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Utilization of Inferior Green Coffee Bean Oil for Air Freshener Gel

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ABSTRACT

More than 20% of the coffee beans harvested are not traded because they do not pass the sorting. Coffee beans that do not pass the sorting are referred to as inferior green coffee beans (inferior coffee).. The purpose of this study was to determine the combination of inferior coffee oil concentration and gel material that gave the best characteristics as air freshener. This research method is a laboratory experimental method with descriptive analysis. The research stages consisted of preparation of materials and equipment, extraction of inferior coffee with the soxhletation method and making air freshener. The concentration of inferior coffee oil used was control (A0) 1%; (A1); 2% (A2); 4% (A3) and each concentration was added to a formulation consisting of 0.75 grams of carrageenan, 0.5 grams of agar, 0.25 grams of pectin, 0.05 grams of sodium benzoate, 5 grams of propylene glycol and aquadest to adjust the amount to 50 grams. Product testing parameters consist of strength test, gel hardness test, gel stability test, preference test, liquid evaporation test and fragrance resistance test. The results showed that the best air freshener with 4% coffee oil concentration resulted in a gel strength of 482 g/cm2; gel hardness test 1064 g/cm2; gel stability test 2.387%; preference test 2.78; evaporation test is 69.632% and the value of fragrance resistance is 3.003.

1. INTRODUCTION

The coffee processing is well known among the people of Indonesia. Common coffee processing methods include full wash, natural, and honey processes. The coffee processing also produces coffee that does not pass the sorting phase, which is called as inferior coffee beans. The characteristics of inferior green coffee beans are defective coffee beans such as black, cracked, perforated, and pale in color. The mixing of inferior green coffee beans with superior green coffee beans can reduce the physical quality and final brew. Lia & Tomy (2017) in a study of the Arabica coffee processing stated that in the natural process after the hulling stage, 85% of coffee cherries is gained and from 7.5 kg of cherries can be collected 1.125 kg of green coffee beans. Then, after sorting was done to

obtain green coffee beans that passed the test, a total loss of 11.11% was observed and as much as 1 kg of quality beans is resulted. Meanwhile, in the honey or fullwash process, after the hulling stage, the shrinkage is the same, i.e. 80% of cherries are produced and from 7.5 kg of cherries, 1,482 kg of green coffee beans can be obtained. After sorting, the green coffee beans that passed the quality test were 1,186 kg, meaning a total loss of 20%. The potential for inferior green coffee beans has not been widely utilized, both in the food and non-food fields. The use of coffee is now very wide apart from being used as a drink, including utilization of coffee as an alternative ingredient in making air freshener. The use of natural ingredients as air fresheners provides a relaxing effect and a strong and distinctive aroma, on the other hand, synthetic fragrances cause adverse effects on health.

The preparation of coffee beans to be used as a room freshener requires coffee extract. One of the results of coffee extract is coffee oil. According to Yuwanti *et al*. (2016) the percentage of Arabica coffee oil reaches around 15%, while that of Robusta coffee is around 10%. Formation of coffee bean oil from eicosatetraenoic acid (ETA), palmitic acid, linoleic acid, myristic acid, lauric acid, oleic acid, methyl palmitic, methyl oleic, tocopherol, stigmasterol, geraniol, pinene, caffeine, androstan, eucalyptol, champor patchouli alcohol, guaiens (sesquiterpenes), phenols, alkenes, benzenes, and ketones (Nurhafni, 2018). The process of processing coffee into coffee powder starts from the roasting process. The roasting process at high temperatures is characterized by a change in color, aroma and chemical composition (Cuong *et al*., 2014). The roasting process undergoes a maillard reaction, stecker degradation (Bekedam, 2008), and pyrolysis (Raba, 2018). These reactions produce various kinds of volatile compounds with distinctive aromas (Janzen, 2010). The volatile compounds in coffee can be extracted to produce flavorious coffee oil (Calligaris *et al*., 2009; Quijano-Celis *et al*., 2015). The yield of oil produced from seeds ranges from 3-4%, and contains 15-17% protein and 25-32% fat (Guenther, 2009). The extraction process from coffee beans into oil that has a flavor component with volatile compounds with a distinctive aroma requires a solvent. The solvent used in the extraction produces oil with a yield of up to 99% (Emran & Susan, 2012; Wildan *et al*., 2013a; 2013b). The function of the solvent is as a medium that contacts the coffee grounds and produces coffee oil. The extraction time has a direct proportional effect on the specific gravity and yield of the coffee oil produced, as well as the increase in solvent volume. More yields were produced using hexane as solvent than that of ethanol. Research by Aziz *et al*. (2009) showed that extraction using 100 grams of coffee grounds and 600 ml of hexane as solvent for 120 minutes resulted in a coffee oil yield of 8.165%. However, the aroma produced from coffee oil using ethanol as a solvent is better than that of using hexane as a solvent. According to Yuwanti *et al*. (2016), the aroma of coffee oil is sensitive to direct sunlight and the storage bottle should not be translucent. Juliantari *et al*. (2018) stated that robusta coffee grounds produce coffee oil extract which is used as an alternative natural additive in non-food products such as massage oil in beauty care places and air fresheners.

Gel-based air freshener production requires a binder. The binder serves as a medium for condensing the coffee oil. The binder commonly used is hydrocolloid. Hydrocolloids include polymer components derived from plants, animals, microbes or synthetic components that have a hydroxyl group. The nature of the polymer component is soluble in water, able to form colloids, thicken or form a gel from a solution. In a research by Purba (2017), the best gel base was obtained by varying the gel base formula by 3% consisting of a combination of carrageenan, agar and pectin. The best gel base is a gel base that has an elastic texture and is not easily crushed with the lowest percent syner-

esis. This study aims to determine the concentration of coffee oil from inferior green coffee beans added to the gel material which gives the best characteristics as a room freshener.

2. MATERIALS AND METHODS

2.1. Experimental Location

This research was conducted from September 2020 to January 2021 at the Food Chemistry Laboratory, Faculty of Agricultural Industrial Technology and at the Post-Harvest and Process Technology Laboratory, Faculty of Agricultural Industrial Technology, Padjadjaran University.

2.2. Materials

The material used in this study is inferior green coffee beans of Arabica (Figure 1). The coffee beans were obtained from the Manglayang Coffee Poktan (Cipanjalu Vilage, District of Cilengkrang, Bandung Regency, West Java). Kappa carrageenan, Swallow brand agar, Kelco CP brand pectin, Koepoe-Koepoe brand sodium benzoate, USP Grade DOW propylene glycol (USA), aquadest and food grade ethanol solvent 96%.

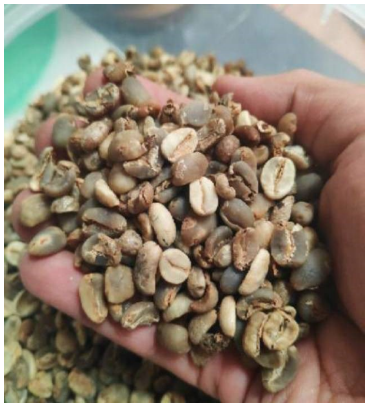

Figure 1. Arabica inferior green coffee bans

2.3. Experimental Steps

The stages of the research were described in a flow chart as shown in Figure 2. Arabica green coffee beans were obtained from the Manglayang Coffee Farmers Group (Cipanjalu Vilage, District of Cilengkrang, Bandung Regency, West Ja**v**a). Coffee beans were sorted to get inferior coffee beans. The inferior coffee is then washed. Inferior coffee was dried and then weighed and the moisture content and yield were calculated. Inferior coffee beans were then roasted using a roasting machine at a temperature of 120-160 °C for 15 minutes, then cooled and then ground with a milling machine to a size of 60 mesh. Inferior coffee powder was then weighed as much as 100 grams. Inferior coffee grounds were wrapped in filter paper and then put into a Sokhlet tube. Extraction was started by using 600 ml of food grade 96% ethanol as solvent, with a time of 4 hours and the temperature was kept stable at 75 °C. The extraction result was a mixture of inferior coffee oil and 96% ethanol that was separated by a rotary vacuum evaporator where the temperature is maintained at around 50 °C and rotation speed of 80 rpm. The results of inferior coffee oil extraction were stored in a closed container that was not penetrated by sun light and was stored for the next process.

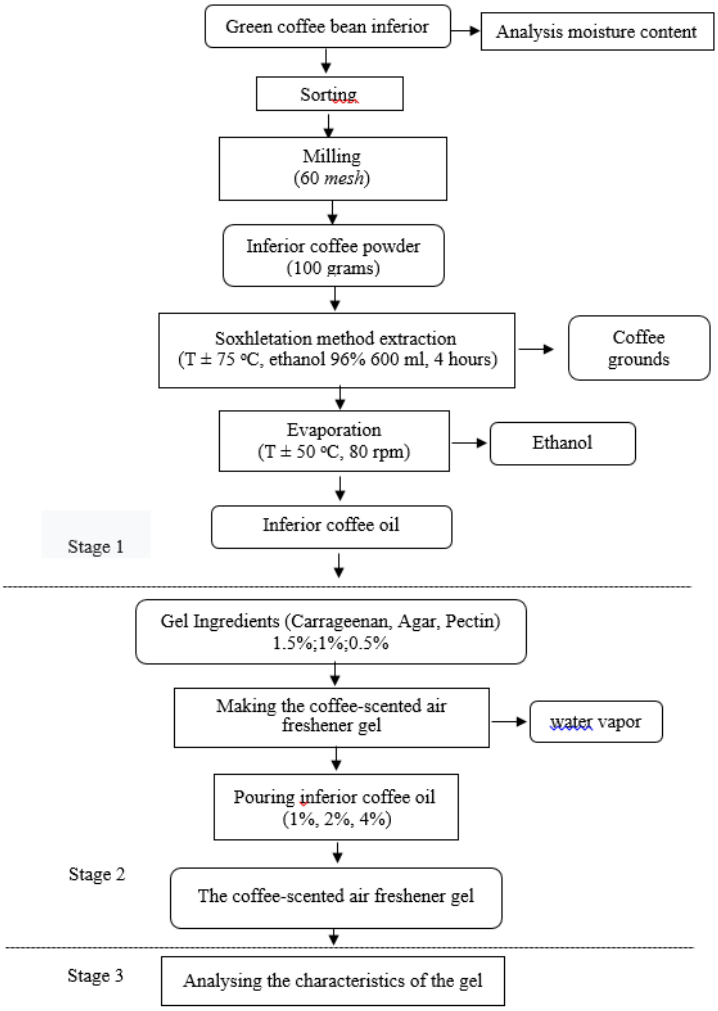

Figure 2. Flowchart of experimental steps

The second steps was the process of making air freshener gel with the addition of inferior coffee oil. This study used a modified method from Purba (2017). Firstly, the material was weighted, and then the distilled water was heated to a temperature of 75 °C. Next, carrageenan, agar and pectin were addad little by little while stirring until dissolved. The mixture was then added with sodium benzoate and stirred until dissolved. Then material was removed from the water bath and stirred to a temperature of 65 °C, then added propylene glycol and stirred until homogeneous. The inferior coffee oil was then poured while stirring rapidly until homogeneous. Finally, the material is poured into molds and left at room temperature to form a gel. The third stage was analysing the coffee-scented air freshener gel to determine the characteristics of the gel that has been made.

2.4. Experimental Methods

The research used a laboratory experimental method with descriptive analysis. The data obtained were processed using descriptive methods. In this study, tables and graphs were presented to analyse the relationship between the concentration of coffee oil and gel material (carrageenan, agar, pectin) on the tested parameters.

Table 1 presents composition or formulae of materials required to prepare freshener gel along with the concentration of inferior coffee oil added as a fragrance. In this case the concentration of inferior coffee oil is the percentage of inferior coffee oil used calculated from the overall ingredients to make air freshener gel, which is 50 grams. So, the treatment with a concentration of 1% (A1) is the addition of 0.5 gram of inferior coffee oil. Similarly, for a concentration of 2% (A2) is addition of 1 gram of inferior coffee oil, 4% (A3) is as much as 2 grams, and (A0) is without the addition of coffee oil. Inferior coffee oil was put into a stock of air freshener gel. The air freshener gel formula in this study used a modified formulation from Purba (2017), where the gel base was obtained by varying the gel base formula by 3% consisting of carrageenan, agar and pectin. Gel base is a gel base that has an elastic texture and is not easily crushed with the lowest percent syneresis. This study used a gel base with a ratio of carrageenan 1.5%, agar 1%, and pectin 0.5%, where 1% = 0.5 grams. Inferior coffee oil was added with three different concentrations (1%, 2% and 4%) and a comparison as a control (not using coffee oil) each with two replications.

Tabel 1. Formula of basis gel and the concentration of inferior coffee bean oil

Material	Control (A0)	A1	A2	A3
Carrageenan (g)	0,75	0,75	0,75	0,75
Agar (g)	0,50	0,50	0,50	0,50
Pectin (g)	0,25	0,25	0,25	0,25
Inferior coffee oil (g)	0	0,5	1,00	2,00
Natrium (sodium) benzoate (g)	0,05	0,05	0,05	0,05
Propilen glicol (g)	5,00	5,00	5,00	5,00
Aquadest (g)	42,95	42,95	42,45	41,45

Note: A0 (control): freshener gel without addition of inferior coffee oil ; A1: freshener gel with addition of inferior coffee oil 1%; A2: freshener gel with addition of inferior coffee oil 2%; A3: freshener gel with addition of inferior coffee oil 4%

Furthermore, an analysis of the air freshener gel parameters was carried out including: gel strength, hardness, and rigidity (Demars & Ziegler, 2001), gel stability test (AOAC, 1995), preference test (Resurrection, 1998), liquid evaporation test (Fitrah, 2013), and fragrance resistance test (Purba, 2017).

3. RESULTS AND DISCUSSION

3.1. Coffee Bean Moisture Content

Prior to the extraction process, the water content of inferior coffee beans was tested using the gravimetric method. This water content test includes testing the moisture content of unroasted and roasted inferior coffee beans. The average water content of inferior coffee beans before roasting 9.73 ± 0.49 is in accordance with SNI 01-2907-2008 on Coffee beans which states that the maximum water content of coffee beans is 12%. The results of the calculation of the water content of inferior coffee indicate that the inferior coffee beans are still suitable for use even though they are physically damaged. According to Wulandari (2017), a moisture content of 12% with a tolerance of 1% is a limit that can guarantee safety during storage. The result of measuring the water content of roasted inferior coffee is 1.65 ± 0.22. This value is very different from the water content of inferior coffee that has not been roasted. The water content of coffee

beans tends to decrease with increasing temperature and roasting time. In accordance with the statement of Estiasih & Ahmadi (2009), that the greater the temperature difference between the heating medium and the food, the faster the heat transfers to the food and the faster the evaporation of water from the food. The roasting process is very important in generating a strong and distinctive aroma in coffee.

3.2. Gel Parameter

3.2.1. Gel Strength and Hardness

Gel strength, which is expressed in kilogram force (kgf) or gram force (gf) or grams per area (g/cm^2), is defined as the maximum force required to break the polymer matrix in the compressed area (Fitrah, 2013). Measurement of strength and hardness of inferior coffee oil air freshener using TA-XT Plus. The Texture Analyzer (Stable Micro Systems) is a cylindrical probe coded 673020 with a diameter of 20 mm. The graph of the strength of the air freshener gel with inferior coffee oil is shown in Figure 3.

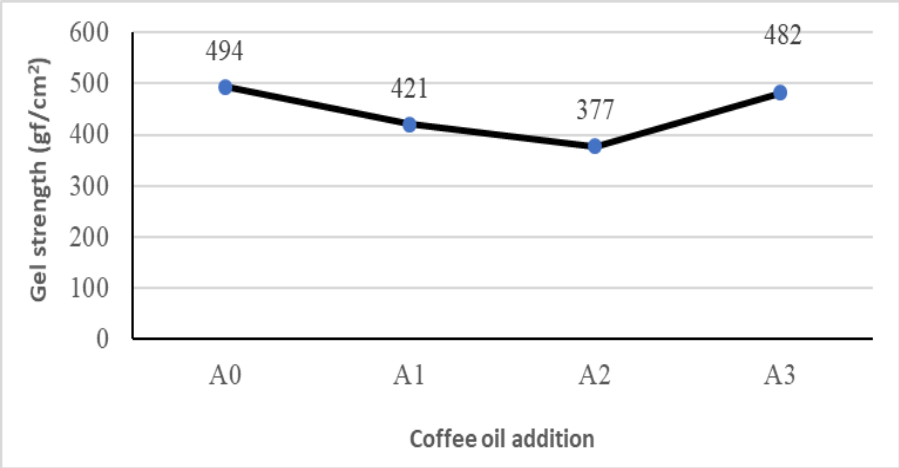

Figure 3. Effect of coffee oil addition on the gel strength

The gel strength obtained from the results of this study ranged from 377 – 494 g/cm^2. The highest gel strength was obtained from air freshener treatment without inferior coffee oil, namely 494 g/cm^2, while the lowest value (377 gf/cm^2) was obtained from air freshener treatment with 2% inferior coffee oil concentration. The results of this measurement indicate that the effect of inferior coffee oil addition on the strength of the air freshener gel studied is inconsistent. The addition of inferior coffee bean oil up to 2% seemed to decrease the gel strength, but further addition up to 4% increased the gel strength. Gerung *et al*. (2019) stated that the strength of the air freshener is influenced by the concentration of each constituent of the carrageenan.

Hardness is the magnitude of the compressive force to break a food product (Indiarto *et al*., 2012). Hardness is expressed as a force given to an object until there is a change in shape (deformation) on the object. The value obtained indicates the amount of force required (Bourne, 2002). The results of hardness measurements in this study can be seen in Figure 4.

3.2.2. Gel Stability Test (Syneresis)

According to Kaya (2018), syneresis shows a stable gel in the evaporation of free water on the gel. The best gel matrix is the matrix with the lowest percentage of syneresis. The more water that flows out of the gel matrix, the higher the percentage of syneresis

produced, and therefore the more unstable the gel matrix. The results of the gel stability test are listed in Table 2.

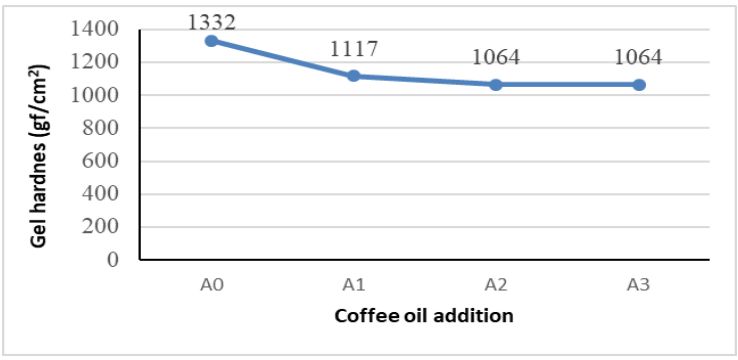

Figure 4. Effect of coffee oil addition on the gel hardness

Tabel 2. Results of gel stability test

Coffee oil addition	Initial mass (g)	Final mass (g)	Syneresis (%)
A0	41.06	39.20	4.53
A1	38.59	37.66	2.41
A2	39.90	38.65	3.13
A3	38.96	38.03	2.39

Based on Table 2, it can be concluded that the gel base formula with the lowest percent syneresis, i.e. the most stable gel base, is the A3 gel base formula (4% inferior coffee oil addition) with a value of 2.39%. This shows that air fresheners with an inferior coffee oil concentration of 4% are more stable than the other air freshener concentrations so that they can retain water in them even though the resulting syneresis rate is still quite high.

3.2.3. Hedonic Test

The preference test aims to determine the most preferred air freshener gel with inferior coffee oil concentration. In this study, the preference test used 25 panelists. The assessment of fragrance preference is done by smelling the air freshener two to three times. During the test the distance between the gel and the nose was 45o with a distance of ± 20 cm. The activity of smelling the fragrance by waving the air freshener towards the nose of the panelists. The data obtained from the questionnaire were tabulated and the preference value for each air freshener gel formula was determined by finding the average result for each panelist at a 95% confidence level (Badan Standarisasi Nasional, 2006). The average results of the panelists on the preference test are in Table 3.

Tabel 3. Results of preference (hedonic) test

Coffee oil addition	Range values	Rounded values	Note
A0	1,246-1,347	1,246 (1)	Not prefered
A1	3,675–4,247	3,675 (4)	Prefered
A2	3,867–4,613	3,867 (4)	Prefered
A3	2,780–3,700	2,780 (3)	Medium prefered

From the results of the preference test, it was found that the panelists preferred the fragrance of the air freshener gel formula A1 (1.0% or 0.5 gram of inferior coffee oil concentration) and A2 (2.0% or 1 gram of inferior coffee oil concentration). The air freshener gel formula that the panelists liked was A3 (4.0% or 2 grams of inferior coffee oil concentration). The results of this study can be seen that the more concentration of inferior coffee oil is added, the less favorable the aroma is because it has a pungent aroma.

3.2.4. Liquid Evaporation Test

The total evaporation of the liquid is known by weighing and calculating the decrease in gel weight every week for a month which is stored in three different types of rooms, namely a room with room temperature at 25-30 °C, room temperature at 20-25 °C with a fan at normal speed, and room temperature that is given air conditioning at a temperature of 15-20 °C. The criteria for the test room used is a room with an area of 3x3 to 3x4 meters. Both in the fan room and in the AC room, it is turned on for 8 hours a day. The results of the measurement of the total percentage of liquid evaporation can be seen in Figure 5.

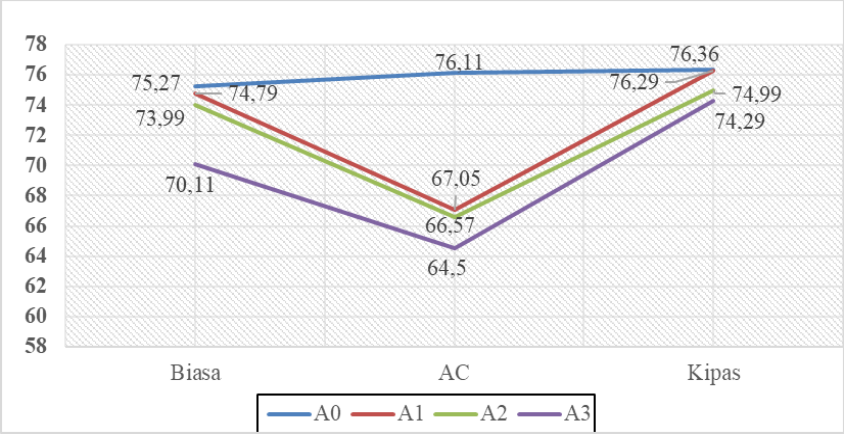

Figure 5. Percentage of total evaporation of liquid

From the results of the total percentage of liquid evaporation, it can be concluded that the best formula is the A3 formula, which is the formula with the inferior coffee oil concentration of 4% because it has the lowest percentage of gel weight loss in each room. This can be because the air freshener gel with a concentration of 4% inferior coffee oil gets the lowest syneresis value so that the evaporation of liquid substances in the air freshener occurs more slowly than other air fresheners. This evaporation rate is closely related to the resistance of the fragrance of the air freshener gel and the decrease in the weight of the air freshener gel (Purba, 2017). In addition to the gel formula, the use of fixatives, and the concentration of fragrance ingredients, fragrance resistance is also influenced by the environmental conditions of the air freshener gel, namely room temperature, room humidity, indoor air circulation, and room size (Fitrah, 2013).

3.2.5. Fragrance Resistance Test

The fragrance resistance test of air freshener products was carried out to determine the strength of the fragrance of the air freshener gel for a month of storage in three different types of rooms, namely ordinary rooms, fan rooms and air conditioning

rooms. The fragrance strength of the gel was assessed by 25 panelists. The test was carried out by comparing the strength of the fragrance of the test gel with the standard gel with a scale of 5−1; where 5=scented; 4=slightly less fragrant; 3=less fragrant; 2=very bad smell; and 1=no smell. During the test, the gel was positioned 45° from the nose with a distance of an inch and the fragrance was smelled by waving the hand towards the nose (Fitrah, 2013). The summary of the results of the fragrance resistance test can be seen in Table 4.

Table 4. Rekapitulation of fragrance resistance test based on room condition

Room condtion	A1		A2		A3	
	Range	Values	Range	Values	Range	Values
Usual	3,28−3,83	3,28 (3)	3,45−4,06	3,45 (3)	3,62−4,71	3,62 (4)
With AC	3,92−4,25	3,92 (4)	3,46−4,30	3,46 (3)	4,16−4,79	4,16 (4)
With Fan	2,95−4,25	2,95 (3)	3,16−3,87	3,16 (3)	3,92−4,33	3,92(4)
Usual	2,54−3,21	2,54 (3)	3,20−3,75	3,20(3)	3,19−3,92	3,19 (3)
With AC	3,31−3,96	3,31 (3)	3,03−3,76	3,03 (3)	3,56−4,26	3,56 (4)
With Fan	2,66−3,49	2,66 (3)	2,82−3,49	2,82(3)	3,56−4,19	3,56 (4)
Usual	1,95−2,44	1,95 (2)	2,45−3,07	2,45(2)	3,16−3,87	3,16 (3)
With AC	2,28−2,83	2,28 (2)	2,46−3,22	2,46 (2)	3,52−4,15	3,52 (4)
With Fan	2,05−2,66	2,05 (2)	2,33−2,87	2,33 (2)	2,95−3,60	2,95 (3)
Usual	1,71−2,36	1,71 (2)	2,10−2,77	2,10(2)	2,91−3,65	2,91 (3)
With AC	1,82−2,42	1,82 (2)	2,40−3,03	2,40(2)	3,07−3,73	3,07 (3)
With Fan	1,79−2,60	1,79 (2)	1,78−2,61	1,78(2)	3,03−3,69	3,03 (3)

From the results of the study, it can be concluded that the longest lasting fragrance of air freshener gel is air freshener gel with a concentration of 4% which still persists with a moderate value, at room temperature, with a fan and with air conditioning. Fragrance resistance is caused by the fragrance ingredients being absorbed in the network/matrix complex or due to the combination of flour/starch and gelling polysaccharides (Savary, 2006). The aroma resistance of air freshener gel products is also influenced by the weight of the remaining gel and the evaporation of liquid in the air freshener. The smaller the decrease in the weight of the liquid or the greater the remaining weight, the less volatile oil and water will evaporate which indicates that the gel aroma will last longer.

3.3. Determination of the Best Gel

This study aims to determine the air freshener gel with the best characteristics of the treatment (A0 (control), A1, A2 and A3). The expected air freshener gels are: the highest gel strength, the lowest gel hardness, the lowest stability or syneresis, the aroma favored by the panelists (lasting fragrance that lasts for 4 weeks in a room at room temperature, at room temperature with a fan and at room temperature), and with air conditioning.

From the recapitulation of research data as presented in Table 5, it can be seen that the best treatment that produces air freshener gel products with the highest gel stability, best fragrance resistance and also the smallest total liquid evaporation is in treatment A3 the coffee oil concentration is 4%.

Tabel 5. Rekapitulation of data from experimental results

Parameter	A0	A1	A2	A3	Standar
Strength (g/cm^2)	494	421	377	482	Highest value
Hardness (g/cm^2)	133	1117	1064	1064	Lowest value
Stability (%)	4,53	2,41	3,13	2,39	Lowest sineresis
Preference	-	3,75	3,87	2,78	Highest mean
Liquid vaporization(%)	75,91	72,71	71,85	69,63	Lowest mean
Fragrance resistance	-	1,77	2,09	3,00	Highest mean

Note:

Rangking	Parameter
1	Preference
2	Stability
3	Fragrance resistance
4	Liquid vaporization

4. CONCLUSION

The results showed that the best air freshener with a concentration of 4% coffee oil produced a gel strength of 482 g/cm$_2$; gel hardness test 1064 g/cm$_2$; gel stability test 2.387%; preference test 2.78; evaporation test is 69.632% and the value of fragrance resistance is 3.003.

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