Tapai Ripeness Monitoring Application Using Fuzzy Tahani Method

Karina Djunaidi[1], Yudhy Setyo Purwanto[1], Rahma Farah Ningrum[1], Hendra Jatnika[1], and Wali Syahputro Cahoyo Kabidoyo[1]

[1]Informatics Department, Sekolah Tinggi Teknik PLN, Jakarta, Indonesia

*karina@sttpln.ac.id

Abstract. Cassava tapai (or tape) is a food made from fermented cassava by involving yeast in the manufacturing process. Conventionally, tapai making process takes 3 to 5 days and the tapai craftsman has difficulty monitoring the fermentation process and determining the ripeness of the tapai. This research was aimed at building an application to help those tapai craftsmen in monitoring the fermentation process until it is riped. Fuzzy Tahani Resistant method is applied as a parameter for determining the maturity of the tape accurately by considering the humidity, temperature and weight of the tapai factors. The result of this study indicates that cassava tapai that was riped at a temperature of 30ºC – 35ºC within 24 hours will be marked by changes in texture, aroma, color, and taste. This method is expected to help the craftsmen to improve the quality of tapai production with shorter production time.

1. Introduction

Cassava tape is one of Indonesia's traditional foods that is produced from the fermentation process or commonly known as fermentation [1]. Fermentation is the process of converting starch to glucose and then converted to alcohol which takes place anaerobically [2]. Cassava tape takes time during the fermentation process so that the texture becomes soft and fluffy [3] [4]. Based on interviews with tape craftsmen, the time needed for cassava fermentation is 4 to 5 days and during the fermentation process, cassava changes its taste, texture, color and aroma so that it becomes a tape [5].

Based on the results of interviews with tape craftsmen about the process of making tape, cassava that has been cleaned and steamed, then placed in a closed container and then given yeast. At the time of the fermentation process, the craftsmen of the tape cannot know the state of the tape being fermented without checking by opening the lid of the fermentation container, causing the disruption of the fermentation process, because the temperature in the fermentation container becomes unstable. In addition, the craftsmen of the tape also could not ascertain the time when the tape was ripe and ready to be harvested, so they could only predict when the cassava tape was ripe. This can lead to tape production quality that is not optimal and often fails.

To overcome this, a study conducted by D. Karina et al. Offered a solution to this problem with a tape detection and monitoring device using temperature, humidity and weight sensors mounted on Arduino Uno [6]. In these devices, the DHT11 temperature and humidity sensor is used to detect the temperature and humidity of the container during the fermentation process. Weight sensor is used to detect cassava weight during the fermentation process then the status and results of the fermentation will be sent by the sensor from Arduino to the tape maturity monitoring application.

This study discusses the application of monitoring tape maturity using the Fuzzy method. Fuzzy is a branch of artificial intelligence which is a development of Boolean logic that emulates the ability of humans to think then is applied to an algorithm to map an input space into an output space and has a continuous value [7] [8] [9]. Fuzzy has been widely applied in various kinds of research, including regulating enemy behavior in action-RPG games [7], Optimization of Smart Traffic Light to overcome traffic congestion [10], in detecting superior varieties in corn [11] and many more. Fuzzy which is applied in tape maturity monitoring application is Fuzzy Resistant to determine tape maturity based on data sent by tape maturity detector and monitoring device [6]. The monitoring application also displays the status of temperature, and humidity during the fermentation process as well as information on cassava weight, so that the tape craftsman can find out the fermentation process information to completion so that the tape is ripe and suitable for consumption.

2. Research Method

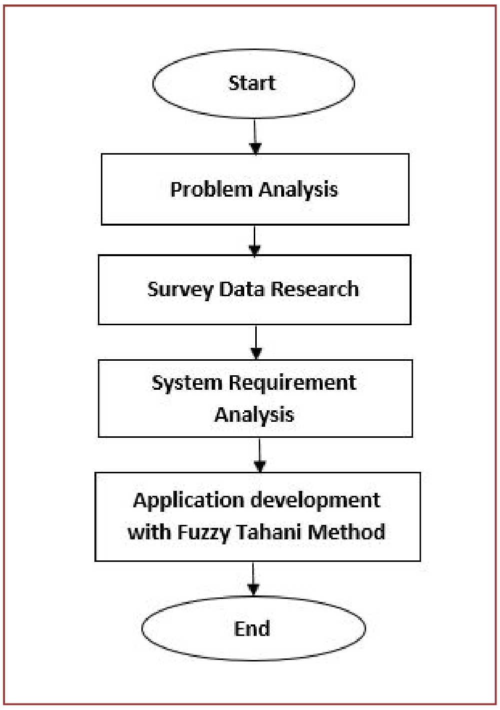

Figure 1. Research method stage

Figure 1 shows the research stages of monitoring the application of tape maturity using the Fuzzy Tahani method. In a study conducted by Asnawi et al. it is mentioned that to improve the quality of the tape being produced, the need for temperature control in the fermentation process is essential [1]. In addition, the interaction between the fermentation process and the temperature of the fermentation container is also very contradictory to the texture of the resulting tape [12] therefore, by maintaining the stability of the fermentation process and the temperature of the fermentation container should be able to produce a maximum tape texture. Research carried out by D. Karina by building detection and monitoring devices using temperature and humidity sensors [13] [14] has the purpose of to process information obtained from the device that is sent to the application by Arduino to monitor the fermentation process [6]. By applying fuzzy Tahani method, the application can determine whether the tape is ripe or not, so that the tape craftsman does not need to open the lid of the fermentation container to find out the fermentation status which can disrupt the fermentation process

3. Result and Analysis

After the temperature data is obtained from the detector and monitoring tape, [6] the data is then applied to the fuzzy Tahani method with the following stages

a. Defining Fuzzy Variables
Fuzzy variable used in this study is the cassava tape maturity temperature.

b. Formation of Fuzzy set
Fuzzy sets are determined to group data based on linguistic variables expressed in membership functions **[15]**. The optimal temperature on fast tape maturity is 25^{0}C - 35^{0}C [1]. Based on these fuzzy variables, it can be determined the fuzzy set for the ripeness temperature variable is as follows:

Table 1. Ripeness Temperature Grouping

Fuzzy Group	Value Domain ^{0}C
Cold	0 - 22
Normal	22 - 30
Hot	30 – 35

Based on the membership set, the domain of the set of fermented temperature Fuzzy variables:

Cold : [0^0 - 22^0] C Notification Failed to Ferment.
Normal : [22^0 - 30^0] C Notification Is Fermented.
Hot : [30^0 - 35^0] C Notification of Successful Fermentation.

c. The temperature membership function uses a trapezoid curve

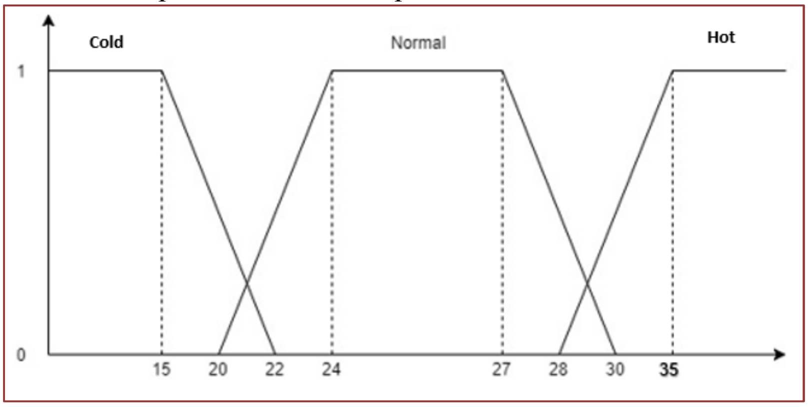

Figure 2. Temperature determinant in trapezoid curve

d. Based on the curve above, the membership function is grouped into 3 categories, namely: Cold, Normal, and Hot.

- Cold (Failed Fermentation process) [0^0 - 22^0] C

$$\mu \text{ Cold}|x| = \begin{cases} 1 & ; \quad x \leq 15 \\ (22 - x)/(22 - 15) & ; \quad 15 \leq x \leq 22 \\ 0 & ; \quad x \geq 22 \end{cases} \tag{1}$$

- Normal (Fermentating) $[20^0 - 30^0]$ C

$$\mu\ \text{normal}|x| = \begin{cases} 0 & ; \quad x \leq 20 \\ (x-20)/(24-20) & ; \quad 20 \leq x \leq 24 \\ 1 & ; \quad 24 \leq x \leq 27 \\ (30-x)/(30-27) & ; \quad 27 \leq x \leq 30 \\ 0 & ; \quad x \geq 30 \end{cases} \qquad (2)$$

- Hot (Successfully Fermented) $[\geq 35^0]$ C

$$\mu\ \text{Hot}|x| = \begin{cases} 0 & ; \quad x \leq 28 \\ (x-28)/(35-28) & ; \quad 28 \leq x \leq 35 \\ 1 & ; \quad x \geq 35 \end{cases} \qquad (3)$$

Based on data analysis of the limits of each fuzzy set in the fermentation temperature variable, the fuzzy rules formed are as follows:

[R1] If the Temperature of the Failed Fermentation is greater than the Fermentating Temperature and the Fermented Failure is greater than the Successful Fermentation Temperature then the Result is Failed Fermentation

[R2] If Fermentation Temperature is greater than the Failed fermentation Temperature and Fermentation Temperature is greater than Successfully Fermented Temperature then Result is Being Fermented

[R3] If the temperature of successful fermentation is greater than the temperature of failed fermentation and the temperature of successful fermentation is greater than being fermented then the results is successful fermentation.

Figure 3 shows the application monitoring page display. The application monitoring page is equipped with real time data sent by the temperature, humidity and weight sensors on the detector and monitoring the maturity of the tape [6] and is equipped with data storage and fermentation status.

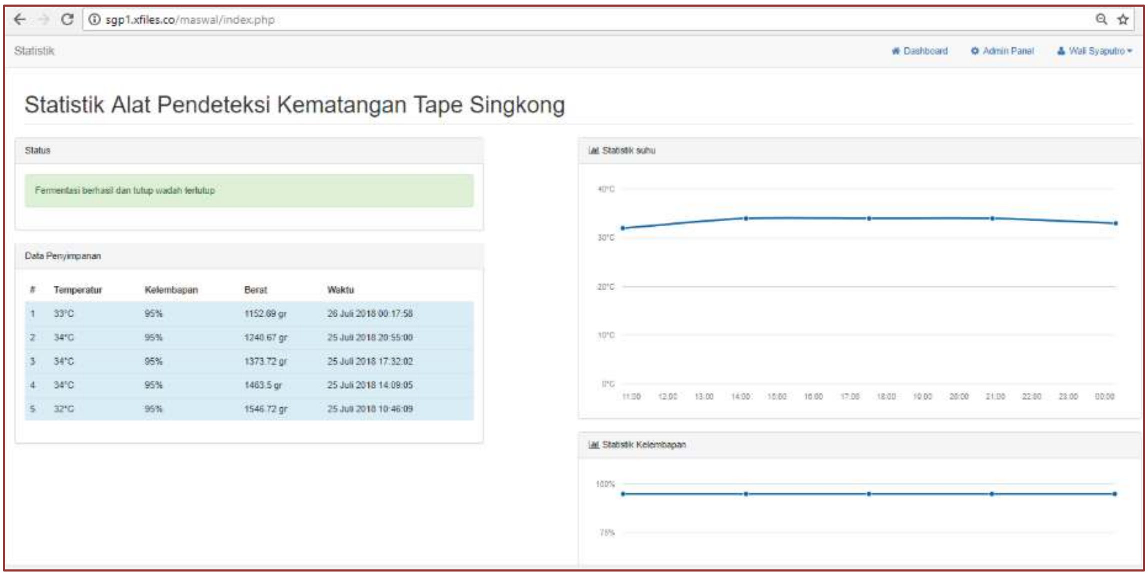

Figure 3. Monitoring menu display

Table 2. presents the temperature data generated in the fermentation tape process for 24 hours.

Table 2. 24 Hours Fermentation Temperature

Date	Time	Temperature ^{0}C
25 - July - 2019	01:05 Wib	30C^{0}
25 - July - 2019	03:10 Wib	32C^{0}
25 - July - 2019	07:14 Wib	32C^{0}
25 - July - 2019	10:46 Wib	32C^{0}
25 - July - 2019	14:06 Wib	34C^{0}
25 - July - 2019	17:32 Wib	34C^{0}
25 - July - 2019	20:55 Wib	34C^{0}
26 - July - 2019	00:17 Wib	33C^{0}

In the observations, an increase in temperature occurs during the fermentation process for 24 hours. The temperature increased from 30^{0}C – 34^{0}C, and at that temperature for 24 hours the cassava tape became ripe. This is characterized by the soft texture of cassava, the distinctive aroma of the tape (the alcoholic aroma) and the tape becomes watery.

4. Conclusion

In this study, the application of the Fuzzy Tahani method helps to determine the temperature detected in the container precisely, so that the level of cassava tape maturity can be determined accurately based on the data recorded in the application database. Based on the data obtained, the level of cassava tape maturity is good at a temperature of 30^{0}C – 35^{0}C.

By combining the monitoring application and the tape maturity detection device [6] the cassava tape production process can take place more quickly, which is 24 hours (1 day) compared to conventional processes of 4 - 5 days. It is expected that this technology can help cassava tape craftsmen in increasing tape production both in terms of the quality of the tape produced and the production process in meeting consumer needs.

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