. https://doi.org/10.1016/j.jep.2016.11.047.

Gupta, S., N.K. Malhotra., M. Czinkota, and P. Foroudi. 2016. "Marketing Innovation: A Consequence of Competitiveness." *Journal of Business Research* **69(12):** 5671–5681. doi:10.1016/j.jbusres.2016.02.042.

Keumala, C.M., and Z. Zainuddin. 2018. "Indicators of Farmer Welfare through Farmer's Exchange Rate (FER) and Sharia Financing as a Solution." *Islamic Journal of Economics* **9(1):** 129–149.

Knudsen, D.C. 2000. "Shift-Share Analysis : Further Examination of Models for the Description Of Economic Change." Socio-Economic Planning Sciences **34(3):** 177–198. https://doi.org/https://doi.org/10.1016/S0038-0121(99)00016-6

Lu, S., J.H. Shen., W. Li., and J. Zhang. 2020. "A Theory of Economic Development and Dynamics of Chinese Economy." *Economic Modelling* **86:** 69–87. www.journals.elsevier.com/Economic-Modelling.

Ministry of Health Republic of Indonesia. 2020. Indonesia Health Profile 2019.

Ministry of Research, Technology and Higher Education. 2020. Problem Financing Analysis. Ministry of Industry of the Republic of Indonesia, 1–125.

National Planning Departement. 2021. Regional Profile and Analysis. http//www.simreg.bappenas.go.id.

North Sumatra Provincial Health Office. 2017. Health Profile of North Sumatra Province. North Sumatra Provincial Health Office.

North Sumatra Provincial Health Office. 2020. Health Profile of North Sumatra Province. North Sumatra Provincial Health Office.

Nurrochmat, D.R., I.A. Nugroho., Hardjanto A. Purwadianto, A. Maryudi and J.T. Erbaugh. 2017. "Shifting Contestation into Cooperation: Strategy to Incorporate Different Interest of Actors in Medicinal Plants in Meru Betiri National Park, Indonesia." *Forest Policy and Economics* **83:** 162–168. https://doi.org/10.1016/j.forpol.2017.08.005.

Pratama. R.S. 2019. "Usability Testing Indonesian Jamu Herbs (IJAH) Analytics Use Thinking Aloud." Tesis. Bogor Agricultural Institute.

Pratama, A. Ridho, K. Sukiyono, and N.N. Arianti. 2017. "A Regency/City Leading Agricultural Subsector Analysis in Bengkulu Province." *AGRIC* **29(2):** 121–136.

Pujiasmanto, B. 2016. "Development Strategy for Medicinal Plant Cultivation to Support Sustainable Agriculture." https://library.uns.ac.id/development strategy of medicinal plant cultivation in supporting sustainable agriculture/.

Purnamasari, S. 2019. *Economic Development*. 1st ed. Unpam Press, Pamulang University. Banten.

Ratag, J.P.D., G.H.M. Kapantow, and C.B.D. Pakasi. 2016. "The Role of the Agricultural Sector. Against the Economy in South Minahasa Regency." *Journal of Agri-Social Economics. Sam Ratulangi University* **12 (2A):** 239–250.

Roosta, R.A., R. Moghaddasi, and S.S. Hosseini. 2017. "Export Target Markets of Medicinal and Aromatic Plants." *Journal of Applied Research on Medicinal and Aromatic Plants* **7:** 84–88. https://doi.org/10.1016/j.jarmap.2017.06.003.

Salim and Munadi. 2017. "Consumption of Medicinal Plants." Medicinal Plant Commodity Info, 1–106.

Salmeron. M.E., C.J.A. Garrido, and A.F. Manzano. 2020. "Worldwide Research Trends on Medicinal Plants." *International Journal of Environmental Research and Public Health*, **17(10):** 3376. doi:10.3390/ijerph17103376.

Sharma, A.K, and K. Pundarikakshudu. 2019. "Regulatory Aspects of Traditional Indian Medicines (TIM) in India and in International Purview." *Journal of AOAC International* **102(4):** 993–1002.

Silalahi, M., N. Eko., B. Walujo, J. Supriatna, and W. Mangunwardoyo. 2016. "The Local Knowledge of Medicinal Plants Trader and Diversity of Medicinal Plants in the Kabanjahe Traditional Market, North Sumatra, Indonesia." *Journal of Ethnopharmacology* **175 (4):** 432–443. https://doi.org/10.1016/j.jep.2015.09.009.

Upton, R.R.H. 2016. "Traditional Herbal Medicine, Pharmacognosy, and Pharmacopoeial Standards: A Discussion at the Crossroads." American Herbal Pharmacopoeia, Scotts Valley, CA, USA." Chapter 3. 45–85.

Volenzo, T. and J. Odiyo. 2020. "Integrating Endemic Medicinal Plants into the Global Value Chains: The Ecological Degradation Challenges and Opportunities." *Heliyon* **6(9):** e04970. doi:10.1016/j.heliyon.2020.e04970.

Wahidin., Firmansyah and E. Astuti. 2021. "Analysis of Patterns and Structures of Mataram City Economic Sector Growth and Relationship between Mataram City and Surrounding Regencies on Lombok Island, West Nusa Tenggara Province." *Journal of Development Economics* **3(1):** 17–25.

World Health Organization. 2019. W.H.O Global Report on Traditional and Complementary Medicine 2019. ISBN 978-92-4-151543-6.