# Dayak Onion (Eleutherine palmifolia (L) Merr) as An Alternative Treatment in Early Detection of Dental Caries using Certainty Factor

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***Abstract*—Dayak onion plants are traditionally used by the Dayak tribe as a medicinal plant to treat dental caries. This plant contains compounds that can inhibit the growth of bacteria that cause dental caries. The public has not yet known about alternative dental caries treatment derived from Dayak onions. This is due to the lack of public knowledge about how to early diagnose dental caries and how to treat using Dayak onions. Expert systems with the Certainty Factor method can be used as a solution in diagnosing early dental caries. The data used in this study consisted of 20 symptoms of dental caries and 6 types of dental caries. This study shows the percentage level of confidence in the results of the initial diagnosis of the type of dental caries suffered by using the certainty factor method and the handling of the diagnosis using the Dayak plant as an initial treatment solution. The results of the accuracy-test showed that the early dental caries diagnosis system was working well.**

***Keywords—Dayak onion, dental caries, certainty factor,***

## I. INTRODUCTION

Biodiversity on the island of Kalimantan has various potentials, including the potential for medicinal plants. The potential of these medicinal plants is scattered in various forest areas in Kalimantan. In terms of utilization, various types of medicinal plants in Kalimantan forests have their properties and have great potential to be developed as traditional or herbal medicines [1], [2]. The use of herbs as traditional medicine has become one of the alternative treatments that are in demand by the community. Medicinal plants that are useful for herbal medicine and are often found in everyday life are onions. Onions are a general term for a group of important plants for humans belonging to the Genus Allium. Tubers, leaves, or flowers are used as vegetables or as spices, depending on how they are used [3]. Dayak onions (Eleutherine palmifolia (L.) Merr.) contain several compounds that act as antimicrobials to inhibit the growth of bacteria that cause dental caries such as alkaloids, glycosides, flavonoids, phenolics, steroids, tannins, and saponins [4]. Compounds that can inhibit the growth of bacteria that cause dental caries in Dayak onions are phenols with a high concentration of 34.32%.

Dental caries is a dental infection caused by the demineralization of enamel and dentin which is closely related to the consumption of cariogenic foods [5]. Dental caries or cavities are characterized by damaged enamel and dentin caused by bacterial metabolic activity in plaque which causes demineralization due to interactions between microorganism products, saliva, and parts derived from food and enamel [6]. Dental caries can cause further damage to the dental pulp in the form of reduced blood flow to the death of the nerves in the affected tooth [7]. Initial treatment for caries-affected teeth must be done quickly so that the pain experienced by people with dental caries can be minimized. However, this is constrained by the lack of knowledge about the type of dental caries suffered. Therefore, an initial diagnosis is needed to determine the type of dental caries suffered and an initial treatment solution using the medicinal plant Dayak onion which has been proven as an alternative treatment for dental caries.

The expert system can be used as a solution to diagnose the early types of dental caries. Expert systems are computer programs derived from the branch of computer science research called artificial intelligence [8] and have been widely used for the diagnosis of various diseases such as dermatitis disease [9], fever disease [10], meningitis disease [11], rickets disease [12] and others [13]–[17]. The part of the expert system contains two main components, namely the knowledge base which contains the knowledge to act as a consultant, and the inference engine that presents the results. The result is an expert system response to user requests [16]. Certainty Factor states belief in an event (fact or hypothesis) based on expert evidence or judgment. Certainty Factor has a higher level of accuracy than other methods because the calculation method only compares each of the two values [18].

This study built an expert system to identify the results of early diagnosis of the type of dental caries using the Certainty Factor method as a calculation method to obtain the level of accuracy of the diagnosis of the type of dental caries suffered. This expert system is expected to be able to assist the public in knowing the type of dental caries suffered by and provide information about how to treat it using Dayak onions. Treatment using Dayak Onions is an alternative treatment that can treat dental caries because Dayak Onions have Phenolic compounds that function as disinfectants to inhibit dental caries-causing bacteria, namely gram-positive and negative bacteria. Gram-positive "cocci" and gram-negative "coccobacilli" bacteria can be found in root canals that colonize necrotic teeth and work together to cause infection [7], [19], [20].

## II. RESEARCH METHODOLOGY

### A. Expert System

The development of technology makes it easier for experienced doctors to document their knowledge and experience. This documentation can be expressed in a system that uses artificial intelligence and a knowledge base to act as a consultant in helping doctors to diagnose various kinds of diseases called expert systems. Expert systems are computer-based system that uses facts, knowledge bases and reasoning techniques to solve problems that usually only an expert in the field can solve [21]. The expert system consists of two main components, namely the knowledge base which contains the knowledge, and the inference engine that presents the results.

The concept of an expert system consists of users to convey facts or information to experts which will then be stored in a knowledge-base and processed by an inference engine so that the system can provide feedback to users in the form of expertise or answers based on previously conveyed knowledge [22]. Expert systems are built with two environments, namely the consultation environment and development environment. In a development environment, an expert system is used to enter expert knowledge into an expert system environment. Furthermore, the consulting environment is used by non-expert users to obtain expert knowledge and advice.

### B. Dental Caries

Based on data from The Global Burden of Disease Study 2016, dental and oral health problems, especially dental caries, are a disease that affects nearly half of the world's population (3.58 billion people). In Indonesia, the prevalence of caries according to data from the Ministry of Health of the Republic of Indonesia in 2018 was 88.8% with a prevalence of root caries of 56.6%. Dental caries generally attacks adolescents and adults due to the high consumption of foods and drinks containing sugar [23]. The word caries itself comes from the Latin which means rot or rotten. Dental caries is a chronic contagious disease caused by the perfect interaction between oral microorganisms in dental plaque, diet, and various host factors (living organisms) such as social and environmental [24]. The bacteria that cause dental caries are Lactobacillus acidophilus (L. acidophilus) and Streptococcus mutans (S. mutans) bacteria. These bacteria in the mouth convert sugar into acids which can erode tooth enamel [25].

### C. Dayak Onion

Dayak onions or ghost onions which have the scientific name Eleutherine palmifolia (L.) Merr is typical plant in the Kalimantan region. This plant has long been used by the Dayak tribe as an alternative treatment. It has a red tuber color with white flowers and green leaves in a ribbon shape. Dayak onions can be used as an alternative medicine to treat dental caries. This is because Dayak onions contain phytochemical compounds, namely glycosides, flavonoids, phenolics, tannins, steroids, and alkaloids [3], [26]. The content of these chemical compounds can inhibit and kill bacterial activity. Dayak bulb extract which can inhibit bacterial growth has the advantage of natural properties of herbal plants which are relatively safe for the body. “Fig. 1” shows the shape of the Dayak onion plant.

Fig. 1. Dayak Onion

From “Fig. 1” it can be seen that the shape of the Dayak onions resembles tubers. Dayak onions are known to have inhibitory power to treat dental caries which consists of

1. Inhibition of Dayak Onions against Streptococcus Mutans

   Dental caries is a disease of the hard tissues of the teeth, one of which is caused by Streptococcus mutans (S. mutans) bacteria. Bacteria that have accumulated on the tooth surface will continue to ferment carbohydrates which produce lactic acid so that it can lower the pH of the oral cavity. S. mutans growth can be prevented by giving mouthwash containing antibacterial compounds. The extract of Dayak onions is anti-bacterial because it contains active phenolic compounds and flavonoids. Phenolic compounds and their derivatives have anti-glucosyltransferase substances so that they can suppress the glucosyltransferase enzyme excreted by S. mutans and can prevent the growth of the S. mutans matrix so that these bacteria cannot adhere to the surface of tooth enamel [27].

2. Inhibition of Dayak Onions against Lactobacillus Acidophilus

   Lactobacillus Acidophilus bacteria are believed to be pioneering bacteria in advanced caries because these bacteria are more isolated in deep caries than before caries development and early tooth damage [28]. Dayak bulb extract has the power to inhibit the growth of Lactobacillus Acidophilus bacteria because the presence of flavonoid compounds. The mechanism of flavonoids as an antibacterial is to denature the cell membrane so that intracellular compounds come out which can cause cell damage or cell death [25].

### D. Certainty Factor

The certainty factor (CF) is a way of combining unbelief and belief in a single number. In certainty theory, qualitative data is presented as a degree of belief. There are two steps in representing qualitative data. The first step is the ability to express the degree of belief according to the method. The second step is to be able to locate data combining these degrees of confidence in an expert system [29], [30]. This concept is then formulated in (1).

$$CF(H, E) = MB(H, E) - MD(H, E) \quad (1)$$

Explanation:

CF : Certainty Factor from hypothesis H which is affected by evidence E. Biggest CF revolve between -1 until 1. Value 1 show belief unconditional, while value -1 show disbelief unconditional.

MB : Measure of Belief (confidence level), is a measure of the increase of trust hypothesis H is affected by the fact E.

MD : Measure of Disbelief (not confidence level), is the belief of mistrust hypothesis influenced the fact E

E : Evidence (events or facts)

H : Hypothesis (Alleged).

The calculation of certainty factor can be combined with two or more rules that have different evidence but in the same hypothesis as follows:

$$\text{Rule 1 } CF(H, E1) = CF1 = C(E1) \times CF(\text{Rule1}) \quad (2)$$

$$\text{Rule 2 } CF(H, E2) = CF1 = C(E2) \times CF(\text{Rule2}) \quad (3)$$

$$CF_{combine}[CF1, CF2] = CF1 + CF2 * (1 - CF1) \quad (4)$$

The certainty factor value states the level of expert confidence in an event (facts or hypotheses). The value of CF (Rule) is obtained from the interpretation of "terms" from experts which are converted into certain CF values. The value range of the certainty factor is between -1 to 1. The value of CF -1 shows evidence of absolute distrust value while the value of 1 refers to the absolute trust value. In calculating the certainty factor only users two data so that the accuracy of the data can be maintained and in an expert system the certainty factor can measure how much confidence the expert system has in diagnosing disease.

### *E. Design of Expert System*

This section will explain the stages in building an expert system as follows:

#### *1) Knowledge Base*

The knowledge base in the expert system stage provides a description of rules used in system to diagnose in. The knowledge base in this study was obtained from interviews with experts who produced six types of dental caries. Types of dental caries can be seen in TABLE I.

TABLE I. DENTAL CARIES DISEASE

| Code | Name of Disease |
|---|---|
| K001 | Reversible pulpitis |
| K002 | Irreversible pulpitis |
| K003 | Hyperplastic pulpitis |
| K004 | Pulp Necrosis |
| K005 | Pulp Gangrene |
| K006 | Gangrene Radix |

After getting the types of dental caries disease, the results of the interview then obtained a list of twenty symptoms in the six types of dental caries.

TABLE II. DENTAL CARIES SYMPTOMS

| Symptom Code | Symptom Name |
|---|---|
| G001 | Bad breath |
| G002 | There are holes in the teeth |
| G003 | Sometimes a sharp pain when eating acidic food |
| G004 | Sometimes a sharp pain if you eat sweet food |
| G005 | Sometimes a sharp pain when eating salty food |
| G006 | Sometimes a sharp pain when eating spicy food |
| G007 | Sometimes a sharp pain when eating hot food |
| G008 | Sometimes a sharp pain when eating cold food |
| G009 | Pain suddenly (spontaneously) |
| G010 | Pain that lasts longer than 30 seconds |
| G011 | Sometimes the pain is mild to severe and fever occurs |
| G012 | Sometimes a throbbing pain |
| G013 | Sometimes the pain gets worse at night |
| G014 | The teeth that were eroded were even wider until they sprouted small flesh |
| G015 | Meat that grows when exposed to rough food or drink aches |
| G016 | The teeth have started to feel numb |
| G017 | The teeth have started to rot |
| G018 | Teeth turn brown, gray |
| G019 | Teeth are only roots |
| G020 | The crown of the tooth is no longer visible |

#### *2) Rule of Certainty Factor*

At this stage, the weight value for each symptom present in each type of dental caries disease is determined by an expert on a scale of values between 0.2 – 1.0

TABLE III. THE WEIGHT OF SYMPTOMS

| Symptom Code | Symptom Name | Weight |
|---|---|---|
| G001 | Bad breath | 0.3 |
| G002 | There are holes in the teeth | 0.3 |
| G003 | Sometimes a sharp pain when eating acidic food | 0.4 |
| G004 | Sometimes a sharp pain if you eat sweet food | 0.4 |
| G005 | Sometimes a sharp pain when eating salty food | 0.4 |
| G006 | Sometimes a sharp pain when eating spicy food | 0.4 |
| G007 | Sometimes a sharp pain when eating hot food | 0.4 |
| G008 | Sometimes a sharp pain when eating cold food | 0.4 |
| G009 | Pain suddenly (spontaneously) | 0.8 |
| G010 | Pain that lasts longer than 30 seconds | 0.8 |
| G011 | Sometimes the pain is mild to severe and fever occurs | 0.6 |
| G012 | Sometimes a throbbing pain | 0.6 |
| G013 | Sometimes the pain gets worse at night | 0.6 |
| G014 | The teeth that were eroded were even wider until they sprouted small flesh | 0.6 |
| G015 | Meat that grows when exposed to rough food or drink aches | 0.6 |
| G016 | The teeth have started to feel numb | 0.7 |
| G017 | The teeth have started to rot | 0.7 |
| G018 | Teeth turn brown, gray | 0.8 |
| G019 | Teeth are only roots | 0.8 |
| G020 | The crown of the tooth is no longer visible | 0.8 |

In applying the CF method to an expert system requires several rules in the form of symptoms and weight values that have been given by the expert. The rules formed from the symptoms and weight values from the experts for each disease are shown in TABLE IV.

TABLE IV. RULES

| No | Rule |
|---|---|
| 1 | IF G001 (0.3) AND G002 (0.3) AND G003 (0.4) AND G004 (0.4) AND G005 (0.4) AND G006 (0.4) AND G007 (0.4) AND G008 (0.4) THEN K001 |
| 2 | IF G001 (0.3) AND G002 (0.3) AND G009 (0.8) AND G010 (0.8) AND G011 (0.6) AND G012 (0.6) AND G013 (0.6) THEN K002 |
| 3 | IF G001 (0.3) AND G002 (0.3) AND G014 (0.6) AND G015 (0.6) THEN K003 |
| 4 | IF G001 (0.3) AND G002 (0.3) AND G016 (0.7) AND G017 (0.7) THEN K004 |
| 5 | IF G001 (0.3) AND G002 (0.3) AND G016 (0.7) AND G017 (0.7) AND G018 (0.8) THEN K005 |
| 6 | IF G001 (0.3) AND G019 (0.8) AND G020 (0.8) THEN K006 |

*3) Dental Caries Treatment*

The method of treating dental caries using Dayak onions as an alternative treatment and prevention of dental caries is further determined based on the type of dental caries selected. Each type of dental caries has different treatment methods, especially in the use of the amount of Dayak onions used.

TABLE V. TREATMENT USING DAYAK ONION

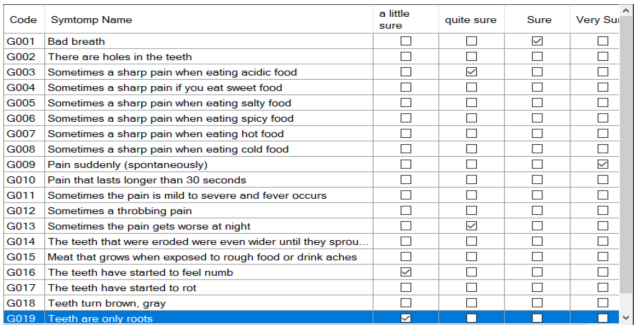
| Code of Disease | Treatment |
|---|---|
| K001 | Treatments using Dayak onions are as follows:<br>• Take 1-3 cloves of Dayak onion then peeled.<br>• Wash the Dayak onions with clean water.<br>• Grate or grind the Dayak bulbs and put the grated results in a glass.<br>• Then pour warm water and stir until well.<br>• Then use it to gargle.<br>• Do it 2-3 times a day for 7 days. |
| K002 | Treatments using Dayak onions are as follows:<br>• Take 3-4 cloves of Dayak onion then peeled.<br>• Wash the Dayak onions with clean water.<br>• Grate or grind the Dayak bulbs and put the grated results in a glass.<br>• Then pour warm water and stir until well.<br>• Then use it to gargle.<br>• Do it 2-3 times a day for 7 days. |
| K003 | Treatments using Dayak onions are as follows:<br>• Take 2-3 cloves of Dayak onion bulbs and then peeled.<br>• Wash the Dayak onions with clean water.<br>• Puree the Dayak onions by pounding them until smooth.<br>• The results of the collision of Dayak onions are inserted into the cavities and rubbed around the cavities.<br>• Let for about 30 minutes then rinse with clean water.<br>• Do it 2-3 times a day for 7 days, the longer the duration of use will further reduce pain in cavities. |
| K004 | Treatments using Dayak onions are as follows:<br>• Take 2-4 cloves of Dayak onion bulbs and then peeled.<br>• Wash the Dayak onions with clean water.<br>• Puree the Dayak onions by pounding them until smooth.<br>• The results of the collision of Dayak onions are inserted into the cavities and rubbed around the cavities.<br>• Let for about 30 minutes then rinse with clean water.<br>• Do it 1-3 times a day for 7 days, the longer the duration of use will further reduce pain in cavities. |
| K005 | Treatments using Dayak onions are as follows:<br>• Take 3-4 cloves of Dayak onion bulbs and then peeled.<br>• Wash the Dayak onions with clean water.<br>• Puree the Dayak onions by pounding them until smooth.<br>• The results of the collision of Dayak onions are inserted into the cavities and rubbed around the cavities.<br>• Let for about 30 minutes then rinse with clean water.<br>• Do it 2-3 times a day for 7 days, the longer the duration of use will further reduce pain in cavities. |
| K006 | Treatments using Dayak onions are as follows:<br>• Take 3-4 cloves of Dayak onion bulbs and then peeled.<br>• Wash the Dayak onions with clean water.<br>• Puree the Dayak onions by pounding them until smooth.<br>• The results of the collision of Dayak onions are inserted into the cavities and rubbed around the cavities.<br>• Let for about 30 minutes then rinse with clean water.<br>• Do it 1-3 times a day for 7 days, the longer the duration of use will further reduce pain in cavities.<br>• Patients are advised to go to a dental specialist to remove remaining teeth or roots that are left and no longer useful. |

## III. RESULT AND DISCUSSION

This section describes the implementation of an expert system that has been built to diagnose the beginning of dental caries and explains the calculation of certainty factors produced by the system.

### *A. Implementation System*

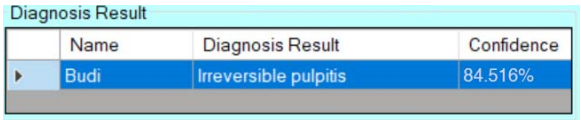
The consultation page displays a list of symptoms entered by user. The symptom input display selected by user is shown in "Fig. 2". The user selects each symptom they feel based on their level of confidence. User can select the confidence levels are A little Sure (0.2), Quite Sure (0.5), Sure (0.7) and Very Sure (0.9).



| Code | Symtomp Name | a little sure | quite sure | Sure | Very Su |
|---|---|---|---|---|---|
| G001 | Bad breath | ☐ | ☐ | ☑ | ☐ |
| G002 | There are holes in the teeth | ☐ | ☐ | ☐ | ☐ |
| G003 | Sometimes a sharp pain when eating acidic food | ☐ | ☑ | ☐ | ☐ |
| G004 | Sometimes a sharp pain if you eat sweet food | ☐ | ☐ | ☐ | ☐ |
| G005 | Sometimes a sharp pain when eating salty food | ☐ | ☐ | ☐ | ☐ |
| G006 | Sometimes a sharp pain when eating spicy food | ☐ | ☐ | ☐ | ☐ |
| G007 | Sometimes a sharp pain when eating hot food | ☐ | ☐ | ☐ | ☐ |
| G008 | Sometimes a sharp pain when eating cold food | ☐ | ☐ | ☐ | ☐ |
| G009 | Pain suddenly (spontaneously) | ☐ | ☐ | ☐ | ☑ |
| G010 | Pain that lasts longer than 30 seconds | ☐ | ☐ | ☐ | ☐ |
| G011 | Sometimes the pain is mild to severe and fever occurs | ☐ | ☐ | ☐ | ☐ |
| G012 | Sometimes a throbbing pain | ☐ | ☐ | ☐ | ☐ |
| G013 | Sometimes the pain gets worse at night | ☐ | ☑ | ☐ | ☐ |
| G014 | The teeth that were eroded were even wider until they sprou... | ☐ | ☐ | ☐ | ☐ |
| G015 | Meat that grows when exposed to rough food or drink aches | ☐ | ☐ | ☐ | ☐ |
| G016 | The teeth have started to feel numb | ☑ | ☐ | ☐ | ☐ |
| G017 | The teeth have started to rot | ☐ | ☐ | ☐ | ☐ |
| G018 | Teeth turn brown, gray | ☐ | ☐ | ☐ | ☐ |
| G019 | Teeth are only roots | ☑ | ☐ | ☐ | ☐ |

Fig. 2. Consultation Page View

After selecting the symptom, the system will display the diagnostic results as shown in "Fig. 3". The diagnostic results show the early diagnosis of the type of dental caries based on the symptoms previously selected by user, namely Irreversible Pulpitis with a confidence level of 84.516%.



Diagnosis Result

| | Name | Diagnosis Result | Confidence |
|---|---|---|---|
| ▶ | Budi | Irreversible pulpitis | 84.516% |

Fig. 3. Results Diagnostic

The next display is treatment using Dayak Onions in accordance with the results of the diagnosis given by the system as in "Fig. 4". Treatment of dental caries Irreversible Pulpitis using Dayak Onions refers to TABLE V.

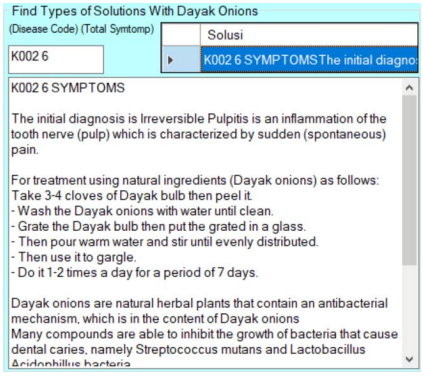



Fig. 4. Treatment using Dayak Onion Page

## B. *Calculation of Certainty Factor*

Calculations to get an early diagnosis of dental caries using the CF method were carried out in several stages. The first stage of using the CF method in the calculation process is to determine the confidence value of the symptoms that have been selected by user (CF user) and the weight value of the rules given by the expert (CF expert) displayed by TABLE VI.

TABLE VI. THE VALUE OF CF EXPERT AND CF USER OF SELECTED SYMTOMPS

| Symptom Code | Symptom Name | CF Expert | CF User |
|---|---|---|---|
| G001 | Bad breath | 0.3 | 0.7 |
| G003 | Sometimes a sharp pain when eating acidic food | 0.4 | 0.5 |
| G009 | Pain suddenly (spontaneously) | 0.8 | 0.9 |
| G013 | Sometimes the pain gets worse at night | 0.6 | 0.5 |
| G016 | The teeth have started to feel numb | 0.7 | 0.2 |
| G019 | Teeth are only roots | 0.8 | 0.2 |

The next stage is to calculate the CF value of each rule by multiplying the value of CF expert with CF user as follows

Rule 1 : Reversible pulpitis

CF1= CFpakar x CFuser = 0.3 x 0.7 = 0.21

CF2= CFpakar x CFuser = 0.3 x 0 = 0

CF3= CFpakar x CFuser = 0.4 x 0.5 = 0.2

CF4= CFpakar x CFuser = 0.4 x 0 = 0

CF5= CFpakar x CFuser = 0.4 x 0 = 0

CF6= CFpakar x CFuser = 0.4 x 0 = 0

CF7 = CFpakar x CFuser = 0.4 x 0 = 0

CF8 = CFpakar x CFuser = 0.4 x 0 = 0

The results of calculating the CF value of each rule can be seen in the TABLE VII.

TABLE VII. THE CF VALUES OF EACH RULE

| CF | Code of Rule | | | | | |
|---|---|---|---|---|---|---|
| | *Rule 1* | *Rule 2* | *Rule 3* | *Rule 4* | *Rule5* | *Rule 6* |
| CF1 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 |
| CF2 | 0 | 0 | 0 | 0 | 0 | 0.16 |
| CF3 | 0.2 | 0.72 | 0 | 0.14 | 0.14 | 0 |
| CF4 | 0 | 0 | 0 | 0 | 0 | |
| CF5 | 0 | 0 | | | 0 | |
| CF6 | 0 | 0 | | | | |
| CF7 | 0 | 0.3 | | | | |
| CF8 | 0 | | | | | |

The next step is to combine the CF values of each rule using (4) to determine the type of dental caries, as follows:

Rule 2: Irreversible pulpitis

$CF_{combine}$ (CF1, CF2) = 0.21 + 0 * (1 – 0.21)

= 0.21 → CFnew1

$CF_{combine}$ (CFnew1, CF3) = 0.21 + 0.72 * (1 – 0.21)

= 0.7788 → CFnew2

$CF_{combine}$ (CFnew2, CF4) = 0.7788 + 0 * (1 – 0.7788)

= 0.7788 → CFnew3

$CF_{combine}$ (CFnew3, CF5) = 0.7788 + 0 * (1 – 0.7788)

= 0.7788 → CFnew4

$CF_{combine}$ (CFnew4, CF6) = 0.7788 + 0 * (1 – 0.7788)

= 0.7788 → CFnew5

$CF_{combine}$ (CFnew5, CF7) = 0.7788 + 0.3 * (1 – 0.7788)

= 0.84516

Percentage of Confidence = CFcombine * 100%

= 0.84516 * 100%

= 84.516% Irreversible pulpitis

The results of calculating the combined CF values of each rule can be seen in the table.

TABLE VIII. THE COMBINED CF VALUES OF EACH RULE

| No | Name of Disease | CF | CF (%) |
|---|---|---|---|
| 1 | Reversible pulpitis | 0.368 | 36.8 |
| 2 | Irreversible pulpitis | 0.84516 | 84.516 |
| 3 | Hyperplastic pulpitis | 0.21 | 21 |
| 4 | Pulp Necrosis | 0.3206 | 32.06 |
| 5 | Pulp Gangrene | 0.3206 | 32.06 |
| 6 | Gangrene Radix | 0.3364 | 33.64 |

From the calculation of the CF value of each rule, the highest CF value with a percentage of 84.516% is Irreversible Pulpitis. Furthermore, the treatment method for the results of the initial diagnosis of types of dental caries Irreversible Pulpitis using Dayak onions which refers to TABLE V.

## C. *Testing Result*

Testing is done by comparing the results of the diagnosis provided by an expert system with an expert so that the accuracy of the expert system being built can be found. TABLE IX shows the test results of cases of early diagnosis of dental caries.

TABLE IX. THE VALIDITY TEST RESULTS

| No | Symptoms | System Results | Diagnostic Expert | True/ False |
|---|---|---|---|---|
| 1 | G002, G004, G017, G020 | Gangrene Radix CF = 62.6% | Gangrene Radix | True |
| 2 | G002, G003, G015, G018, G020 | Reversible Pulpitis CF = 36.8% | Reversible Pulpitis | True |
| 3 | G003, G009, G011, G016 | Irreversible Pulpitis CF = 65.2% | Irreversible Pulpitis | True |
| 4 | G005, G008, G012, G013, G014 | Hyperplastic pulpitis CF = 45.48% | Hyperplastic Pulpitis | True |
| 5 | G001, G002, G017, G018 | Pulp Gangrene CF = 55.17% | Pulp Gangrene | True |
| 6 | G006, G009, G010. G013, G016 | Pulp Necrosis CF = 49% | Pulp Necrosis | True |

The results of case testing consisting of six test case studies in TABLE IX show that six data are in accordance with the expert's data. This shows that the expert system has good accuracy.

## IV. CONCLUSION

This study has succeeded in building an expert system that can early diagnose types of dental caries and provide recommendations for treating dental caries using traditional Dayak herbs. Based on the results of the initial diagnosis of dental caries on the symptoms given by the user, the appropriate treatment using Dayak onions is gargling according to advice to inhibit the growth of bacteria that cause dental caries so that it does not get worse. The result of testing the level of accuracy the expert system for early diagnosis of dental caries in six test cases prove that this expert system is able to work well to diagnose the type of dental caries accompanied by proper treatment using Dayak onions.

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