Expert System for Measuring the Level of Spinach Freshness using Certainty Factor Method

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Abstract: Expert system for measuring the level of spinach freshness is made because spinach is one of the vegetables that has a good nutritions and often consumed by people, especially in Indonesia. Spinach that will be consumed must be check first the freshness level. However, not everyone know how to find out the level of spinach freshness Therefore, an expert system is needed to measure the level of spinach freshness. Expert system for measuring the level of spinach freshness is also rarely found, especially in Indonesia. The measurement of level of spinach freshness can be seen from several factors or symptoms, such as soft texture, leaf color between light green and green, and no white spots on the leaves. These factors or symptoms determine the level of spinach freshness or spinach quality whether the spinach is good or normal. Expert system created in this study uses the Certainty Factor method because this method has been widely used in several other studies and gives good results. This research still uses prototype system, but it cant give good results, namely the system made to show the quality calculation of the level of spinach freshness in accordance with manual calculations. Test result on expert get 90% accuracy.

1 INTRODUCTION

This research will discuss the level of spinach freshness using Certainty Factor method with the help of an expert system. Artificial intelligence are everywhere, perform in so many sector such as security using biometric, health etc (Alexander et al., 2018). Expert system is part of artificial intelligence that combines knowledge from the research of an expert who has knowledge of a field to help make a decision(Islam and Mishra,). It has been implemented in many fields including health (Kusnadi, 2013), education (Futra, 2014) and others.

Spinach contains vitamin K, iron, flavonoids, carotene, vitamin C, and other good nutrients. These nutrients are good for the body and can prevent several diseases such as cancer, presbyopia, cataract, and other diseases. This has been proven from an international research journal entitled Nutritional Value of Spinacia Oleraecea Spinach which states that spinach is good for the body (Singh et al., 2016). In addition, these benefits make people become interested in consuming spinach, including Indonesian.

Indonesia has abundant natural resources, including spinach. Based on data from Statistics Indonesia regarding spinach production in Indonesia, the increase level of spinach production in Indonesia is increasing almost every year (Statistik, 2019). The increase in spinach production each year is between 10.000 and 20.000 per ton. This shows that spinach is in demand by Indonesian people. Therefore, the quality of spinach also needs to be considered. Before spinach is consumed, it is better to check the freshness level first so that the nutrients in spinach can be beneficial to the body. The level of spinach freshness is generally seen from the physical condition. However, not everyone knows how to check the level of spinach freshness. Therefore, an expert system is needed to help people in giving advice on choosing fresh spinach.

Spinach that is good to be consume is fresh spinach and useful substances in spinach can still be utilized. Checking the level of spinach freshness is generally seen from the physical condition of spinach. However, not everyone knows how to check the level of spinach freshness. Therefore, an expert system is needed to help people in giving advice on choosing fresh spinach. Currenlty in Indonesia there are not many system for measuring the level of vegetable freshness, especially spinach. Based on this, an expert system for measuring the level of spinach freshness needs to be made. Expert system that

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will be created is to use the certainty factor method. This method was chosen because there are already many research journals that use this method, such as Sistem Pakar Mendiagnosa Penyakit Tanaman Kol Menggunakan Metode Certainty Factor (Rayuwati, 2013), Sistem Pakar Diagnosa Penyakit Tomat dengan Metode Certainty Factor (Rohmah, 2017), Sistem Pakar Mendiagnosa Penyakit Kolesterol pada Remaja dengan Metode Certainty Factor Berbasis Web (Sihotang, 2017), and other researches. Based on these researches, certainty factor method can provide good suggestions to users.

The system that will be created will receive input from the user to select factors or symptoms that exist in spinach that will be checked for the freshness. After that, the user fills in the certainty level (CF User) on each factor or symptom. The system will calculate the CF factor to get the freshness percentage of spinach. Based on the testing result expert system was successfully made with 90% accuracy so it can be useful to help people or users who have difficulty in choosing fresh spinach. Therefore, people or users can choose spinach that is good for the body and get maximum benefits from the spinach.

2 LITERATURE REVIEW

2.1 Level of Spinach Freshness

The level of spinach freshness can be seen from the color of spinach leaves which are still integrated with the stem. Spinach leaves that are suitable for consumption are spinach leaves that are green or dark green while spinach that is not suitable for consumption is spinach with yellow leaves and also on the surface of a good spinach leaf there are no white spots (fungus) (Zhang and Zhang, 2014).

2.2 Certainty Factor Method

The following are literature review of researches using Certainty Factor method.

1. Sistem Pakar Mendiagnosa Penyakit Tanaman Kol Menggunakan Metode Certainty Factor by Danil Iskandar in 2017. This research diagnosed cabbage plant diseases that can provide advice to users and farmers and provide solutions that are appropriate to the symptoms experienced by cabbage.

2. Sistem Pakar Diagnosa Penyakit Tomat dengan Metode Certainty Factor by Siti Nur Romah in 2017. This research produced a system that can

provide disease indication results based on the selected symptoms and the level of confidence. Validity testing is done by using system calculation and manual calculation by finding highest CF value that is equal to confidence value 93.77%. So the system can be declared as valid.

3. Sistem Pakar Mendiagnosa Penyakit Kolesterol pada Remaja dengan Metode Certainty Factor Berbasis Web by Hengki Tamando Sihotang in 2014. This research simplify and provide a calculation of the completion of how certain the users are aware of teenage cholesterol disease.

2.3 Results Validation

System testing is done by comparison result of manual testing with those calculated through the system. This research will be testing the highest CF value. The following are literature review of research testing.

1. Sistem Pakar Diagnosa Penyakit Tomat dengan Metode Certainty Factor by Siti Nur Romah in 2017. This research examines the highest CF value with confidence value of 93.77%.

There are also rules that determine the level of spinach freshness that is influenced by the color of leaf, the amount of mold, and the texture of the leaf. The test result are in the form of a comparison between manually calculated Certainty Factor and system calculated using system.

Certainty Factor can be calculated using the following formula.

$$CF[H,E] = MB[H,E] - MD[H,E] \qquad (1)$$

Variables:

CF[H,E] : Certainty factor hipotesis which is influenced by evidence e known with certainty.
MB[H,E]: Measure of belief against hypothesis H, if given evidence E (between 0 and 1).
MD : Measure of disbelief
P : Probability
E : Evidence

The basic formula is used if there is no CF value for each spinach fact. The Certainty Factor used to measure the quality of spinach is as follows.

1. Certainty Factor for rules with a single premise/factor

$$CF\,factor = CF[user] * CF[expert] \qquad (2)$$

2. If there are more than factors, then it will be determined by the following equation.

$$CF combination = CFold + CF factor \\ * (1 - CFold) \quad (3)$$

3. Whereas to calculate the percentage of quality freshness can use the following equation.

$$CF percentage = CF combination * 100 \quad (4)$$

3 SYSTEM DEVELOPMENT METHOD

The method used to develop this system is prototype method due to one of the advantages of prototype method because this method able to take concrete needs and can be developed into largescale system but only the simplified version was made (bambang hermawan, 2015). System only accepts input in the form of confidence percentage in a spinach quality category. The steps of this method are as follows:
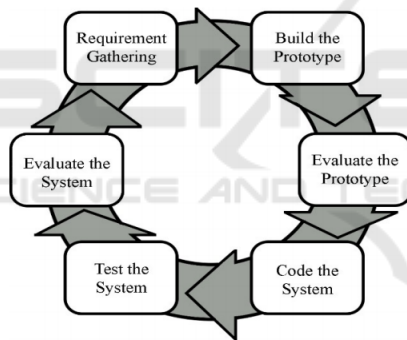

Figure 1: Prototype Method

1. Requirements gathering
   Identify all the requirements and system outline that will be made. Requirements are explored with stakeholders to define software requirements.

2. Build the prototype
   After gathering requirements, temporary design will be made for the user. The temporary design consist of input, process, and output that can be seen by the user.

3. Evaluate the prototype
   Evaluate the prototype to find out if it has fulfilled all the necessary requirements. If not, then the developer must gather requirements more deeper and prototype must be designed and built or developed so that it suits the overall requirements.

4. Code the system
   Prototype that has been approved will be code into certain programming language.

5. Test the system
   System has become a software and must be tested using either White Box, Black Box, and other testing.

6. Evaluate the system
   Sistem will be evaluated and quality of the system will be checked. If quality of the system is still not according to user expectations, then system will be code and test again. When system is ready to be use, system can measure the level of spinach freshness. If there is an update, then there will be requirements gathering again.

System will be made with C/C++ programming language with CodeBlock editor. System will accept 2 inputs number with float data type where the value of the inputs are probability value that range from -1 to 1 and each input comes from experts and users. System has 3 criteria for determining the quality of spinach, those are the state of spinach leaves, the color of spinach leaves, and the number of white mold under the spinach leaves. Each criterion receives 2 inputs, namely from the experts and the users, so that the total input is 8 kinds. System will process input data from users and experts to measure certainty factor based on the level of certainty, the level of uncertainty, and probability then processed using the formula described in the previous chapter. Output from the system is the value of a certainty factor that ranges from -1.0 to 1.0 (certainly not to very certain) to determine whether spinach leaves are suitable for consumption or not.

4 RESEARCH RESULT

4.1 Knowledge Base

Research conducted by interviewing experts who have experience in understanding the level of spinach freshness. The following are the categories of symptoms and quality in spinach obtained from experts.

Code	Factor	Expert Value
F1	Soft texture	0.4
F2	Leaf color green	0.8
F3	There are no white spots under the leaves	0.8

Figure 2: Symptoms Category.

Code	Quality
K1	Good

Figure 3: Quality Category.

To determine certainty factor information from the expert, seen from CF combination based on the CF term table.

4.2 Rule CF

The application of the Certainty Factor method requires several rules in form of variables and weight values given by experts. The weight value needed for each symptom can be seen in Figure 4. CF rules that contain symptoms and weight values from experts for each disease are shown in Figure 5.

No.	Certainty Term	CF $_{end}$
1	Certainly not	0.0
2	Uncertain	0.2
3	Little certain	0.4
4	Pretty certain	0.6
5	Certain	0.8
6	Very certain	1.0

Figure 4: Symptoms Percentage.

CF	CF Expert	CF User	CF factor
1	0.4	0.2	0.08
2	0.8	0.4	0.32
3	0.8	0.8	0.64

Figure 5: Test case calculation.

4.3 Implementation

System will display list of symptom criteria consisting of 3 types which can be seen in Figure 6.

Figure 6: Symptoms criteria

User will input their certainty level about symptoms found in spinach with inputs ranging from 0 (certain), 0.2 (not certain), 0.4 (little certain), 0.6 (pretty certain), 0.8 (certain), 1.0 (very certain) as in Figure 7.

Figure 7: Input certainty factor

If the user has finished inputting all certainty about symptoms found, then the application will issue a certainty percentage of spinach quality which can be seen in Figure 8.

Figure 8: Result certainty percentage of spinach quality

4.4 Application Calculations

Application calculations are used to determine the quality of spinach freshness. The calculation method used is Certainty Factor.

The first step of using CF method in the calculation process based on symptoms that have been inputted by the user in figure 3 is to multiply 2 probability values namely weight given by the user with the weight value rule given by the expert. The results of multiplication are shown in Figure 5.

The next step is the combination of the multiplication results of each symptom from the product in table 4 with each combined iteration show in Figure 9 where the good spinach has 77% percentage value of spinach quality which can be seen in Figure 8.

Iteration	CF1 + (CF2 * (1 − CF1))
1	0,08 + 0,32 * (1 - 0,08) = 0.37
2	0,37 + 0,64 * (1 - 0,37) = 0.77

Figure 9: Symptoms Percentage.

4.5 System Testing

System testing is done to determine the accuracy between the calculation of the certainty percentage of spinach freshness from the system equal to the manual calculation. The system is tested by giving users to input CF which can be seen in Figure 5. The results of calculations on the system can be seen from figure 4 and the results of manual calculation can be seen in Figure 9. From these calculations were shown to experts and checked by experts to know the accuracy level. The level of accuracy is obtained from compatibility between the spinach that is checked for the

level of freshness manually by experts and those that are checked with the system. From the test result it can be said that the accuracy is 90% which can be seen in Figure 11.

Symptoms Criteria	Expected Result	Displayed Result
1	Soft Texture	Fit
2	Leaf color between green and dark green	Fit
3	There are no white spots under the leaves	Fit

Figure 10: Symptoms Criteria Testing.

Test Case	F (n)	CF User	CF Factor	Expected Result	CF End
1	1	0.2	0.08	Not Good	67 %
	2	0.4	0.32		
	3	0.6	0.48		
2	1	0.2	0.08	Not Good	67 %
	2	0.6	0.48		
	3	0.4	0.32		
3	1	1	0.4	Good	93 %
	2	0.6	0.48		
	3	1	0.8		
4	1	0.4	0.24	Not Good	42 %
	2	0.4	0.32		
	3	0	0		
5	1	0.6	0.24	Good	64 %
	2	0.4	0.32		
	3	0.4	0.32		
6	1	0.6	0.24	Good	73 %
	2	0.4	0.32		
	3	0.6	0.48		
7	1	0.6	0.24	Not Good	48 %
	2	0.4	0.32		
	3	0	0		
8	1	0.2	0.08	Not Good	37 %
	2	0.4	0.32		
	3	0	0		
9	1	0.6	0.24	Not Good	48 %
	2	0.4	0.32		
	3	0	0		
10	1	0.2	0.08	Not Good	22 %
	2	0,2	0,16		
	3	0	0		

Figure 11: Expert Test Result.

Result from Figure 11 can produce 90% accuracy because out of 10 test cases, there was one wrong test case, that was test case 5, where the expected result

is different from result checked in system. Test case 5 included in category not good because CF end is under 70%. Failure might be caused by expert give inputs or weight that are not quite right.

From the research conducted there are still weaknesses in several aspects. This research might be developed to give maximum result, such as add more criteria or expert value that can be checked with other experts.

5 CONCLUSIONS

Based on research conducted, the expert system with the Certainty Factor method can be implemented well for the measurement of the level of spinach freshness. Calculations made with the system that are made compared with calculations done manually. The results of the comparison done are same. So that the system created can help to see the quality of spinach from the symptom entered by user. With this system, it is expected to be useful for people who want to see the spinach quality or spinach freshness.

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