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EXPERIMENTAL DESIGN FACTORIAL PARAMETERS OF HONEY WATER CONTENT LEVELS TO IMPROVE HONEY PROCESSING PRODUCTIVITY

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Abstract. In producing honey products, must meet all SNI quality standards (8665:2018), one of which is honey water content of less than 22%. Honey from farmers has a moisture content of more than 22% so the water content must be reduced. On of the technique that use in a company to meet those standard uses a dehumidification system combined with air conditioning and a honey rain device. With the current machine configuration, the required honey moisture reduction process time is 11 days. This study focuses on finding a combination of degrees Celsius temperature factor and relative humidity percentage factor that results in the optimal rate of reduction in water content. The results showed that temperature and relative humidity each had an effect on the rate of decrease in the water content of honey and no interaction effect was found between the factors of temperature and relative humidity on the rate of decrease in the water content of honey. The combination of selected temperature and relative humidity factors, namely 27°C and 40%, in the most optimal rate of decrease in water content with an average of 0.416667% per hour. When compared with the combination of temperature and relative humidity in the company, namely 30°C and 60%, the selected treatment combination can reduce the processing time for reducing the honey moisture content and increases productivity by 50%.

Keywords : honey, temperature, relative humidity, drying, reduced moisture content, dehumidification, experimental design, factorial experiment.

1. INTRODUCTION

Honey is a natural liquid usually has a sweet taste produced by honey bee (Apis sp.) from flower essence or parts other plants [1]. Honey has many benefits in the field of industry, food, health, and cosmetics which has been widely known by the public [2]. According to [3], consumers' desire to improve immune system causes high demand honey today. However, not accompanied by production to meet this demand. This indicates that there is potential promising industry due to production honey has not been able to meet the many requests consumer

Because honey is a product that has been standardized by National Standardization Body so product must meet honey quality standards which has been determined in Indonesia National Standard (SNI) (SNI 8664: 2018) One of them is the water content of honey does not exceed 22%. However, based on the information from the farmers an average percentage water content level was24%. High water content of harvested honey caused by the tropical climate of Indonesia so that the high humidity of the surrounding air affects the high water content of honey [4]. For meet the SNI quality standards, then honey must be carried out the process of reducing the water content so that does not exceed 22%. One of the system that particularly use was dehumidification of the process to reducing levels their honey water. This dehumidification system combined with a rain gear made of stainless steel, i.e. honey flows into the container large capacity to be dropped later in the form of droplets like rain. System dehumidification applied using AC as temperature

controller and refrigerant machine dehumidifier as a humidity regulator. System dehumidification allows the reduction of levels water in honey due to suction water by air (evaporation of water) caused by inequality of ambient air moisture content and moisture content honey. If the water content of the air is low enough it means air has low relative humidity so that the probability of evaporation will be the greater it is. The further the difference in vapor content water in the air with the material, will be more and more the moisture content of the material that can be evaporated due to the capacity to hold water in the air is getting bigger [5]. The process that the forest honey goes through is first the honey is received from the farmer and immediately carried out the filtering process for 1 day. Then, forest honey goes through the process reduction in water content. To lower the water level forest honey 600kg of the average initial moisture content of 24% to 20% according to company standard, needed time 9 days. After the process of reducing the water content carried out, bottling and packing processes Jungle honey is done for 2 days and is ready to eat marketed to consumers.

According to [6], there are some things related to time The reduction in the water content of honey includes: water content at the beginning and end of the process, the total weight of honey which you want to reduce the water content, as well as the rate of reduction in water content. Percentage of initial water content of honey before processing and the final moisture content of honey after the process is related to the process of reducing the water content of honey. The greater the difference between the initial moisture content and the moisture content to be achieved, then the processing time will be longer it takes [7]. The water content of honey must be achieved after the process of reducing the water content is less than 22% according to SNI standards. While the water content of honey before has variations this is caused by honey came forest honey that collect by honey farmers. Furthermore, processing time reduction in the water content of honey is associated with the amount of honey weight to be reduced, the greater the amount of honey that will carried out the process of reducing the water content, it will take longer the processing time [8]. For remarks, time to process the reduction of the water content of honey inline with the rate of reduction of the water content so that to achieve a short processing time, the rate of water content reduction should be increased [6]. In general, in order to increase the rate The reduction in the water content of the material can include: by increasing the velocity of the air flow, expand the surface of the material to bedried, and temperature and humidity settings [9]. Flow speed air can be increased by using exhaust fan or fan because the air moving will avoid saturation so that the material will dry faster [9]. However, the procurement of exhaust fans and the fan will cost some money. In addition, the rate of decrease in the water content of the material can also be accelerated by expanding the surface of the material to be dried due to material surface contact with drying medium will be wider so that the water will be easier diffuses so that the material dries faster [9]. Increase in surface area in the solution can be done by reducing the size of the solution into granules [10]

There are other ways to speed up the pace reduction of the water content of the material, namely by regulate the temperature and relative humidity of the air (Relative Humidity/RH) [11]. The increase in temperature will increase the rate of heat transfer to the material which is dried and the rate of evaporation of water at dried material [12] Will however, there is a quality-degrading impact on honey because high temperatures can reduce levels diastase enzymes and increase levels of 5 hydroxymethyl-2-furfural (HMF) [13][14] To avoid dropping honey quality, honey should not be heated above 45°C [15]. On the other hand, humidity relatively low air will help movement of water from the dried material [12]. Relative humidity determines the ability of the drying air to accommodate moisture content of the material that has been evaporated so that if the lower the RH, the more water vapor absorbed by the drying air [11]. Therefore, the temperature and humidity can theoretically affect the rate decrease in water content in honey. Darmawan et. al. [16] stated that temperature affects the rate of decline dehumidification system honey moisture content. Temperature set using air conditioning and relative humidity percentage regulated using a refrigerant dehumidifier. The use of trays arranged as containers honey concludes that combination of 25°C AC temperature and relative humidity dehumidifier 40% can reduce the water content of honey faster than the temperature combination AC 30°C at relative humidity percentage the same dehumidifier. Singh et. al. [17] states that the rate of decrease in water content at honey temperature 40°C faster than temperature 35°C. The temperature is set using hot water which is circulated around the honey container and honey is mixed with a disc that rotates to expand the surface of the honey exposed to drying air due to honey attached to the disc. While the type The dehumidifier used is a desiccant dehumidifier with silica gel.

There are some related differences research conducted [1][6] compared to [17]. These differences include low temperature on [16] produces the fastest rate of decrease in water content while in [17] the temperature high is the fastest. Next difference depends on the type of dehumidifier used and given temperature treatment. Singh [17] specifically to change the temperature honey by circulating hot water around the honey container while doing mixing in the honey. However, the temperature the air is fickle because of what is maintained is the temperature of the honey not the temperature of the air. Whereas [16] regulate temperature treatment using AC but does not provide specific information about the data. Therefore, it is necessary to design experiment to find the right combination between temperature and humidity so that the rate of decrease water content in the rain reducer water content honey

2. METHODS

The process of collecting data in this study are:

a. Selection of dependent, independent, control, and confounding research variables are divided based on the nature of the relationship between variables, in this case is dependent variable and independent variable. In addition, there are control variable whose value is kept constant for controlling the relationship between independent and dependent variables. The following variables are used in this study is:

1. Variable temperature and relative humidity will be the independent variable because manipulation of these two variables judged to be easy to do and does not require the procurement of tools addition. Temperature related changes carried out using air conditioning and change in relative humidity is regulated with a dehumidifier. Then monitoring related to air temperature and actual relative humidity monitored with a thermos hygrograph digital.
2. The dependent variable measured in this study, the rate of reduction in the water content of honey will be known of the total reduction in water content per time unit.
3. Control variables in this study taken from other factors that affect the rate of decline water levels are:
   a) Time span for control drop in levels water.
   b) Weight of honey in each treatment.
   c) Honey granules that come out from the honey raindrops.
   d) Airflow velocity in room during processing experiments were carried out.
4. Confounding variables in the study this is the initial water content of honey varies due to using forest honey from farmers directly

b. Selection of factors and free variable factor levels

The selection of the number of factors and the factor level will affect the level of difficulty in doing experiment. The number of factors and the level of the factors more and more will lead to experimentation and data processing takes longer and can increase costs. Darmawan et. al. [16] stated that the AC temperature of 25°C which combined with relative humidity dehumidifier 40% can reduce the water content of honey faster than the combination of 30°C and AC temperature the percentage of the dehumidifier's relative humidity same. However, research conducted by Singh [17] stated that rate of decrease in water content at a honey temperature of more than 40°C faster than 35°C. Temperature set using hot circulating water around the honey container and stirred honey so that the temperature can be maintained. While the type of dehumidifier used is a desiccant dehumidifier that is with silica gel. Chua et. al [12] said that the increase in temperature will increase the rate of transfer heat to the material being dried and the rate of diffusion water on the dried material. As well as low relative humidity of the air will help move water away from the material dried [12]. Then on company, previously used configuration 30°C and 60% relative humidity. Based on these considerations, in In this study, 2 factors will be used, namely the degrees celsius temperature and percentage factor relative humidity. AC temperature degree celsius factor has a level of 27°C and 28°C. While the factor dehumidifier relative humidity percentage have a level of 40% and 53%

c. Selection of experimental design method

This study will simultaneously investigate effect of several different factors. Each factor consists of several levels so that the combination certain level of each factor is called a combination treatment. All combinations between levels of each factor will be noticed. Therefore, this research suitable for using factorial experimental design [18].

d. Preliminary trial stage

The preliminary experimental stage was carried out for know in advance the rate of decrease in water content honey in the conditions that have been applied to company. This preliminary experimental stage will done by testing the reduction of water content of 50 kg of honey with a temperature configuration of 30°C and the relative humidity is 60% of the honey water content 24% until it reaches the company standard i.e. 20%. Preliminary experiments carried out one time replication. By doing preliminary experiment, it can be seen how much the length of time the experiment must be carried out and also the benchmark measure the rate of decrease in the water content of honey as comparison to actual experimental results which will be done later.

e. Determination of factors and variable factor levels independent as well as the variables considered constant. Factors tested on in this study, the temperature and relative humidity. Both factors can theoretically affect the rate of decline water content and was chosen because it was rated relatively easy to do manipulation using AC and existing dehumidifier. Then for factor level selection is set 2 levels, namely 27°C and 28°C for temperature factor while for the relative humidity factor will be 2 factor levels are set, namely 40% and 53%. Factor level number. This temperature was chosen because there is a difference between the temperature hotter or more cold that can produce rate of reduction in water content optimal. Room temperature reducing the water content of honey is regulated using AC as in the research done by Darmawan et al. [16]. Arrangement temperature using air conditioning has limitations, namely it cannot be set up to decimal number accuracy and only positive

integers of 16°C to 30°C. Therefore, this experiment uses temperature level 27°C and 28°C with the basis that the two numbers it is the middle value which not a decimal number between temperature of 25°C and 30°C which previously researched by Darmawan et. al. [16]. While the level number the relative humidity is selected based on machine limitation dehumidifier generate the condition of the most relative humidity low at 40% and 53% units

Variables that are considered constant in this study are:

1. The difference in the weight of the material dried then time what is needed is different also [8]. By therefore, to minimize bias on results in this study limited amount of honey which will be reduced its water content were 50 kg in each treatment.
2. Time becomes variable control in this study. Because this experiment will monitor percentage decrease in water content in certain time span. Based interview with user it takes 18 hours for the reduction process honey water content of 50 kg and will be validated back while doing preliminary experiment. By Therefore, this research will take time span 18 hours on each combination treatment. Besides, will related observations were made honey water content at the time the experiment was run on every 3 hours as data addition showing rate of reduction of water content per unit time for each treatment.
3. Honey granules that come out from the raindrops hole honey is assumed to have surface area uniform. Surface area just be a variable control because there is only a honey rain tool so related modification this tool is difficult to do and worried about interfere with the way production activities company.
4. Reduction of honey water content done in the room closed size 6.96×4.90×3.15 meters by using only rain gear, machine dehumidifiers, and air conditioners. Settings against air speed can use exhaust fan or fan, however will add cost procurement and installation. By Therefore, air speed considered uniform for each treatment.
5. Initial water content of honey when received from honey farmer can be different so can affect the results experiment so must control is carried out. According to Purnomo et. al. [19] honey water content found in temperate climates tropical areas such as Riau and the surroundings have an average 24%. Accepted honey can be done mixing between jerry cans honey to get initial water content before experiment that is 24%
6. Determination of the number of replications is carried out for provide an estimate of the experimental error can be used to determine the hose trust, resulting in more estimates accurate for experimental error, and allows researchers to obtain estimates better about the mean effect of a factor [18] In this study, researchers perform a 2×2 factorial experimental design with each 3 times of replication plus 1 preliminary trials, which means there are a total of 13 trials. Experiment with each combination the treatment was carried out randomly (not sequentially).

f. Stage of preparation of test objects and equipment Tools and materials prepared for this research is:

Honey as much as 50 kg in each treatment combination. Study this requires a combination 4 kinds of treatment

which was replicated 3 times and added one try prelude 1 time so there are 650 kg of honey needed.

1. Honey water reducing device in the form of a honey raining device, dehumidifiers, and air conditioners.
2. Refractometer to measure honey water content before and after the combination experiment treatment is done.
3. Thermohygrograph for knowing the temperature and humidity relatively actual room.

g. Experimental stage

Experiments in this study were carried out according to company production time fo save costs and cannot be done parallel because there is only one raindropper honey. Each sample of treatment combination does not have a relationship with each other. After all replications of each treatment have been get a turn, calculate the difference of subtraction initial and final moisture content then divide by the total amount of time the experiment was carried out in each treatment that is 18 hours for get the rate of reduction of water content in each treatment replication

Data Processing Techniques. Data on the rate of reduction of water content can be illustrated by the reduction in the water content of honey per time unit. Data processing is done by factorial experimental design analysis with using the Minitab 17 software help. At this stage, the influence of the factors that has been determined by looking fulfilled or whether or not the following hypotheses:

a. H01: the temperature factor has no significant effect significant on the rate of reduction of water content honey dehumidification system
b. H11: the temperature factor has a strong influence significant on the rate of reduction of water content honey dehumidification system
c. H02: relative humidity factor is not significantly affect the rate honey water content reduction system dehumidification
d. H12: the relative humidity factor has significant effect on the rate honey water content reduction system

dehumidification

e. H03: temperature and relative humidity factor no significant effect on system honey water content reduction rate dehumidification

f. H13: temperature and relative humidity factor have a significant effect on rate reduction of honey moisture content system dehumidification

Here are the various tests that used in this research are:

a. Test assumptions The first step in analysis using design factorial experiment is testing data on assumptions, namely normality, homogeneity, and independence. If the assumption test is not met, then the results of the analysis of variance do not apply.

1. Normality test Normality test is used to check whether population normal distribution or not. Data that normally distributed will reduce the possibility of bias [20]. Test Normality was carried out by using the Shapiro Wilk. The Shapiro Wilk test was used because the number of samples in this study was less than 50 [21].

2. Homogeneity test to see 2 or more group of data that comes from a population that have the same variance. One test To find out the homogeneity of variance, with Bartlett's test.

b. ANOVA test of factorial experimental design in experimental design, the term variance analysis technique. Anova test can be done if the data has met the assumption test. Analysis technique variance (Anova) works to test whether the average of a classification or source of variation significantly different to some degree.

c. Advanced test Follow-up tests were carried out to find out more the relationship between variables, namely the large influence each independent variable on the variable certain. Tukey's test was carried out to determine differences between treatment combinations and which treatment combination is the most optimal. In addition, a comparison chart will also be presented between each treatment on the dependent variable i.e. the rate of reduction of the water content

Research methods at least describe the approaches used in research, population and research samples, explain the operational definition of variables along with data measurement tools or how to collect data, and data analysis methods. If the data measurement tool uses a questionnaire, it is necessary to include the results of the validity and reliability of the research instrument.

3. RESULTS AND DISCUSSION

Experiment Execution Before the experiment was carried out, honey first prepared on 13 jerry cans. Honey on each container can have different water content level. Therefore, mixing to all container of honey so it is obtained the initial water content before the experiment which was 24%. Then the experiment is carried out starting with a preliminary experiment then by randomizing the order of the experiments until all treatment combinations get a turn.

Before collecting experimental data for calculation and analysis, especially:
First, a preliminary experiment was carried out for knowing how long the experiment should take performed for each treatment combination. Preliminary experiments were carried out with combination of temperature and relative humidity this is done by the company that is 30°C and 60%.

Table 1 Preliminary Experiment Data

Experiment Time (hours)	Temperature Fluctuation (C)	RH Fluctuation	Water level (%)
0	30	60	24
3	29,7	59	23
6	29,9	57	22,5
9	30,5	60	21,5
12	31,3	58	21
15	31,7	58	21,5
18	31,1	59	20

After the preliminary experiments were carried out, to lower the water content of honey with water content 24% to 20% a total of 50 Kg using tools rain and dehumidification system is obtain time for 18 hours. The moisture content of 20% honey is the upper limit of the standard that the company sets for maintain the quality of honey and to meet the standards SNI quality. By knowing the 20% water content has been reached at the 18th hour, then the experiment preliminary was terminated and it was determined that The experiment will be carried out for 18 hours for each treatment combination Next, the experiment was carried out with the data collected in the form of reduction data honey moisture content, residual honey, and fluctuations in temperature and relative humidity in the reduction chamber water every 3 hours for 18 hours of experiment every treatment combinations were performed.

After all data is collected on during the experiment, the next step is perform data processing. Data of initial water content and the end is calculated the difference and divided by time the length of time the experiment was carried out on each combination of treatments, ie 18 hours. Whole these calculations are presented in Table 2. Then after getting the speed reduction of water content in each combination experimental treatment, test calculations are carried out assumptions to know the normality and homogeneity of data. When the data is declared normal and homogeneous, the data can be continued for testing ANOVA to determine the effect of each factor as well as its interaction with the dependent variable

Table 2. Difference and rate of reduction of honey moisture content after experiment

Temperature	RH(%)	Replication	Water Level (%) beginning	Water level end period (%)	Water level Difference	Water Level Reduction (%/Hours)
27	40	1	24	17	7	0.38889
		2	24	16	8	0.44444
		3	24	16.5	7.5	0.41667
	54	1	24	19	5	0.27778
		2	24	18.5	5.5	0.30556
		3	24	18	6	0.33333
28	40	1	24	17	7	0.38889
		2	24	17.5	6.5	0.36111
		3	24	18	6	0.33333
	54	1	24	19	5	0.27778
		2	24	18.5	5.5	0.30556
		3	24	19.5	4.5	0.25

Table 3. Temperature Fluctuations at the time of the experiment for each treatment

Temperature	RH(%)	Replication	Fluctuations in Actual Temperature Conditions (°C) after the experiment						
			0 hours	3 hours	6 hours	9 hours	12 hours	15 hours	18 hours
27	40	1	27	26	25.5	25	26	28	29.7
		2	27.2	27	26.2	25.4	25	24.9	24.7
		3	26.8	28.7	28.8	28.5	27.8	27.7	27.6
	54	1	27.3	20.9	26.8	27.7	27.1	27	27.1
		2	27.2	27	26.9	27.2	27.1	27.3	27.2
		3	27	27.4	27.1	26.8	27	27.1	27.3
28	40	1	28.3	29.3	28.3	28.5	28.6	28.7	28.1
		2	27.9	28.6	30.5	29.8	30.1	30.1	29.1
		3	28	28.9	29.5	30.2	32.6	32.2	30.3
	54	1	27.8	27.6	27.3	28	28.1	27.9	28.6
		2	28.1	27.8	27.2	28	28.1	27.7	28.8
		3	28	29.1	27.6	26.9	27.8	28.2	28.5

Table 4. Relative Humidity (RH) fluctuations at the time of the experiment for each treatment

Temperature	RH(%)	Replication	Fluctuations in Actual RH Conditions after the experiment						
			0 hours	3 hours	6 hours	9 hours	12 hours	15 hours	18 hours
27	40	1	43	41	41	41	40	40	41
		2	41	42	41	41	41	43	45
		3	40	43	40	39	38	41	43
	54	1	53	50	47	45	46	55	61
		2	52	49	42	54	57	56	54
		3	54	53	47	49	50	53	54
28	40	1	41	38	37	42	47	44	41
		2	40	41	39	38	39	38	37
		3	40	39	41	43	45	43	42
	54	1	54	46	45	57	48	47	51
		2	53	45	43	55	46	47	50
		3	54	55	53	50	49	49	52

Based on the interpretation of the output results calculations the temperature factor affects the rate of reduction honey water content. However, the influence given is different from the theory that the temperature directly proportional to the drying rate of the material which means that high temperatures cause the reduction in the water content of the material will be faster [22] While in this research the opposite is found. The experimental results show that the lower the temperature in the room, the lower the level water, the faster the rate of reduction of the water content. This happens allegedly because the AC engine plays a role to the results of this study. AC machines not only change the temperature, but also the humidity in the water reduction room. According to Gabriel [23] the higher the room temperature, then the relative humidity of the air also higher, and the lower the temperature, then the humidity is lower. This matter related to the working mechanism of the AC engine that sucks in warm and humid air to then be exchanged for more air drier and cooler temperatures. Based on the experiments conducted by Wirawan et. al. [24] the lower the target given temperature to the AC controller, then the performance of the AC compressor will be longer at a temperature of same start. In connection with that matter, performance of the air conditioner that tries to lower the temperature to achieving the target will also reduce relative humidity of the air so that in the end will also accelerate the decrease in water content in honey. Therefore, in this study It was found that the lower temperature i.e 27°C will cause a decrease in the water content of honey which is faster than 28°C. The results of this study are similar to research conducted by Darmawan et al. [16] namely lower temperatures (25°C) results in a further decrease in water content much higher than the higher temperature (30°C). Both of these studies use tools that are relatively the same, namely AC and refrigerant dehumidifier only, the only difference is in [16] used a tray container with different thicknesses of honey, whereas This study uses a rain tool to increase the water content of honey. Darmawan et. al. [16] concluded that at the same level of humidity i.e 40%, the temperature of 25°C can reduce the water content of honey by 0.82% per day compared to 30°C is only 0.42% per day. As well as in this study it was concluded that the low temperature ie 27°C resulted in a decrease in average water content of 0.36111% per hour, more than the higher temperature of 28°C only an average of 0.319444% per hour

The relative humidity factor affects the rate reduction in the water content of honey. In line with theory humidity effect on the evaporation of the material. Air with low relative humidity will be able to accommodate the water that comes out of honey to then be absorbed by the dehumidifier machine and air conditioning. The dehumidifier and air conditioner will restores dry air and has low relative humidity to return holds the water evaporated from the honey. Cycle This is repeated throughout the experiment. Air relative humidity 40% contains less water than 54% so 40% relative humidity will be more accommodate the water vapor from the evaporation of honey. By Therefore, 40% relative humidity can be reduce honey water content by an average of 0.388889% per hour, more than 54% relative humidity i.e. average only 0.291667% per hour in the same time interval. The results of this study are in accordance with previous studies which said that the relative humidity of the air was lower when reduction of the water content of the material was carried out, it will then speed up the reduction in the water content of the material or at the same time period, then the lowest percentage of air relative humidity which produces the most material moisture content low [8][9][11][12].

The interaction of temperature and relative humidity factors is not significant effect on the rate of reduction of levels of honey water. This is presumably due to the distance between the level at the temperature is too close

so it is relatively difficult to detect the interaction between the temperature factor and relative humidity at the time of the experiment. the distance not too far between the level of the temperature factor, namely by 1°C, causing the results between treatments does not have a significant difference statistics although in general it has an average (means) different.

Based on Tables 3 and 4 the recording results actual temperature and relative humidity at the time Experiments show that the temperature and relative humidity has a similar fluctuation So it is suspected that this is also the cause interactions between factors were not statistically detected. Theoretically, fluctuations in temperature and humidity relative indoors can occur due to climate and outdoor weather [25]. Hot weather affect the increase in indoor temperature while the rainy weather affects the rise indoor humidity. Even in closed room, outside air can still enter through door gaps and so on so that you can affect temperature and humidity fluctuations relatively indoors. In addition, the performance of the AC engine and a dehumidifier that gives off different air, suspected to be the cause of temperature fluctuations and relative humidity in the room. AC Machine letting out cold air in the meantime dehumidifier engine blows out air warm so there are differences and fluctuations factors in each observation carried out. By Therefore, the interaction effect on temperature andrelative humidity to rate of reduction honey water was not detected in this study. When compared to research previously done by Darmawan et. al. [16] and Singh [17], these two studies did not examine the effect of interaction of temperature and relative humidity factor.

Darmawan et. al. [16] examined 2 levels of temperature, namely 25°C and 30 with only one level relative humidity 40% so that the effect of interaction temperature and relative humidity cannot be studied. Singh [17] did research on decreasing the water content of honey with temperature of 35°C and 40°C combined with method of dehumidification desiccant dehumidifier type. The relative humidity of the air resulting from this type of This desiccant dehumidifier is not controlled, has quite a lot of variation compared to variations in relative humidity in this study, and the effect of the interaction between degrees Celsius temperature and percentage of relative humidity on reduction honey water content is not studied

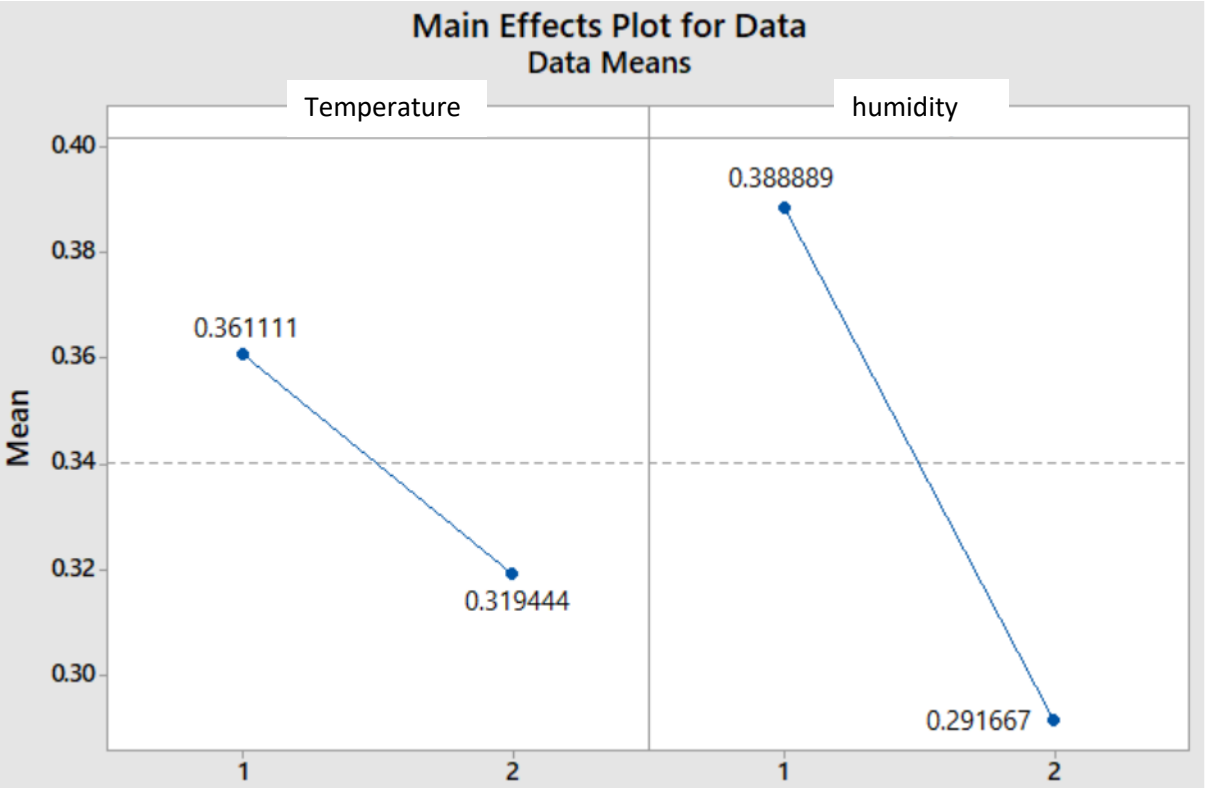

Figure 1. Main Effect Plot for Data Means (Temperature and Humidity)

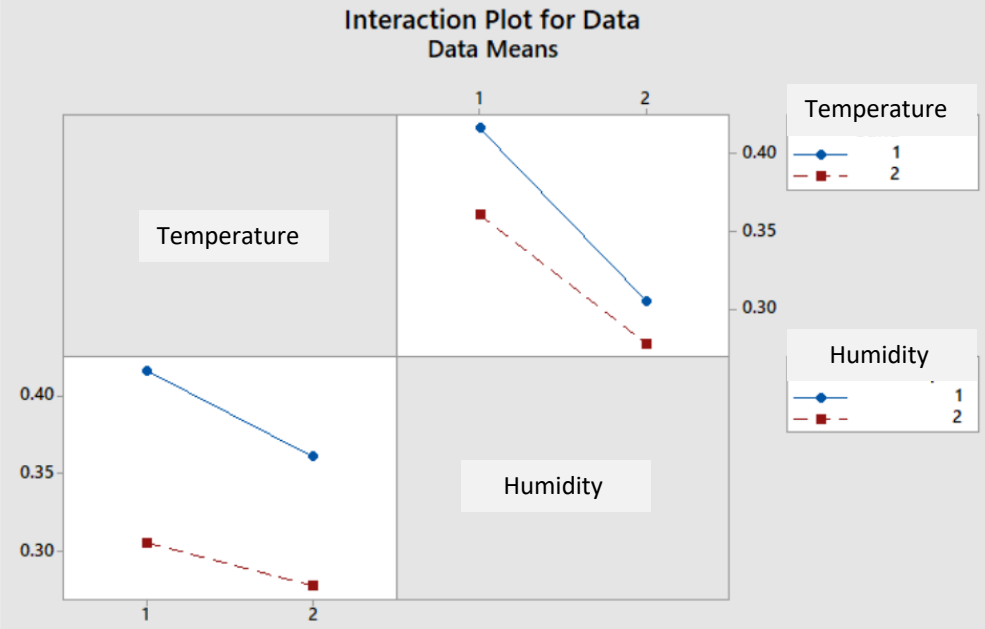

Figure 2. Graph of the effect of interaction between factors on the rate of reduction of levels honey water

Tukey Pairwise Comparisons: Response = Data, Term = Temperature*Humidity

Grouping Information Using the Tukey Method and 95% Confidence

Suhu*Kelembapan	N	Mean	Grouping
1 1	3	0.416667	A
2 1	3	0.361111	A B
1 2	3	0.305556	B C
2 2	3	0.277778	C

Means that do not share a letter are significantly different.

Figure 3. Tuker Pairwise Comparisons

Based on Figure 1 The chart on the left shows that the level of the temperature factor which has an average the highest level is level 1 which is 27°C with an average of 0.36111% per hour compared to level 2 i.e. a temperature of 28°C which only has an average 0.319444% per hour. While the next graph On the right described the level of the relative humidity factor which has the highest average is level 1 ie 40% with an average of 0.388889% per hour compared to level 2 which is 54% with an average of 0.291667% per hour

Next in Figure 2 Graph of the effect of interaction between factors on the rate of reduction of levels honey water relative as well as Figure 3 further test results using the Tukey test method shows that the treatment combination level 1 temperature 27°C and level 1 relative humidity 40% has the highest average of 0.416667% per hours followed by a combination of treatment level 1 temperature 27°C and level 2 relative humidity 54% which has an average of 0.361111% per hour. In the third and last is occupied by the combination treatment level 2 temperature 28°C and level 1 humidity relative 40% with an average of 0.305556% per hour and the combination of treatment level 2 temperature 28°C and level 2 relative humidity 54% with an average the smallest is 0.277778% per hour.

4. CONCLUSION

Based on these results, it can be it was concluded that the treatment combination the best is level 1 temperature 27°C and level 1 40% relative humidity due to having the highest mean among all combinations treatment. The highest mean indicates that the greatest rate of reduction in water content occurs optimal among other treatment combinations. If compared to the combination of temperature and The relative humidity previously applied to the company was 30°C and 60%, a combination of selected temperature and relative humidity 27°C and

40% can produce a high rate of reduction in water content faster. In Table 1 experimental results preliminaries that combine temperatures of 30℃ and 60% relative humidity of the air can be known that to achieve the standard water content honey 20%, the process of reducing the water content of honey must be carried out for 18 hours. While on combination of temperature and relative humidity treatment selected 27℃ and 40%, 20% moisture content was achieved at around 9 o'clock. Thus, it can be interpreted that the selected treatment combination can reduce honey water content reduction time and increase productivity by 50%.

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