



Early Diagnosis of Dental Caries Using Fuzzy Inference The Sugeno Method System

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ABSTRACT

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Many are not aware of the dangers of oral health, especially dental caries. In 2018 the proportion of dental caries in Indonesia was 45.3%, according to the results of the Basic Health Research (RISKESDAS). Until now, dental health services have not reached the middle and lower class of society due to the very high cost. One way to make it easier for the public to recognize the disease's characteristics and diagnose dental caries as early as possible is to make an expert system application. The system in this application is made using the Sugeno fuzzy method. System testing yields an accuracy of 93%.

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1. Introduction

In line with computer science, progressively progress has a developmental impact on increasingly modern technology. Computer science helps doctors adopt human knowledge to the system computer designed to implement an expert's ability. One of the branches of artificial intelligence, namely, expert systems, can help the community in the early diagnosis of dental caries. [1]. According to the World Health Organization (WHO), the number of ideal comparisons between dentists and population is 1: 2000 inhabitants. At the opening ceremony of the year, FKG UNPAD gold in 2016 explains the comparison ideal for dentists with Indonesia's population: 1: 9000 inhabitants. The ratio is growing up to 1: 24,000. This condition is exacerbated by not yet even dentists' distribution, where 70% of them still collected on Java's island. [2] [3]. Teeth are systems digestion in the mouth which functions to process food. In 2018, the proportion of dental caries in Indonesia as much as 45.3%, according to the results of Basic Health Research (RISKESDAS) [4] [5] [6]. Caries is a lining disease with hardened teeth, namely enamel, dentin, and cementum, yang caused by microbial interactions in a carbohydrate which can be fermented [7]. Dental caries is a disease that is especially severe in the lining of the teeth because it is the interaction of various factors characterized by the absorption of salt and mineral ions deposition of calcium ions on the hard layer teeth [8]. The expert system is a system that is pursued to implement human to computer knowledge to solve problems like an expert [9]. On this expert system application, in conducting patient diagnosis required to fill out a questionnaire along with the percentage of sick times of each symptom, then then the symptom will be on analysis using Sugeno method and produce caries diagnosis suffered by the patient. On research, a former expert application program that can detect oral and dental diseases based on android and have a level of application accuracy is 71.67%. Give three types of dental caries and symptoms unspecified [10]. It also does not provide complete information about solutions and diagnoses that the patient has got from the results consultation through the system made [11]. Research This applies the Fuzzy Sugeno method, which has the following abilities [12]:

- The system can make it easier for patients and doctors.
- Users or patients can use the system to find out what caries is currently on the pain.
- Provide diagnostic results and an explanation of causes and solutions of the caries disease suffered by the patient.

Based on the background of the problems above, then created an expert system application can provide a more efficient initial diagnosis and is expected to reach various society groups.



2. Research Methods

2.1 Research Flowchart

This flowchart is made to explain - the steps conducted at the time of conducting diagnostic research caries.

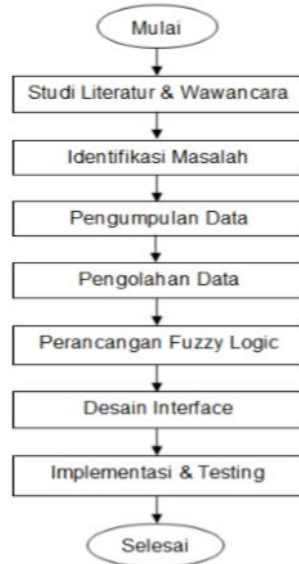


Fig 1. Research Flowchart

The flowchart above explains several steps implementation of research that starts from literature study to interface design and implementation and testing system, as follows [13]:

a. Literature & Interview Studies

At this stage, the researcher looked for references from various articles on the basics used in the study time. Then conducted interviews with several experts about the obstacles that are being experienced. Identification of problems perform frequent analysis of the depth occur.

b. Data collection

collect data regarding symptoms seen and felt physically from each – every the specified disease.

c. Data processing

at this stage, the data is processed to determine the severity and diagnostic results.

d. Fuzzy Logic Design

this stage sets each minimum limit and maximum on each symptom so it will display the final diagnostic results.

e. Interface Design

making this interface design is divided into two sides, namely, the admin side and the user side.

f. Testing & Implementation

This stage performs testing of the system which has been designed so that it can be in implement without causing errors.

2.2 System Flowchart

Here is a flowchart that describes the flow of the system from the running process dental caries diagnosis application.

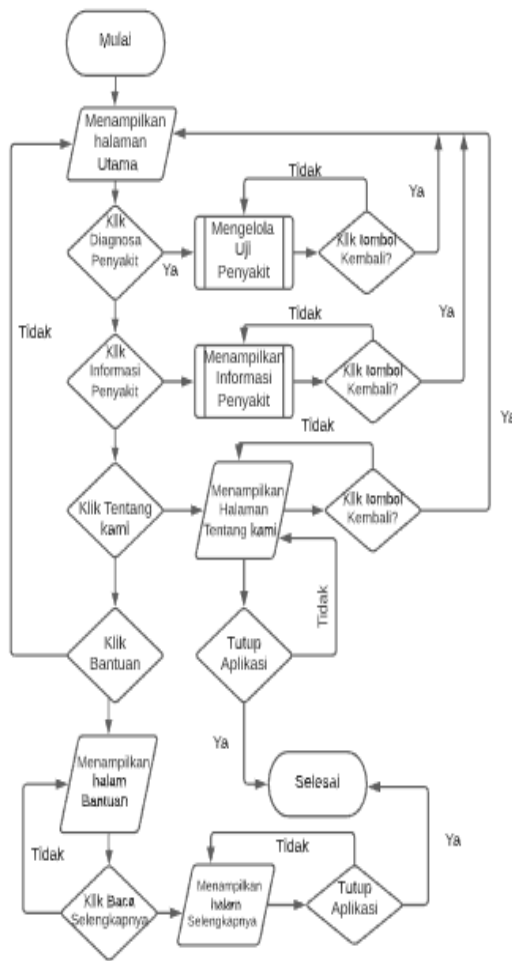


Fig 2. Flowchart of the application system diagnosis of dental caries

The program starts from the user entering the main menu program; in the main menu, there is a menu to start a search among them, the diagnosis menu disease, disease information menu, and form menu. If the user chooses to go to the diagnostic process, the user will enter the registration form or login form. The user will be asked to fill in the complete personal data; then, next, the user will fill out several questionnaires and vote the symptoms he feels along with the taste percentage level sick. After all the questionnaires are filled in, the system will automatically perform tracing to expert system rules using the Sugeno method. Then, the results will be displayed in the form of a list of rules with results diagnosis in the form of information about the type of caries diagnosed, causes, and treatment solutions. If the user wants to do a new search, then the user will return to the main menu search for diseases; if not, then it can return to the program main view [14].

Rumus Fuzzifikasi, sebagai berikut [15]:

$$\mu[x, a, c] \begin{cases} \frac{0(x - a)}{(b - a)}; a \leq x \leq b \\ \frac{(c - x)}{(c - b)}; b \leq x \leq c \end{cases}$$

Keterangan:

x = Nilai maximal dan minimal bobot ditentukan dari setiap gejala yang dipilih.

b = Nilai tengah .

c =Nilai maksimum pada gejala

Rumus Defuzzifikasi [16]:

$$WA = \frac{a_1 z_1 + a_2 z_2 + a_3 z_3 + \dots + a_n z_n}{a_1 + a_2 + a_3 + \dots + a_n}$$

Keterangan:

WA= Nilai rata-rata

zn = Nilai aturan ke-n

zn = Nilai input

3. Results and Discussion

3.1 Input Variable

The following is a table of variables along with fuzzy sets and domain (percentage of pain):

Table 1.
Fuzzy Set Input Variable

Variabel Input	Himpunan Fuzzy	Domain
Terkena Rangsangan (Asam,Manis, Dingin)	Tidak Ngilu	[0-25]
	Cukup Ngilu	[25-50]
	Sakit	[50-75]
Tampak Karies	Garis Coklat	[0-10]
	Lubang Coklat	[10-30]
	Lubang Hitam	[30-50]
Kemasukan Makanan	Tidak Ngilu	[0-25]
	Cukup Ngilu	[25-50]
	Sakit	[50-75]
Karies terketuk (perkusi)	Tidak Ngilu	[0-25]
	Cukup Ngilu	[25-50]
	Sakit	[50-75]

The table above contains four variable symptoms and percentages of pain.

3.2 Membership Function Design

Input criteria that have a slight curve and the trapmf curve. The useful range for different input depending on needs and generate Input Membership Functions as following:

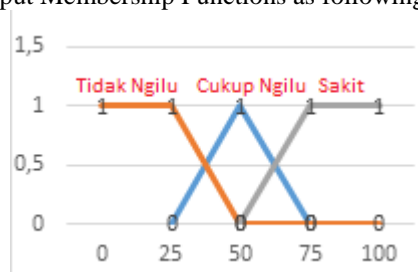


Fig 3. Stimulated Membership Functions.

The picture above has three categories membership function and percentage of pain, namely No. Ache (0-25), Quite an ache (25-50), and Sick (50-75).

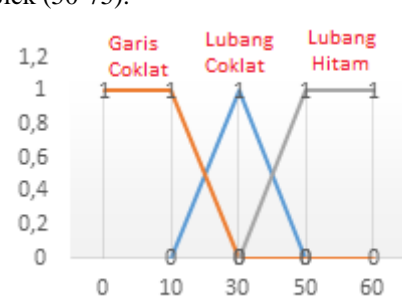


Fig 4. Caries Appearance Membership Function

The picture above has three categories membership function and percentage of pain, namely Line Chocolate (0-10), Chocolate Hole (10-30), and Hole Black (30-50).

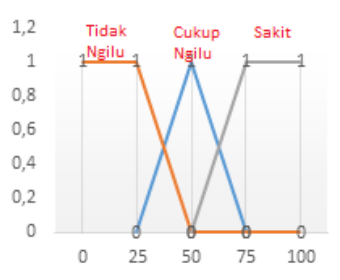


Fig 5. Pass Membership Function Food

The picture above has 3 categories membership function and percentage of pain, namely No. Ache (0-25), Quite ache (25-50), and Sick (50-75).

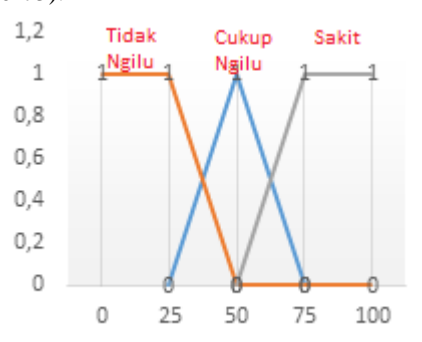


Fig 6. Membership Function Tapped or Percussion

The picture above has three categories membership function and percentage of pain, namely No. Ache (0-25), Quite an ache (25-50), and Sick (50-75).

3.3 Rule Basis

The input criteria used have 3 Membership Function, so as many rules are made, the number of Membership Functions used by rank The number of Input Criteria is 81 pieces with an algorithm as follows:

Table 2.
Rule Basis

No.		Karies terkena (asam, manis, dingin)		Tampak Karies		Kemasukan makanan		Terketuk		Penyakit
1	IF	Tidak Ngilu	AND	Garis coklat	AND	Tidak Ngilu	AND	Tidak Ngilu	THEN	Insipiens
2	IF	Tidak Ngilu	AND	Garis coklat	AND	Tidak Ngilu	AND	Cukup Ngilu	THEN	Superfisialis
3	IF	Tidak Ngilu	AND	Garis coklat	AND	Tidak Ngilu	AND	Sakit	THEN	Superfisialis
4	IF	Tidak Ngilu	AND	Garis coklat	AND	Cukup Ngilu	AND	Tidak Ngilu	THEN	Superfisialis
5	IF	Tidak Ngilu	AND	Garis coklat	AND	Cukup Ngilu	AND	Cukup Ngilu	THEN	Superfisialis
6	IF	Tidak Ngilu	AND	Garis coklat	AND	Cukup Ngilu	AND	Sakit	THEN	Media
7	IF	Tidak Ngilu	AND	Garis coklat	AND	Sakit	AND	Tidak Ngilu	THEN	Superfisialis
8	IF	Tidak Ngilu	AND	Garis coklat	AND	Sakit	AND	Cukup Ngilu	THEN	Media
9	IF	Tidak Ngilu	AND	Garis coklat	AND	Sakit	AND	Sakit	THEN	Media
10	IF	Tidak Ngilu	AND	Lubang Coklat	AND	Tidak Ngilu	AND	Tidak Ngilu	THEN	Insipiens
11	IF	Tidak Ngilu	AND	Lubang Coklat	AND	Tidak Ngilu	AND	Cukup Ngilu	THEN	Superfisialis
12	IF	Tidak Ngilu	AND	Lubang Coklat	AND	Tidak Ngilu	AND	Sakit	THEN	Superfisialis
13	IF	Tidak Ngilu	AND	Lubang Coklat	AND	Cukup Ngilu	AND	Tidak Ngilu	THEN	Superfisialis
14	IF	Tidak Ngilu	AND	Lubang Coklat	AND	Cukup Ngilu	AND	Cukup Ngilu	THEN	Superfisialis
15	IF	Tidak Ngilu	AND	Lubang Coklat	AND	Cukup Ngilu	AND	Sakit	THEN	Media
16	IF	Tidak Ngilu	AND	Lubang Coklat	AND	Sakit	AND	Tidak Ngilu	THEN	Media
17	IF	Tidak Ngilu	AND	Lubang Coklat	AND	Sakit	AND	Cukup Ngilu	THEN	Media
18	IF	Tidak Ngilu	AND	Lubang Coklat	AND	Sakit	AND	Sakit	THEN	Media
19	IF	Tidak Ngilu	AND	Lubang Hitam	AND	Tidak Ngilu	AND	Tidak Ngilu	THEN	Insipiens
20	IF	Tidak Ngilu	AND	Lubang Hitam	AND	Tidak Ngilu	AND	Cukup Ngilu	THEN	Superfisialis
21	IF	Tidak Ngilu	AND	Lubang Hitam	AND	Tidak Ngilu	AND	Sakit	THEN	Superfisialis
22	IF	Tidak Ngilu	AND	Lubang Hitam	AND	Cukup Ngilu	AND	Tidak Ngilu	THEN	Media
23	IF	Tidak Ngilu	AND	Lubang Hitam	AND	Cukup Ngilu	AND	Cukup Ngilu	THEN	Media
24	IF	Tidak Ngilu	AND	Lubang Hitam	AND	Cukup Ngilu	AND	Sakit	THEN	Media
25	IF	Tidak Ngilu	AND	Lubang Hitam	AND	Sakit	AND	Tidak Ngilu	THEN	Media
26	IF	Tidak Ngilu	AND	Lubang Hitam	AND	Sakit	AND	Cukup Ngilu	THEN	Media
27	IF	Tidak Ngilu	AND	Lubang Hitam	AND	Sakit	AND	Sakit	THEN	Media
28	IF	Cukup Ngilu	AND	Garis coklat	AND	Tidak Ngilu	AND	Tidak Ngilu	THEN	Superfisialis
29	IF	Cukup Ngilu	AND	Garis coklat	AND	Tidak Ngilu	AND	Cukup Ngilu	THEN	Media
30	IF	Cukup Ngilu	AND	Garis coklat	AND	Tidak Ngilu	AND	Sakit	THEN	Media
31	IF	Cukup Ngilu	AND	Garis coklat	AND	Cukup Ngilu	AND	Tidak Ngilu	THEN	Media
32	IF	Cukup Ngilu	AND	Garis coklat	AND	Cukup Ngilu	AND	Cukup Ngilu	THEN	Media
33	IF	Cukup Ngilu	AND	Garis coklat	AND	Cukup Ngilu	AND	Sakit	THEN	Media
34	IF	Cukup Ngilu	AND	Garis coklat	AND	Sakit	AND	Tidak Ngilu	THEN	Media
35	IF	Cukup Ngilu	AND	Garis coklat	AND	Sakit	AND	Cukup Ngilu	THEN	Media
36	IF	Cukup Ngilu	AND	Garis coklat	AND	Sakit	AND	Sakit	THEN	Media
37	IF	Cukup Ngilu	AND	Lubang Coklat	AND	Tidak Ngilu	AND	Tidak Ngilu	THEN	Media
38	IF	Cukup Ngilu	AND	Lubang Coklat	AND	Tidak Ngilu	AND	Cukup Ngilu	THEN	Media
39	IF	Cukup Ngilu	AND	Lubang Coklat	AND	Tidak Ngilu	AND	Sakit	THEN	Media
40	IF	Cukup Ngilu	AND	Lubang Coklat	AND	Cukup Ngilu	AND	Tidak Ngilu	THEN	Media
41	IF	Cukup Ngilu	AND	Lubang Coklat	AND	Cukup Ngilu	AND	Cukup Ngilu	THEN	Media
42	IF	Cukup Ngilu	AND	Lubang Coklat	AND	Cukup Ngilu	AND	Sakit	THEN	Media
43	IF	Cukup Ngilu	AND	Lubang Coklat	AND	Sakit	AND	Tidak Ngilu	THEN	Media
44	IF	Cukup Ngilu	AND	Lubang Coklat	AND	Sakit	AND	Cukup Ngilu	THEN	Profunda
45	IF	Cukup Ngilu	AND	Lubang Coklat	AND	Sakit	AND	Sakit	THEN	Profunda

46	IF	Cukup Ngilu	AND	Lubang Hitam	AND	Tidak Ngilu	AND	Tidak Ngilu	THEN	Media
47	IF	Cukup Ngilu	AND	Lubang Hitam	AND	Tidak Ngilu	AND	Cukup Ngilu	THEN	Media
48	IF	Cukup Ngilu	AND	Lubang Hitam	AND	Tidak Ngilu	AND	Sakit	THEN	Media
49	IF	Cukup Ngilu	AND	Lubang Hitam	AND	Cukup Ngilu	AND	Tidak Ngilu	THEN	Media
50	IF	Cukup Ngilu	AND	Lubang Hitam	AND	Cukup Ngilu	AND	Cukup Ngilu	THEN	Media
51	IF	Cukup Ngilu	AND	Lubang Hitam	AND	Cukup Ngilu	AND	Sakit	THEN	Profunda
52	IF	Cukup Ngilu	AND	Lubang Hitam	AND	Sakit	AND	Tidak Ngilu	THEN	Media
53	IF	Cukup Ngilu	AND	Lubang Hitam	AND	Sakit	AND	Cukup Ngilu	THEN	Profunda
54	IF	Cukup Ngilu	AND	Lubang Hitam	AND	Sakit	AND	Sakit	THEN	Profunda
55	IF	Sakit	AND	Garis coklat	AND	Tidak Ngilu	AND	Tidak Ngilu	THEN	Media
56	IF	Sakit	AND	Garis coklat	AND	Tidak Ngilu	AND	Cukup Ngilu	THEN	Media
57	IF	Sakit	AND	Garis coklat	AND	Tidak Ngilu	AND	Sakit	THEN	Profunda
58	IF	Sakit	AND	Garis coklat	AND	Cukup Ngilu	AND	Tidak Ngilu	THEN	Media
59	IF	Sakit	AND	Garis coklat	AND	Cukup Ngilu	AND	Cukup Ngilu	THEN	Profunda
60	IF	Sakit	AND	Garis coklat	AND	Cukup Ngilu	AND	Sakit	THEN	Profunda
61	IF	Sakit	AND	Garis coklat	AND	Sakit	AND	Tidak Ngilu	THEN	Media
62	IF	Sakit	AND	Garis coklat	AND	Sakit	AND	Cukup Ngilu	THEN	Profunda
63	IF	Sakit	AND	Garis coklat	AND	Sakit	AND	Sakit	THEN	Profunda
64	IF	Sakit	AND	Lubang Coklat	AND	Tidak Ngilu	AND	Tidak Ngilu	THEN	Media
65	IF	Sakit	AND	Lubang Coklat	AND	Tidak Ngilu	AND	Cukup Ngilu	THEN	Profunda
66	IF	Sakit	AND	Lubang Coklat	AND	Tidak Ngilu	AND	Sakit	THEN	Profunda
67	IF	Sakit	AND	Lubang Coklat	AND	Cukup Ngilu	AND	Tidak Ngilu	THEN	Profunda
68	IF	Sakit	AND	Lubang Coklat	AND	Cukup Ngilu	AND	Cukup Ngilu	THEN	Profunda
69	IF	Sakit	AND	Lubang Coklat	AND	Cukup Ngilu	AND	Sakit	THEN	Profunda
70	IF	Sakit	AND	Lubang Coklat	AND	Sakit	AND	Tidak Ngilu	THEN	Profunda
71	IF	Sakit	AND	Lubang Coklat	AND	Sakit	AND	Cukup Ngilu	THEN	Profunda
72	IF	Sakit	AND	Lubang Coklat	AND	Sakit	AND	Sakit	THEN	Profunda
73	IF	Sakit	AND	Lubang Hitam	AND	Tidak Ngilu	AND	Tidak Ngilu	THEN	Media
74	IF	Sakit	AND	Lubang Hitam	AND	Tidak Ngilu	AND	Cukup Ngilu	THEN	Profunda
75	IF	Sakit	AND	Lubang Hitam	AND	Tidak Ngilu	AND	Sakit	THEN	Profunda
76	IF	Sakit	AND	Lubang Hitam	AND	Cukup Ngilu	AND	Tidak Ngilu	THEN	Profunda
77	IF	Sakit	AND	Lubang Hitam	AND	Cukup Ngilu	AND	Cukup Ngilu	THEN	Profunda
78	IF	Sakit	AND	Lubang Hitam	AND	Cukup Ngilu	AND	Sakit	THEN	Profunda
79	IF	Sakit	AND	Lubang Hitam	AND	Sakit	AND	Tidak Ngilu	THEN	Profunda
80	IF	Sakit	AND	Lubang Hitam	AND	Sakit	AND	Cukup Ngilu	THEN	Profunda
81	IF	Sakit	AND	Lubang Hitam	AND	Sakit	AND	Sakit	THEN	Profunda

The table above represents as many rules as 81 pieces in each algorithm are associated with AND operator.

3.4 Accuracy Testing

The following table is a comparison of the results from some data made from experts, systems, and matlab2015a:

Table 3.
Accuracy Testing

Pasien	Terkena Rangsangan (Skala)	Tampak Karies (Skala)	Kemasukan Makanan (Skala)	Karies Terketuk (Skala)	Data Sistem (Status Karies)	Data Pakar (Status Karies)	Data Matlab (Status Karies)	Validasi Matlab	Validasi Sistem
1	75	9	16	75	Profunda	Profunda	Profunda	S	S
2	75	4	48	25	Media	Media	Media	S	S
3	75	4	50	50	Profunda	Profunda	Profunda	S	S
4	75	6	43	75	Profunda	Profunda	Profunda	S	S
5	71	10	70	21	Media	Media	Media	S	S
6	63	8	75	45	Media	Profunda	Media	TS	TS
7	75	3	54	75	Profunda	Profunda	Profunda	S	S
8	72	30	25	25	Media	Media	Media	S	S
9	64	30	22	46	Media	Profunda	Media	TS	TS
10	75	27	12	75	Profunda	Profunda	Profunda	S	S
11	75	30	50	1	Profunda	Profunda	Profunda	S	S
12	75	29	49	50	Profunda	Profunda	Profunda	S	S
13	75	30	41	72	Profunda	Profunda	Profunda	S	S
14	75	30	70	18	Profunda	Profunda	Profunda	S	S
15	72	30	75	50	Profunda	Profunda	Profunda	S	S
16	75	24	75	75	Profunda	Profunda	Profunda	S	S
17	56	50	6	0	Media	Media	Media	S	S
18	75	47	4	50	Profunda	Profunda	Profunda	S	S
19	75	44	8	73	Profunda	Profunda	Profunda	S	S
20	75	50	50	1	Profunda	Profunda	Profunda	S	S
21	69	49	37	38	Media	Profunda	Media	TS	TS
22	71	50	50	75	Profunda	Profunda	Profunda	S	S
23	75	49	50	9	Profunda	Profunda	Profunda	S	S
24	75	44	72	38	Profunda	Profunda	Profunda	S	S
25	64	47	75	74	Profunda	Profunda	Profunda	S	S
26	0	0	15	0	Insipiens	Insipiens	Insipiens	S	S
27	5	10	18	50	Superfisialis	Superfisialis	Superfisialis	S	S
28	12	10	2	75	Superfisialis	Superfisialis	Superfisialis	S	S
29	8	8	50	25	Superfisialis	Superfisialis	Superfisialis	S	S
30	10	6	50	50	Superfisialis	Superfisialis	Superfisialis	S	S
31	10	10	50	75	Media	Media	Media	S	S
32	17	9	70	25	Superfisialis	Superfisialis	Superfisialis	S	S
33	20	10	68	40	Superfisialis	Media	Superfisialis	TS	TS
34	0	8	75	68	Media	Media	Media	S	S
35	5	28	18	20	Insipiens	Insipiens	Insipiens	S	S
36	6	50	25	25	Insipiens	Insipiens	Insipiens	S	S
37	20	35	19	50	Superfisialis	Superfisialis	Superfisialis	S	S
38	10	43	25	70	Superfisialis	Superfisialis	Superfisialis	S	S
39	25	50	50	14	Media	Media	Media	S	S
40	7	50	50	47	Media	Media	Media	S	S
21	69	49	37	38	Media	Profunda	Media	TS	TS
22	71	50	50	75	Profunda	Profunda	Profunda	S	S
23	75	49	50	9	Profunda	Profunda	Profunda	S	S
24	75	44	72	38	Profunda	Profunda	Profunda	S	S
25	64	47	75	74	Profunda	Profunda	Profunda	S	S
26	0	0	15	0	Insipiens	Insipiens	Insipiens	S	S
27	5	10	18	50	Superfisialis	Superfisialis	Superfisialis	S	S
28	12	10	2	75	Superfisialis	Superfisialis	Superfisialis	S	S
29	8	8	50	25	Superfisialis	Superfisialis	Superfisialis	S	S
30	10	6	50	50	Superfisialis	Superfisialis	Superfisialis	S	S
31	10	10	50	75	Media	Media	Media	S	S
32	17	9	70	25	Superfisialis	Superfisialis	Superfisialis	S	S
33	20	10	68	40	Superfisialis	Media	Superfisialis	TS	TS
34	0	8	75	68	Media	Media	Media	S	S
35	5	28	18	20	Insipiens	Insipiens	Insipiens	S	S
36	6	50	25	25	Insipiens	Insipiens	Insipiens	S	S
37	20	35	19	50	Superfisialis	Superfisialis	Superfisialis	S	S
38	10	43	25	70	Superfisialis	Superfisialis	Superfisialis	S	S
39	25	50	50	14	Media	Media	Media	S	S
40	7	50	50	47	Media	Media	Media	S	S



41	18	45	50	75	Media	Media	Media	S	S
42	23	46	75	21	Media	Media	Media	S	S
43	25	50	72	50	Media	Media	Media	S	S
44	22	50	68	65	Media	Media	Media	S	S
45	50	10	25	25	Superfisialis	Superfisialis	Superfisialis	S	S
46	50	8	20	50	Media	Media	Media	S	S
47	50	6	25	75	Media	Media	Media	S	S
48	50	2	50	21	Media	Media	Media	S	S
49	50	10	50	50	Media	Media	Media	S	S
50	37	1	50	75	Media	Media	Media	S	S
51	50	4	75	25	Media	Media	Media	S	S
52	46	9	75	50	Media	Media	Media	S	S
53	41	0	75	75	Media	Media	Media	S	S
54	50	30	25	25	Media	Media	Media	S	S
55	50	30	4	36	Media	Media	Media	S	S
56	50	21	18	70	Media	Media	Media	S	S
57	50	30	50	25	Media	Media	Media	S	S
58	50	24	42	50	Media	Media	Media	S	S
59	46	22	50	75	Media	Media	Media	S	S
60	42	30	75	16	Media	Media	Media	S	S
21	69	49	37	38	Media	Profunda	Media	TS	TS
22	71	50	50	75	Profunda	Profunda	Profunda	S	S
23	75	49	50	9	Profunda	Profunda	Profunda	S	S
24	75	44	72	38	Profunda	Profunda	Profunda	S	S
25	64	47	75	74	Profunda	Profunda	Profunda	S	S
26	0	0	15	0	Insiptens	Insiptens	Insiptens	S	S
27	5	10	18	50	Superfisialis	Superfisialis	Superfisialis	S	S
28	12	10	2	75	Superfisialis	Superfisialis	Superfisialis	S	S
29	8	8	50	25	Superfisialis	Superfisialis	Superfisialis	S	S
30	10	6	50	50	Superfisialis	Superfisialis	Superfisialis	S	S
31	10	10	50	75	Media	Media	Media	S	S
32	17	9	70	25	Superfisialis	Superfisialis	Superfisialis	S	S
33	20	10	68	40	Superfisialis	Media	Superfisialis	TS	TS
34	0	8	75	68	Media	Media	Media	S	S
35	5	28	18	20	Insiptens	Insiptens	Insiptens	S	S
36	6	50	25	25	Insiptens	Insiptens	Insiptens	S	S
37	20	35	19	50	Superfisialis	Superfisialis	Superfisialis	S	S
38	10	43	25	70	Superfisialis	Superfisialis	Superfisialis	S	S
39	25	50	50	14	Media	Media	Media	S	S
40	7	50	50	47	Media	Media	Media	S	S
21	69	49	37	38	Media	Profunda	Media	TS	TS
22	71	50	50	75	Profunda	Profunda	Profunda	S	S
23	75	49	50	9	Profunda	Profunda	Profunda	S	S
24	75	44	72	38	Profunda	Profunda	Profunda	S	S
25	64	47	75	74	Profunda	Profunda	Profunda	S	S
26	0	0	15	0	Insiptens	Insiptens	Insiptens	S	S
27	5	10	18	50	Superfisialis	Superfisialis	Superfisialis	S	S
28	12	10	2	75	Superfisialis	Superfisialis	Superfisialis	S	S
29	8	8	50	25	Superfisialis	Superfisialis	Superfisialis	S	S
30	10	6	50	50	Superfisialis	Superfisialis	Superfisialis	S	S
31	10	10	50	75	Media	Media	Media	S	S
32	17	9	70	25	Superfisialis	Superfisialis	Superfisialis	S	S
33	20	10	68	40	Superfisialis	Media	Superfisialis	TS	TS
34	0	8	75	68	Media	Media	Media	S	S
35	5	28	18	20	Insiptens	Insiptens	Insiptens	S	S
36	6	50	25	25	Insiptens	Insiptens	Insiptens	S	S
37	20	35	19	50	Superfisialis	Superfisialis	Superfisialis	S	S
38	10	43	25	70	Superfisialis	Superfisialis	Superfisialis	S	S
39	25	50	50	14	Media	Media	Media	S	S
40	7	50	50	47	Media	Media	Media	S	S
61	50	30	75	50	Profunda	Profunda	Profunda	S	S
62	50	30	75	75	Media	Profunda	Profunda	S	TS
63	50	50	25	25	Media	Media	Media	S	S
64	50	50	34	50	Media	Media	Media	S	S
65	50	48	18	72	Media	Media	Media	S	S
66	39	50	50	4	Media	Media	Media	S	S
67	31	50	50	43	Media	Media	Media	S	S
68	50	50	50	75	Profunda	Profunda	Profunda	S	S
69	50	34	46	12	Media	Media	Media	S	S
70	50	49	75	50	Profunda	Profunda	Profunda	S	S
71	50	47	75	71	Profunda	Profunda	Profunda	S	S
72	75	10	25	25	Media	Media	Media	S	S
73	64	10	23	50	Media	Media	Media	S	S
74	20	30	25	50	Superfisialis	Superfisialis	Superfisialis	S	S
75	25	30	25	75	Superfisialis	Superfisialis	Superfisialis	S	S
76	12	25	50	24	Superfisialis	Superfisialis	Superfisialis	S	S
77	17	20	40	50	Superfisialis	Superfisialis	Superfisialis	S	S
78	11	27	50	75	Media	Media	Media	S	S
79	0	30	75	25	Media	Media	Media	S	S
80	18	25	75	50	Superfisialis	Media	Media	S	TS
81	13	20	75	70	Media	Media	Media	S	S
82	3	6	2	0	Insiptens	Insiptens	Insiptens	S	S
83	6	5	9	50	Superfisialis	Superfisialis	Superfisialis	S	S
84	12	10	16	64	Superfisialis	Superfisialis	Superfisialis	S	S
85	18	2	50	25	Superfisialis	Superfisialis	Superfisialis	S	S
86	25	10	43	50	Superfisialis	Superfisialis	Superfisialis	S	S
87	20	9	50	75	Media	Media	Media	S	S
88	23	5	68	21	Superfisialis	Superfisialis	Superfisialis	S	S
89	14	4	75	50	Media	Media	Media	S	S
90	16	7	75	68	Media	Media	Media	S	S
91	13	26	21	24	Insiptens	Insiptens	Insiptens	S	S
92	19	28	14	50	Superfisialis	Superfisialis	Superfisialis	S	S
93	22	23	1	67	Superfisialis	Superfisialis	Superfisialis	S	S
94	19	27	50	2	Superfisialis	Superfisialis	Superfisialis	S	S
95	7	24	50	48	Superfisialis	Superfisialis	Superfisialis	S	S
96	8	28	46	72	Superfisialis	Media	Superfisialis	TS	TS
97	9	30	75	4	Media	Media	Media	S	S
98	23	30	75	46	Media	Media	Media	S	S
99	19	27	75	71	Media	Media	Media	S	S
100	6	34	8	2	Insiptens	Insiptens	Insiptens	S	S

* Note: (S: Suitable, TS: Not Suitable).

From the results of the data obtained, there are using the system with 93 data in the table above. Furthermore, according to the expert, while using matlab2015a, there are 95 relevant data. This result will

affect the resulting accuracy from expert systems and matlab2015a. Test result The accuracy in this study is obtained:

Validation of Use of Matlab2015a:

$$\begin{aligned} &\equiv \frac{\text{Data Matlab}}{\text{data Dokter}} \times 100\% \\ &= \frac{95}{100} \times 100\% = 95\% \end{aligned}$$

Validation Using the System:

$$\begin{aligned} &\equiv \frac{\text{Data Sistem}}{\text{data Dokter}} \times 100\% \\ &= \frac{93}{100} \times 100\% \\ &= 93\% \end{aligned}$$

After testing with using 100 data concluded the system has accuracy of 93%, while using Malab2015a produces 95% accuracy

4. Conclusion

Based on the results of the discussion of the expert system for diagnosing caries, then the conclusions can be taken as follows:

- Expert system application for early diagnosis of dental caries can explain the kinds of dental caries results in disease diagnosis and can provide an explanation of the causes and the solution of the diagnosis in suffering.
- Testing system accuracy based on the application made to give the accuracy value of 93% while testing in using matlab2015a by 95%.
- From this research, the system can display the results diagnosis and description of the disease.

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