Chapter IV

Research Results

This research has been divided into two sections: DSWS development and the effectiveness of DSWS evaluation. The results of the study will be presented in the following order:

1. DSWS development
   - DSWS architecture
   - Herbal knowledge analysis
2. The evaluation of effectiveness of DSWS
   - Population characteristics
   - System effectiveness
   - Hypothesis testing
   - Frequencies of sample responding to system effectiveness

4.1 DSWS Development

4.1.1 DSWS Architecture

The Decision Supported Web System (DSWS) is a web-based system in which an expert system is integrated as a decision making tool. It supports web users in choosing suitable herbs for primary health care. The DSWS was designed to have three components; web pages, an expert system, and a CGI program.

1. Web pages are developed through the use of an HTML program. They have two purposes; first of all, as an interface module to enable users to request and obtain information from the system, and second, to provide herbal information pages.

2. An expert system is developed as a decision-making tool designed to support web users' search for specific information pertinent to their health needs. The system is designed as a selected expert system with a forward inference engine through the use of Jess 5.0 (the Java Expert System Shell).

3. A CGI program is an intermediate program for handling requests between web pages and the expert system for the transfer of knowledge or skills from

the expert system to the users. A Java program was used as the CGI program with servlet architecture. Servlet architecture has three components: inference engine, output generator, and controller.

The inference engine is a Rete algorithm from Jess. It is defined as Jess.Rete class in a Java servlet program. It carries matching rules from the knowledge bases to the output generator.

- An output generator performs as an interface between the user and the system. It has to generate new HTML files to impart herbal knowledge.
- A controller is defined as that which is used to control all servlet models.

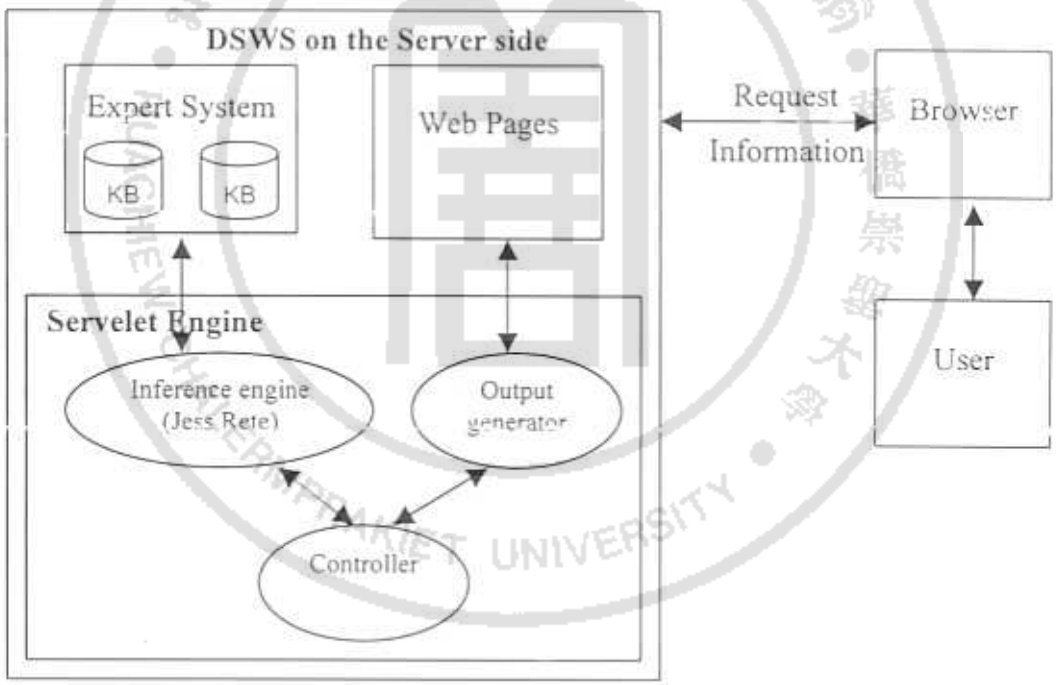

Figure 4.1 The DSWS Architecture

4.1.2 Herbal Knowledge Analysis

The herbal database for primary healthcare contains sixty-one herbs (See appendix 1) listed in five categories according to use in treating disease: herbs for digestive system diseases, respiratory system diseases, urinary system diseases, skin diseases, and other diseases. Herbal knowledge from an expert was analyzed utilizing a decision tree, is a graphical representation which is used in problem solving. Then, herbal knowledge was expressed as set of rules to be stored in a knowledge base. Each rule has two parts: the 'if' part and the 'then' part. The 'if 'part is a set of facts or conditions, and the 'then' part is a solution or result for each condition set. Users of the expert system will get solutions from the particular rules if part of the rule matches the user information. Knowledge of herbs for primary health care was stored in five knowledge bases in order to reduce the complexity of the program. The knowledge base is organized according to disease groups.

Knowledge analysis for digestive system diseases

A knowledge base of digestive system diseases provides knowledge to support users in determining the choice of herbs for eight symptoms or ailments; gastrosis, flatulence, constipation, diarrhea, nausea, parasitic infection (Ascariasis = organism one, Uncinariasis = organism two, threadworm = organism three and Teniasis =organism four), odontopathy and anorexia.

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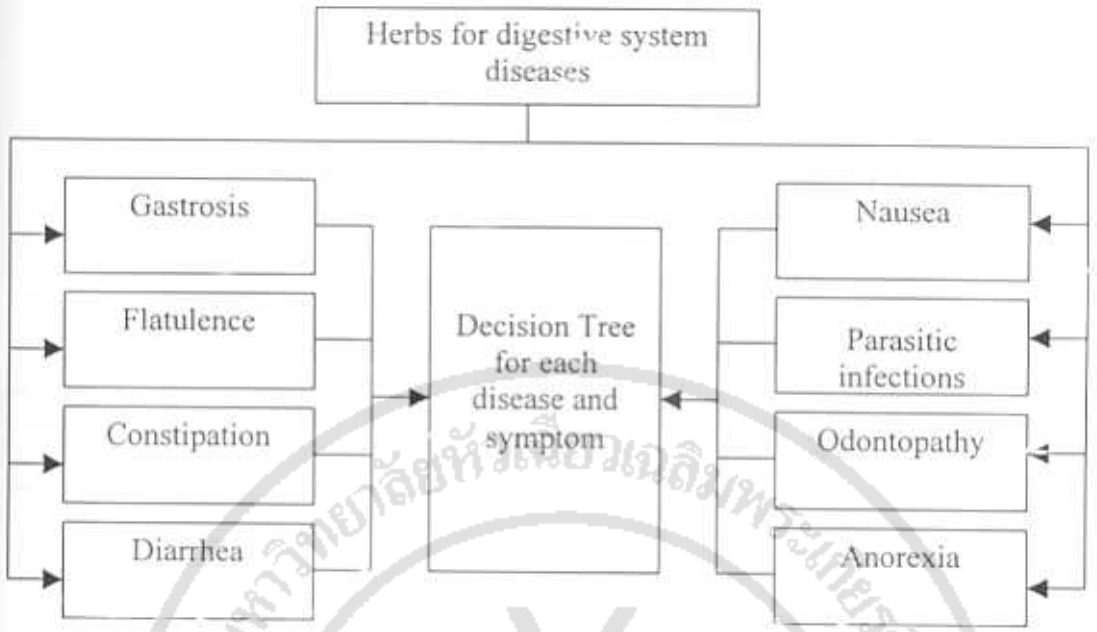

Figure 4.2 Herb choice for digestion system diseases decision tree

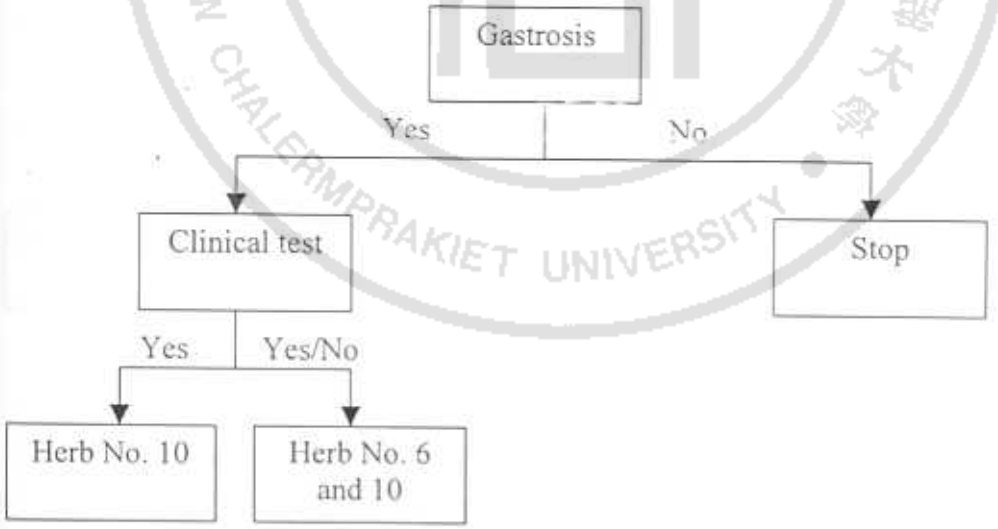

Figure 4.3 Herb choice for stomach diseases decision tree

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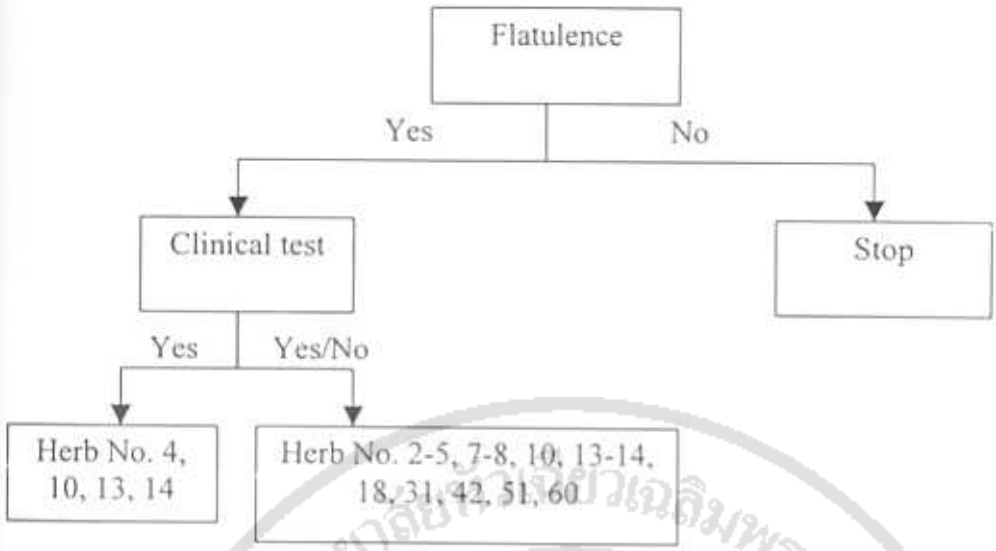

Figure 4.4 Herb choice for flatulence decision tree

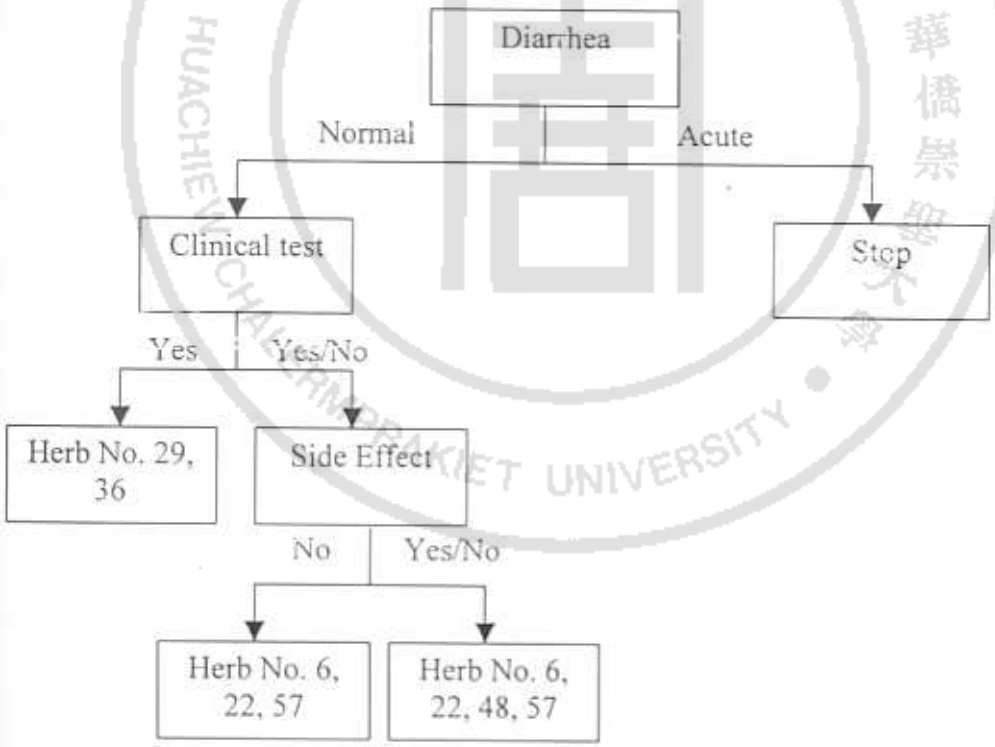

Figure 4.5 Herb choice for diarrhea decision tree

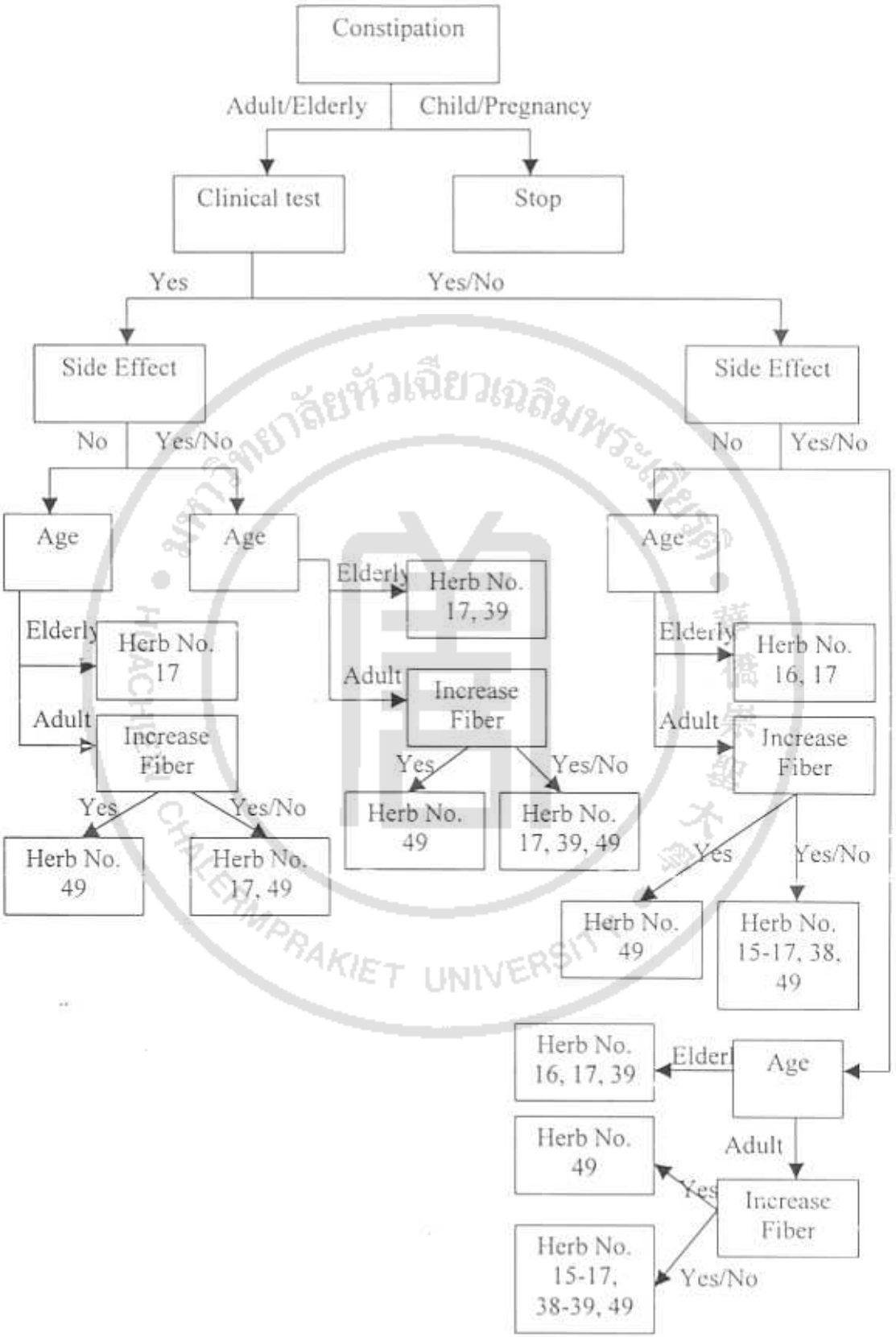

Figure 4.6 Herb choice for constipation symptoms decision tree

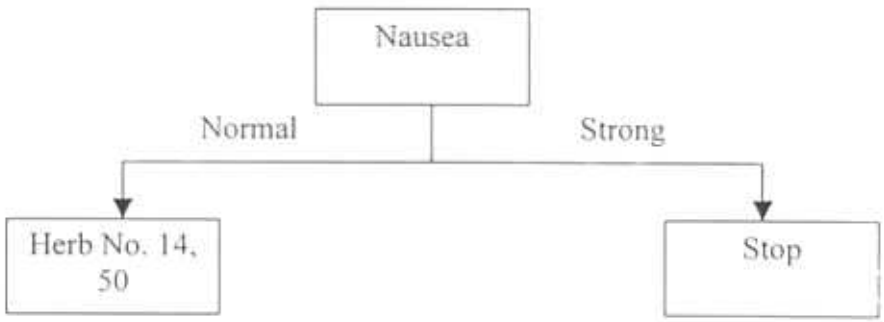

Figure 4.7 Herb choice for nausea decision tree

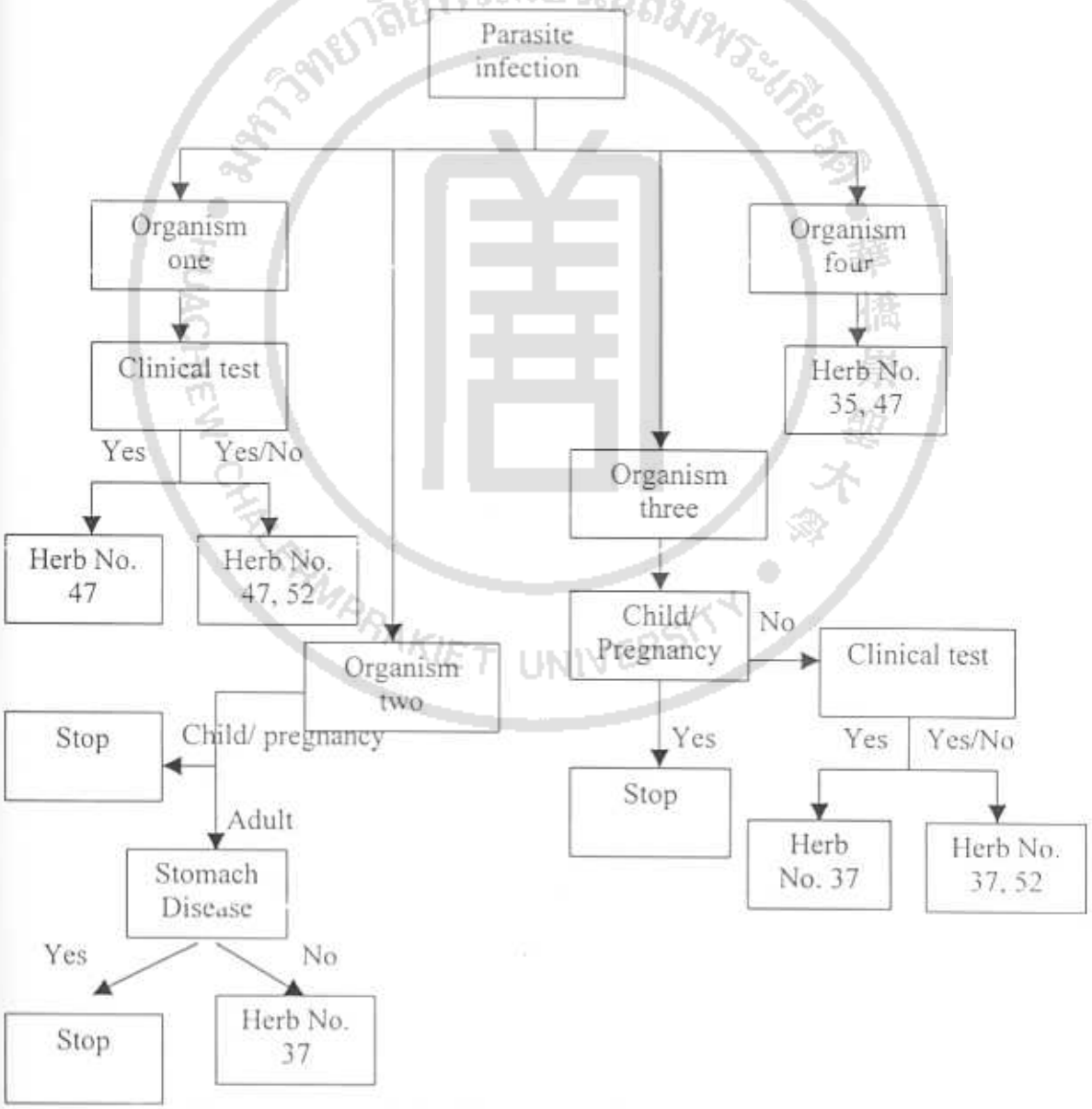

Figure 4.8 Herb choice for parasite infection decision tree

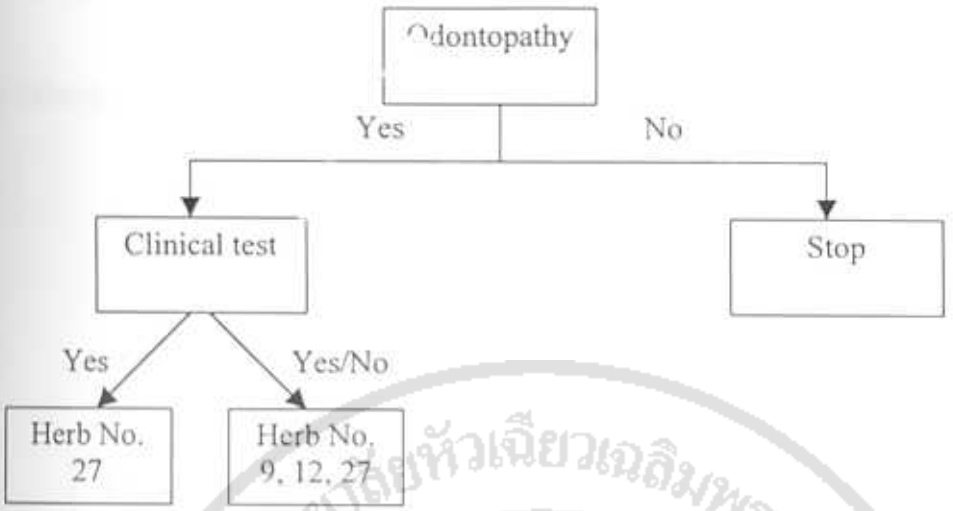

Figure 4.9 Herb choice for Odontopathy decision tree

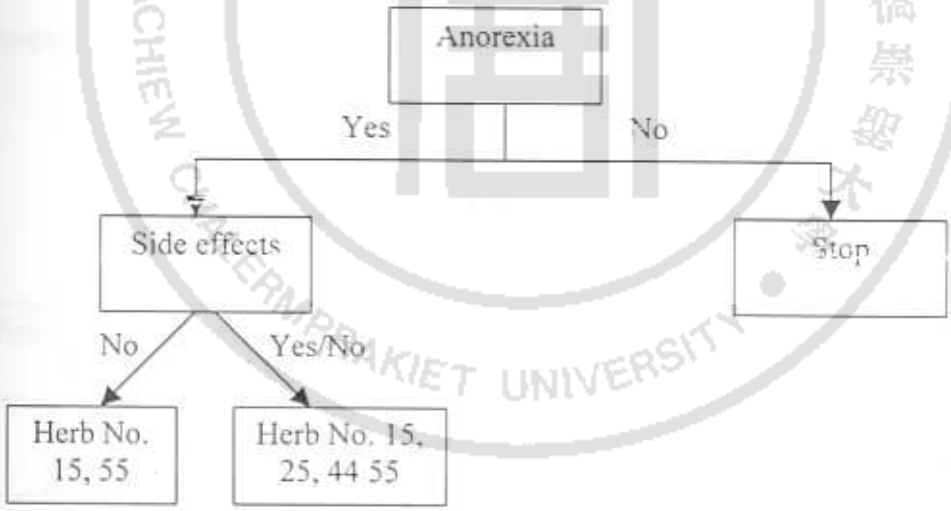

Figure 4.10 Herb choice for anorexia decision tree

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Knowledge analysis for respiratory system diseases

A knowledge base of respiratory system diseases has provided knowledge for determining the choice of herbs for treatment of cough.

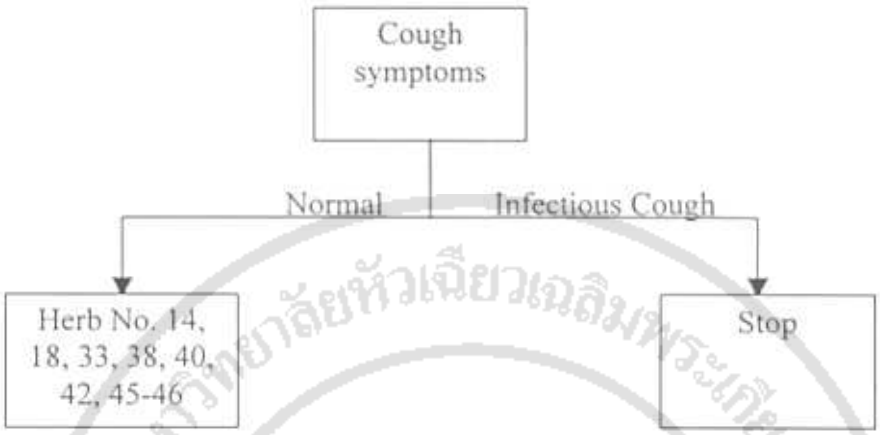

Figure 4.11 Herb choice for cough decision tree

Knowledge analysis for urinary system disease

A knowledge base of urinary system disease has provided knowledge to determine the choice of herbs to treat symptoms of urine retention.

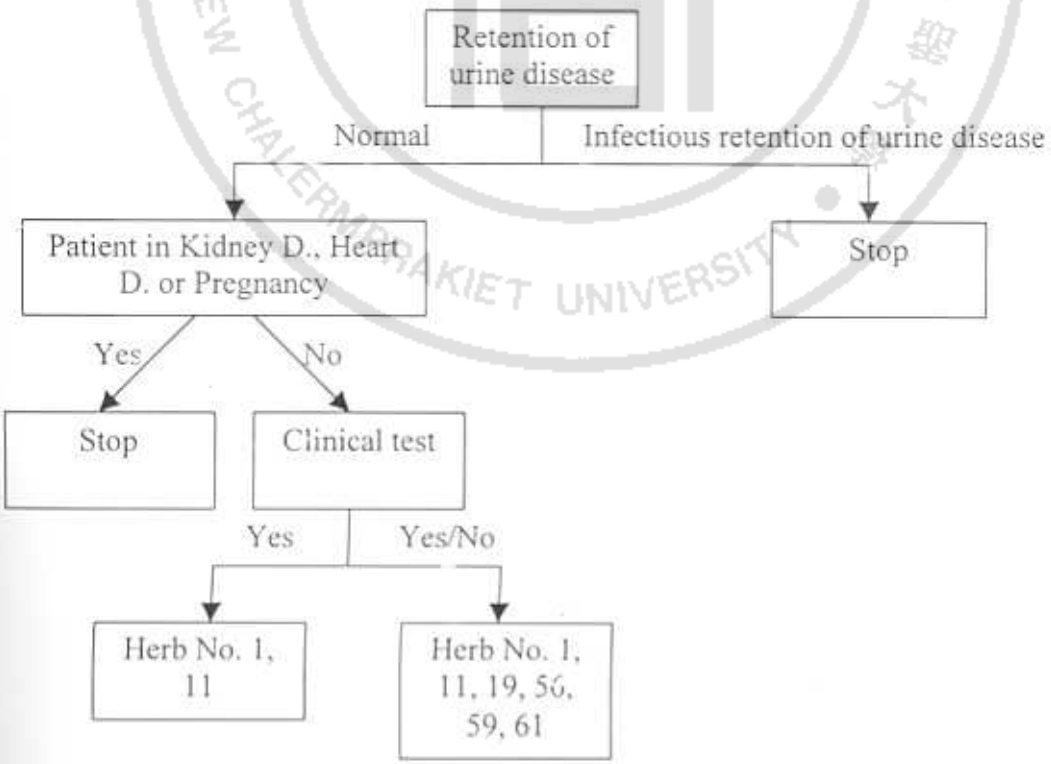

Figure 4.12 Herb choice for urine retention decision tree

Knowledge analysis for skin diseases

A knowledge base for skin diseases has provided knowledge to support the user in determining the choice of herbs for seven symptoms or diseases; ringworm and liver spots, scald head, scalds and burns, abscesses, skin inflammations due to insects and animal, allergic hives, herpes simplex, and nettle rash.

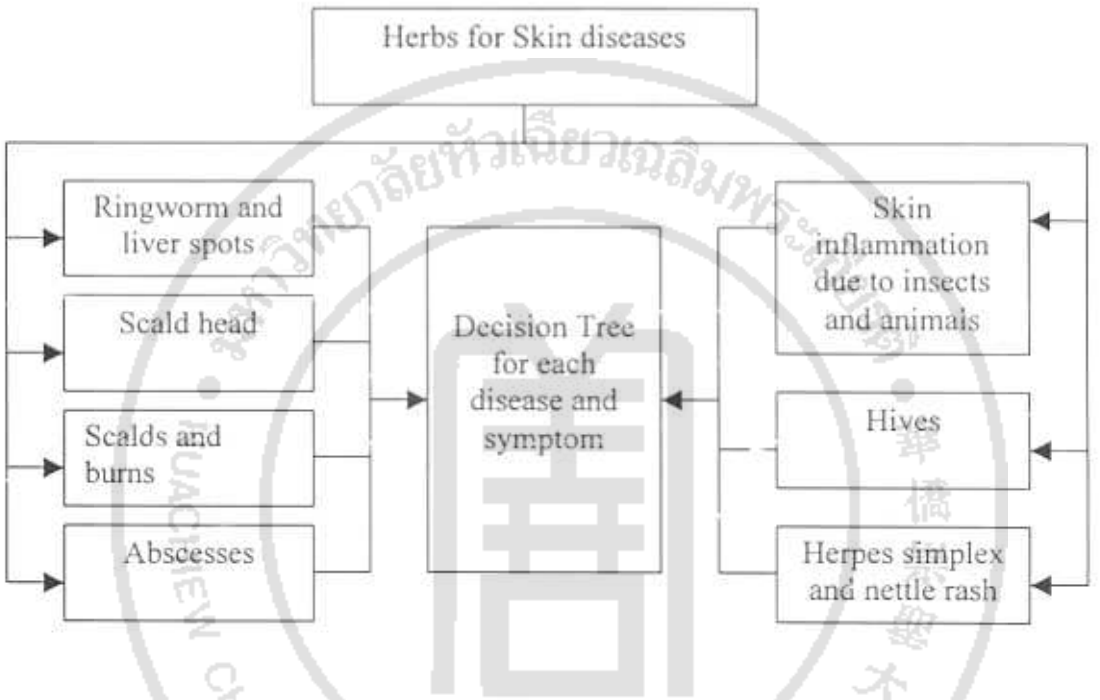

Figure 4.13 Herb choice for skin diseases decision tree

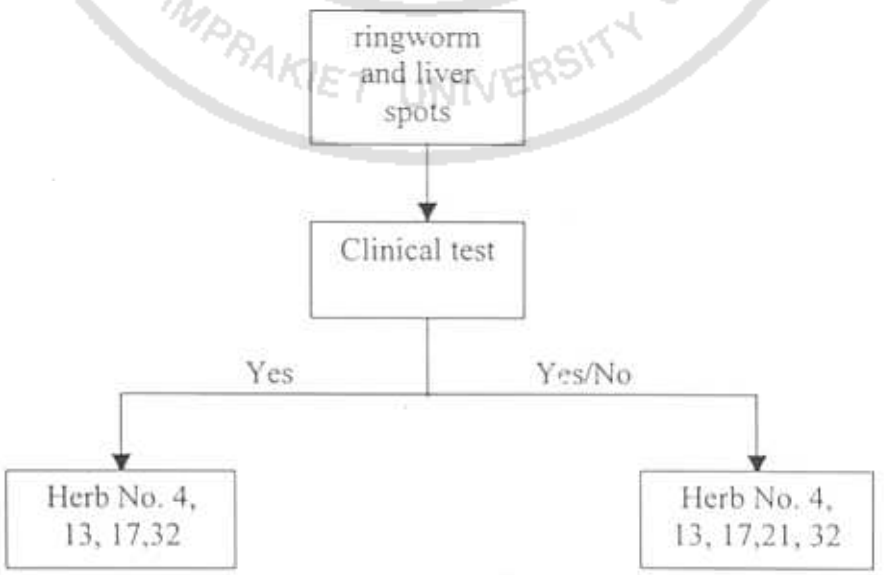

Figure 4.14 Herb choice for ringworm and liver spots decision tree

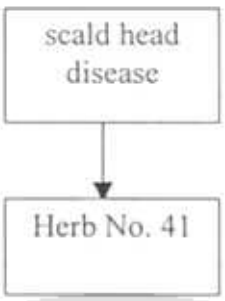

Figure 4.15 Herb choice for sunstroke decision tree

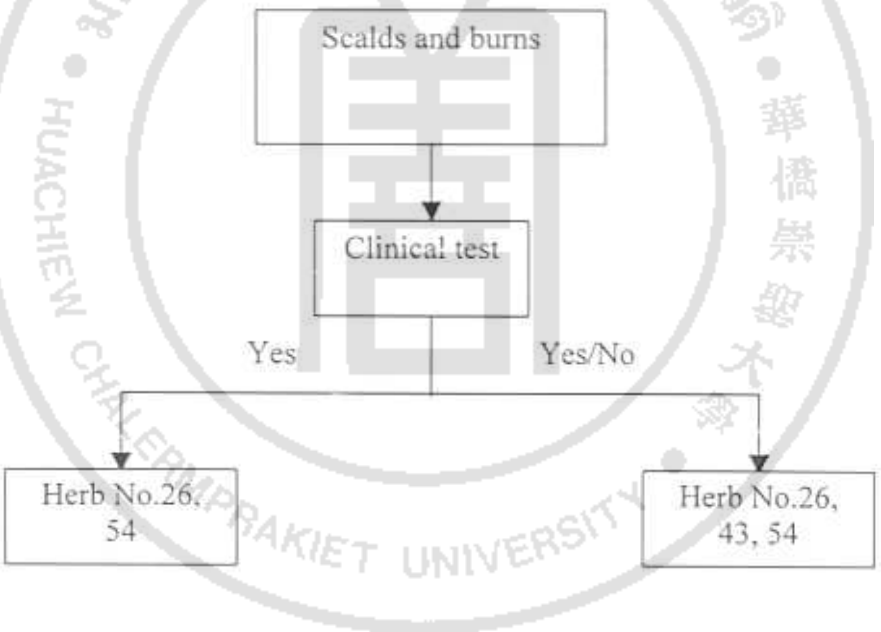

Figure 4.16 Herb choice for scalds and burns decision tree

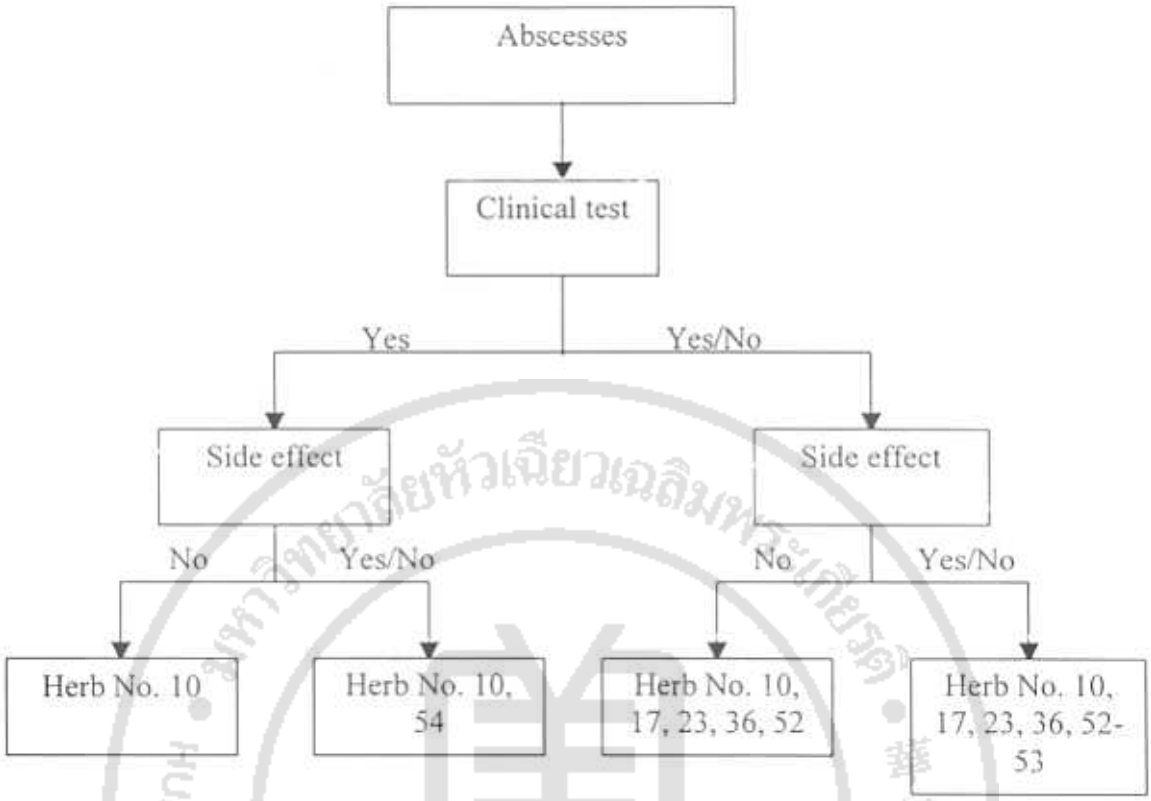

Figure 4.17 Herb choice for abscesses decision tree

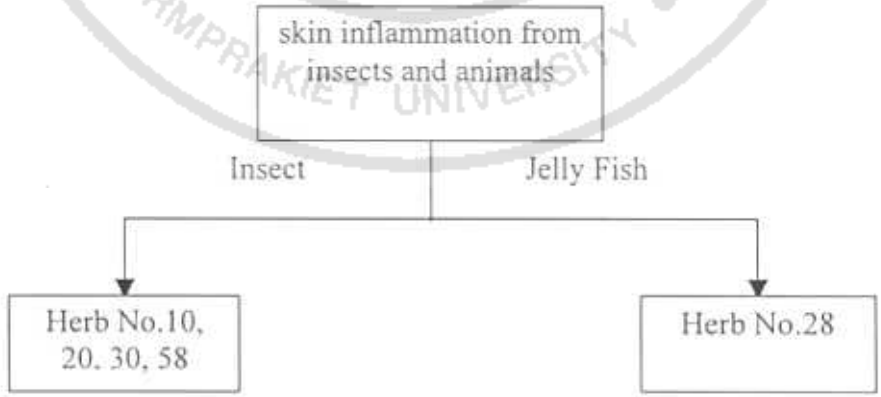

Figure 4.18 Herb choice for skin inflammation by insect and animal decision tree

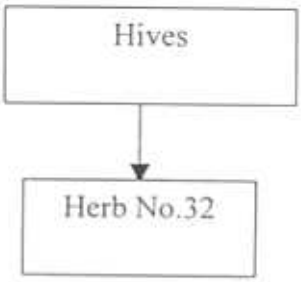

Figure 4.19 Herb choice for hives decision tree

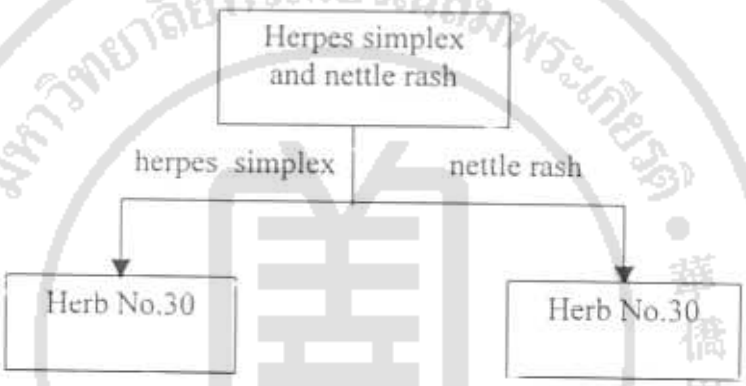

Figure 4.20 Herb choice for herpes simplex and nettle rash decision tree

Knowledge analysis for other diseases

A knowledge base of other diseases has provided information to assist the user in determining a choice of herbs for treatment of four syndromes or diseases: sprains, insomnia, fever, and pediculosis capitis.

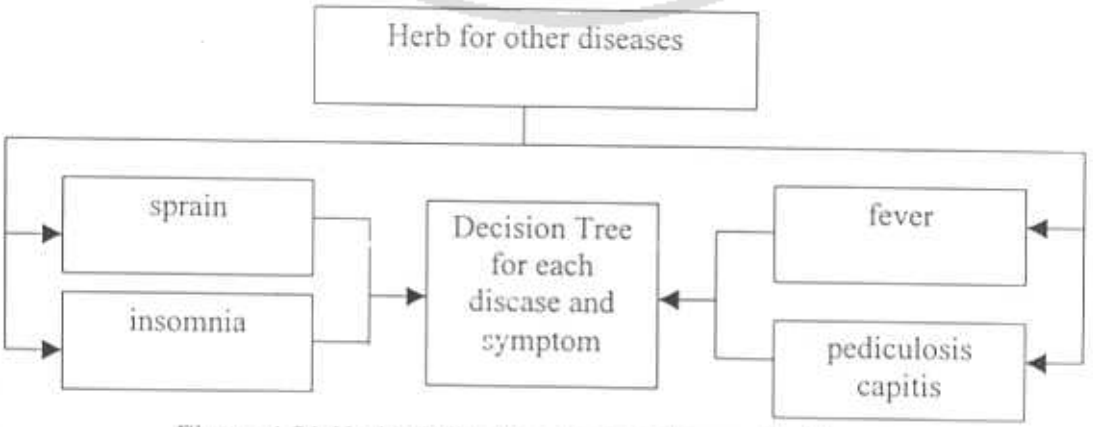

Figure 4.21 Herb choice for other syndromes decision tree

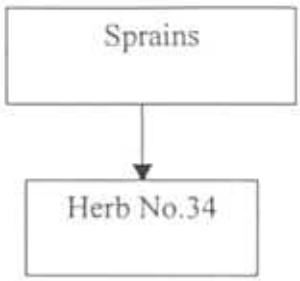

Figure 4.22 Herb choice for sprains decision tree

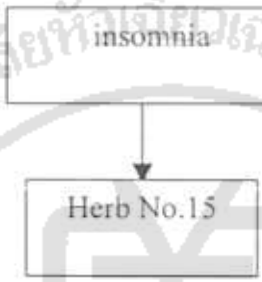

Figure 4.23 Herb choice for insomnia decision tree

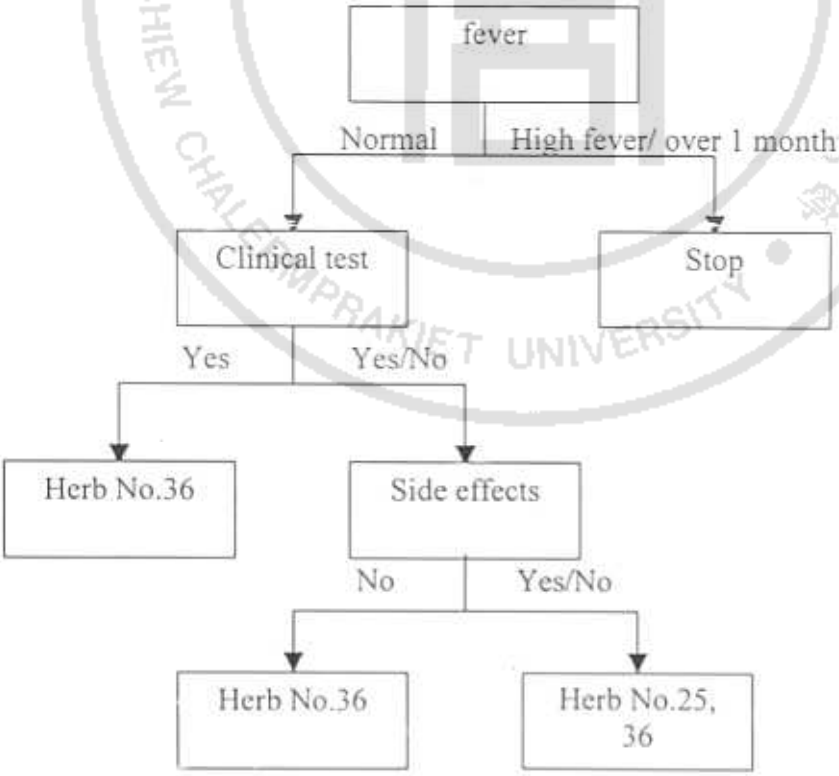

Figure 4.24 Herb choice for fever decision tree

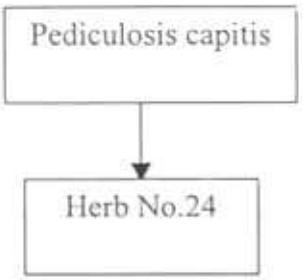

Figure 4.25 Herb choice for Pediculosis capitis decision tree

4.2 Evaluation of the effectiveness of the DSWS

Effectiveness of herbal knowledge dissemination on the WWW was evaluated by three instruments: the WWW of herbs for primary healthcare, the DSWS, and questionnaires. The data was analyzed utilizing three statistical methods; mean, Z-test and Chi-square test.

4.2.1 Population Characteristics

The samples of the research was divided into two groups. Group I answered the questionnaire for the general web pages and group II answered the questionnaire for the DSWS. The researchers studied the characteristics of the samples relevant to two points: herbal knowledge and WWW familiarity. The two groups of samples exhibited the following characteristics as shown in table 4.1 – 4.2

Table 4.1 Characteristic of the population in herbal knowledge

Population characteristics	Group I (for general web pages)		Group II (for DSWS)	
	No. of population	Percentage	No. of population	Percentage
Weak	32	46.38	28	38.89
Moderate	34	49.28	41	56.94
Strong	3	4.35	3	4.17
Total	69	100.00	72	100.00

According to the data in table 4.1, most of samples have moderate to weak herbal knowledge. Group I, samples who answered the questionnaire for general web pages have moderate herbal knowledge at 49.28 percent and 46.38 percent for the weak group. Group II, the samples who answered the questionnaire for the DSWS, have moderate herbal knowledge at 56.94 percent and 38.89 percent in the weak group. Only three persons per group are strong in herbal knowledge, which calculates as 4.35 percent for group I, and 4.17 percent for group II.

Table 4.2 Characteristics of population in WWW familiarity

Population characteristics	Group I (for general web pages)		Group II (for DSWS)	
	No of population	Percentage	No. of population	Percentage
Weak	6	8.70	3	4.17
Moderate	31	44.93	44	61.11
Strong	32	46.38	25	34.72
Total	69	100.00	72	100.00

According to the data in table 4.2, most of the samples in group I are strong to moderate in WWW familiarity. They can be calculated as 46.38 and 44.93 percent respectively. Most of the samples of group II are moderate which calculates as 61.11 percent. Some of them are strong; and a few of them are weak, which calculates as 34.72 and 4.17 percent respectively.

4.2.2 System Effectiveness

1) Effectiveness in information retrieval

Effectiveness of information retrieval was studied in respect to two criterion: time required to locate information and quantity of accurate information gained. The results are shown in table 4.3. The samples evaluated the general web pages and the DSWS and found moderate effectiveness in information retrieval.

Table 4.3 Effectiveness of information retrieval in the systems

System characteristics	Group I (for general webpages)		Group II (for DSWS)	
	Average	Result	Average	Result
- time to locate information	2.9	Moderate	3.2	Moderate
- quantity of accurate information	3.3	Moderate	3.5	Moderate
Average	3.1	Moderate	3.3	Moderate

2) Effectiveness of the decision-making process

Evaluation of the effectiveness of the decision-making process focuses on three phases of the process, which include three points:

- problem (needs) identification capability
- alternative provision capability
- alternative choice capability

The samples evaluated the general web pages and the DSWS with the determination of moderate effectiveness in the decision-making process.

Table 4.4 Effectiveness of the decision-making process of the systems

System characteristics	Group I (for general web pages)		Group II (for DSWS)	
	Average	Result	Average	Result
- needs identification capability	3.3	Moderate	3.5	Moderate
- alternative provision capability	3.2	Moderate	3.4	Moderate
- alternative choice capability	3.3	Moderate	3.5	Moderate
Average	3.3	Moderate	3.5	Moderate

3) Effectiveness of the content of decision support system features

This portion of the research was concerned with eight features:

- direct utilization of the system by the user
- quantity of information provided by the system
- facility of use. This feature has two issues: less training or fewer directions, and less time to learn how to use the system.

- system flexibility and ease of control
- system interactivity
- the system incorporating a model to support the decision-making process
- the system is attractive

The sample evaluated the general web pages with moderate effectiveness in content of decision support system features, and the DSWS with strong effectiveness in content of decision support system features. The results are shown in table 4.5.

Table 4.5 Characteristics of the systems concerning decision support system content features

System characteristics	Group I (for general web pages)		Group II (for DSWS)	
	Average	Result	Average	Result
- System can be directly utilized by user	3.9	Strong	4	Strong
- System is easy to use	3.2	Moderate	3.3	Moderate
- System is flexible and controllable	3.6	Strong	3.7	Strong
- System is interactive	3.3	Moderate	3.6	Strong
- System provides extensive information	3.3	Moderate	3.4	Moderate
- System contains a model	3.3	Moderate	3.4	Moderate
- System is attractive	3.4	Moderate	3.5	Moderate
Average	3.4	Moderate	3.5	Strong

4) Effectiveness in system accuracy

This portion of the research is concerned with two points:

- user confidence in the system's solutions (information)
- users' impressions

The samples evaluated the general web pages and the DSWS as having strong effectiveness in system confidence. The results are shown in table 4.6.

Table 4.6 Effectiveness in systems accuracy

System Truthfulness	Group I (for general web pages)		Group II (for DSWS)	
	Average	Result	Average	Result
- user confidence	3.7	Strong	3.6	Strong
- users' impressions	3.6	Strong	3.6	Strong
Average	3.6	Strong	3.6	Strong

4.2.3 Hypothesis testing of the system's effectiveness

According to resulting data from the questionnaires, the effectiveness of the DSWS is different from the data for general web pages effectiveness in some areas. Table 4.9 presents the effectiveness of the systems with the hypothesis test results with the null hypothesis. Both systems exhibit similar effectiveness at the 0.05 level of significance, and the region of rejection is less than –1.96 and greater than 1.96.

According to the results of the hypothesis test, the effectiveness of the system in information retrieval exhibiting the null hypothesis is significantly rejected at 0.05 level of significance. The effectiveness of the DSWS in information retrieval is higher than that of the general web pages. An evaluation of the effectiveness of the system in the decision-making process indicates that the null hypothesis is significantly ejected at the 0.05 level of significance. The effectiveness of the DSWS in the decision-making process is higher than that of the general web pages. The evaluation of the effectiveness of the system in content of decision support system features shows that the null hypothesis is significantly rejected at the 0.05 level of significance. The effectiveness of the DSWS in content of decision support

Table 4.7 Hypothesis of the systems effectiveness

System Characteristics	Group I (General web pages)			Group II (DSWS)			Z score	Accepted/ Rejected
	No. in sample	Mean	SD	No. in sample	Mean	SD		
- Information Retrieval	69	3.1	0.6	72	3.5	0.6	4.59	Rejected
- Decision-making process	69	3.3	0.7	72	3.5	0.7	11.56	Rejected
- Content of DSS features	69	3.4	0.4	72	3.5	0.5	3.65	Rejected
- System accuracy	69	3.6	0.6	72	3.6	0.6	0.00	Accepted
- Over all effectiveness	69	3.4	0.4	72	3.5	0.5	4.69	Rejected

Hypothesis test at 0.05 level of significance, the region of refection is less than −1.96 or greater than 1.96

system features is higher than that of the general web pages. The effectiveness of the system in system accuracy, the null hypothesis is significantly accepted at the 0.05 level of significance. The effectiveness of the DSWS in decision support system features is not different from that of the general web pages. In evaluation of the effectiveness of the system overall, the hypothesis is significantly rejected at the 0.05 level of significance. The effectiveness of the DSWS overall is higher than that of the general web pages.

4.2.4 Frequencies of sample responding to system effectiveness

The researchers conjectured that the levels of herbal knowledge and WWW familiarity of the samples may have some relationship with the expression of their opinions concerning system effectiveness. Table 4.8 presents the results of the hypothesis test with chi-square distribution (χ^2). at 0.05 level of significance.

According to the computed chi-square values in table 4.8, the levels of herbal knowledge of the samples were independent of the opinion expression concerning the effectiveness of DSWS in time required to located information, alternative provision capability and user confidence with system accuracy, and the levels of WWW familiarity of the samples were independent of the opinion expression concerning the effectiveness of DSWS in time required to located information, alternative provision capability, the system in ease of use and system

interactivity but there was relationship between levels of WWW familiarity of the samples and degree of opinion expression concerning the effectiveness of DSWS in system controllability.

Table 4.8 The results of hypothesis testing using chi-square distribution (χ^2)

Problem	χ^2	df	Asymp.Sig.
1. Time required to locate information			
- level of herbal knowledge	3.173	2	0.205
- level of WWW familiarity	0.585	2	0.746
2. Effectiveness of the system in providing alternatives			
- level of herbal knowledge	1.809	1	0.228
- level of WWW familiarity	3.561	1	0.083
3. Effectiveness of the system in ease of use			
- level of WWW familiarity	4.279	3	0.233
4. Effectiveness of the system in system controllability			
- level of WWW familiarity	5.178	1	0.035
5. Effectiveness of the system in system interactivity			
- level of WWW familiarity	1.091	1	0.325
6. Effective of the system in user confidence with system accuracy			
- level of herbal knowledge	0.607	1	0.476

Hypothesis test at 0.05 level of significance