The Antioxidant Effect of Nanoparticle Gels Grounds Arabica Coffee *(Coffea arabica L.)*

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Abstract
Arabica coffee's grounds are the wastes from the production of coffee beverages and are known to contain several active compounds that can be used as an antioxidant. This research is therefore a follow-up work on the use of these coffee grounds nanoparticles as an active compound in gel production. This study focuses on the antioxidant effects of the gel product, using Box-Behnken Design with 3 factors(x) (carbopol 940, TEA, and coffee grounds nanoparticles) at 3 levels. Based on the results of this study, it is found that the high antioxidant effect with an average inhibition value was 43.485%. Furthermore, data analysis on the other hand showed a significant effect of linear Box-Behnken Design model on percentage inhibition with a p-value greater than 0.0001 and insignificant lack of fit validated by an F-value of 0.60, in addition to a p-value of 0.7621. The optimal solution of about 0.50% carbopol, 940 formulation, 0.40% TAE, and 2,313% nanoparticles produced 45,636% inhibition value with 0.812 desirability. Moreover, this arabica coffee grounds can be claimed as a new invention that has great potential in the health sector as an active compound for pharmaceutical preparations.

Keywords: *Inhibition, Nanogel, Coffee Grounds, Box-behnken*

1. Introduction

Aceh province is also known as 1001 coffee outlets province since there are many coffee shops that can be found easily around Aceh. Based on the high abundance and low utilization rate, several forms of this beverage especially arabica coffee (*Coffea arabica L.*) was then locally sourced and sold here. Furthermore, some studies have been conducted on successful utilization of these coffee grounds especially in compost manufacturing (Putri et al., 2017; Siahaan & Suntari, 2019), activated charcoal production (Baryatik et al., 2019), and perfume bases (Juliantari et al., 2018). (Shang et al., 2017) and (Nurman et al., 2019) emphasized the active compounds of this beverage as a potential resource to be developed and used by industrial and health sectors. Also, there are reports on the successful antioxidant effect of the extracted gel, with an inhibition rate of 32,650% (Nurman et al., 2019a).

This study, therefore, aims to figure out the antioxidant effect of arabica coffee grounds nanoparticle gel produced in previous research using the waste biomass processed into nanoparticles (Nurman et al., 2020a, 2020b, 2019b). Meanwhile, arabica coffee grounds nanoparticle gel contains some active compounds used as antioxidants to protect the skin from exposure. According to (Suryani et al., 2017) and (Yati et al., 2018) gel preparation is a suitable pharmaceutical process with several advantages on the skin especially cool features, non-sticky ability, easily cleaned, in addition to being used on any hairy body. Based on the above description, this study then evaluates the antioxidant effect of arabica coffee pulp nanoparticle gel using *Box-Behnken's* Design with 3 factors (x) and levels to calculate optimal conditions.

2. Method

2.1. Tools and materials

The tools used in this study were glass wares, mortar and pestle, analytical balance, with UV-Vis Spectrophotometer (UV-1700 pharma sec, Shimadzu Corporation, Japan). Furthermore, the materials used were nanoparticles of Arabica coffee grounds (*Coffea arabica L.*), carbopol 940, glycerin, methylparaben, triethanolamine (TEA), aqua dest, (*Pharmaceutical Grade*), methanol, and DPPH (2,2-diphenyl-1-picrylhydrazyl).

2.2. Arabica Coffee Grounds Nanoparticles

The Arabica coffee grounds nanoparticles used in this research are based on the results of previous studies, with 396.0nm particle sizes and 0.254 polydepersity index (Nurman et al., 2020b).

2.3. Arabica Coffee Grounds Nanoparticle Gel

Table 1 shows the formulation design of arabica coffee dregs nanoparticle gel based on previous studies, using *Box-Behnken* analysis with 3 factors (x) and levels (Nurmane et al., 2019b).

Table 1.Design of the Arabica coffee grounds nanoparticle gel formulation with 3 factors and 3 levels (Nurman, Yulia, et al., 2019b)**.**

Factor	Parameters	Levels		
		Low (-)	Medium (0)	High (+)
x_1	Carbopol 940 (%)	0.50	0.75	1.00
x_2	TEA (%)	0.40	0.50	0.60
x_3	Nanoparticles (%)	1.50	2.25	3.00

2.4. DPPH solution 0.4 mM

The DPPH weighed about 7.9mg was dissolved in 50mL pumpkin with methanol, homogenized and then wrapped in aluminum foil.

2.5. Blank Solution

About 1mL of 0.4mM DPPH solution was dissolved with methanol in a 5mL flask, homogenized, covered with an aluminum foil, and then incubated for 30 minutes.

2.6. Sample Solution Variations

The Arabica coffee nanoparticle gel ground with weight of about 0.01gram was dissolved using an ethanol in a 10mL flask and then homogenized. This solution took 1000µL to be diluted to 100ppm by adding 1mL of DPPH 0.4mM solution dissolved with methanol in a 5mL flask wrapped in aluminum foil and incubated for 30 minutes (Ginting et al., 2017).

2.7. Testing of Blank Solutions and Samples

This blank solution and incubated sample was inserted into a cuvette with an absorption measurement of 517nm wavelength using UV-Vis spectrometer. The inhibition percentage was then calculated using equation 1 below after the absorption values have been computed.

$$\%\ inhibition = \frac{blank\ absorption - sample\ absorption}{blank\ absorption}\ x\ 100$$

$$\%\ inhibition = \frac{blank\ absorption - sample\ absorption}{blank\ absorption}\ x\ 100 \qquad (1)$$

3. Results and Discussions

The arabica coffee grounds nanoparticle gel had antioxidant potentials (Nurman et al., 2019), with inhibition value of 43,485% as shown in Table 2. Meanwhile, percentage inhibition refers to the ratio differences between blank (DPPH) and sample absorptions. The more significant this difference in comparison becomes, a higher antioxidant effect is noticed.

Table 2. Percentage inhibition of Arabica coffee grounds nanoparticle gel

Run	Factor 1 A: Carbopol 940 (%)	Factor 2 B: TEA (%)	Factor 3 C: Nanoparticles (%)	Response (1) Inhibition (%)
1	1.00	0.50	1.50	34.835
2	0.75	0.50	2.25	43.290
3	1.00	0.40	2.25	43.934
4	0.50	0.40	2.25	44.164
5	0.50	0.50	3.00	53.952
6	0.75	0.60	1.50	35.616
7	0.75	0.40	1.50	40.119
8	0.75	0.50	2.25	39.568
9	0.75	0.50	2.25	47.978
10	0.75	0.50	2.25	42.647
11	0.75	0.40	3.00	46.875
12	0.75	0.60	3.00	50.827
13	0.50	0.50	1.50	34.467
14	0.75	0.50	2.25	45.358
15	1.00	0.50	3.00	50.551
16	0.50	0.60	2.25	45.313
17	1.00	0.60	2.25	39.752

The *linear* design model of this study was chosen because it has a significant effect on the percentage inhibition with p-value of <0.0001 and insignificant *lack of fit* validated by the F-value of 0.60, in addition to a p-value of 0.7621, as shown in Table 3. This computed inhibition was strongly influenced by the concentration of arabica coffee waste nanoparticles with <0.0001 p-value, while carbopol 940 and TEA has no significant effect revealed by a p-value of 0.2623 and 0.6420, respectively. Based on the relationship between carbopol 940 and nanoparticles to percentage inhibition as shown in figure 1, higher concentration of these ultrafine particles invariably leads to more percentage inhibition produced. The results of this study was consistent with outcomes of previous research using arabica coffee grounds water extract (Nurman et al., 2019a). Meanwhile, the interaction between gel percentage inhibitions and factor (x) was observed from the *coefficient* value shown in equation (2). The optimization solution produced through Box-Behnken's Design analysis is 0.50% carbopol 940. 0.40% TAE and therefore 2,313% nanoparticles produced 45,636% inhibition value with desirability of 0.812.

$$y = 43.49 - 1.10A - 0.45B + 7.15C \quad (2)$$

Table 3. ANOVA analysis for a linear model of percentage inhibition of Arabica coffee grounds nanoparticle gel preparations

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	characterization
Model	419.88	3	139.96	19.75	< 0.0001	significant
A-Carbopol 940	9.73	1	9.73	1.37	0.2623	
B-TEA	1.61	1	1.61	0.23	0.6420	
C-Nanoparticles	408.54	1	408.54	57.64	< 0.0001	
Residual	92.15	13	7.09			

Lack of Fit	52.77	9	5.86	0.60	0.7621	not significant
Pure Error	39.38	4	9.84			
Cor Total	512.02	16				

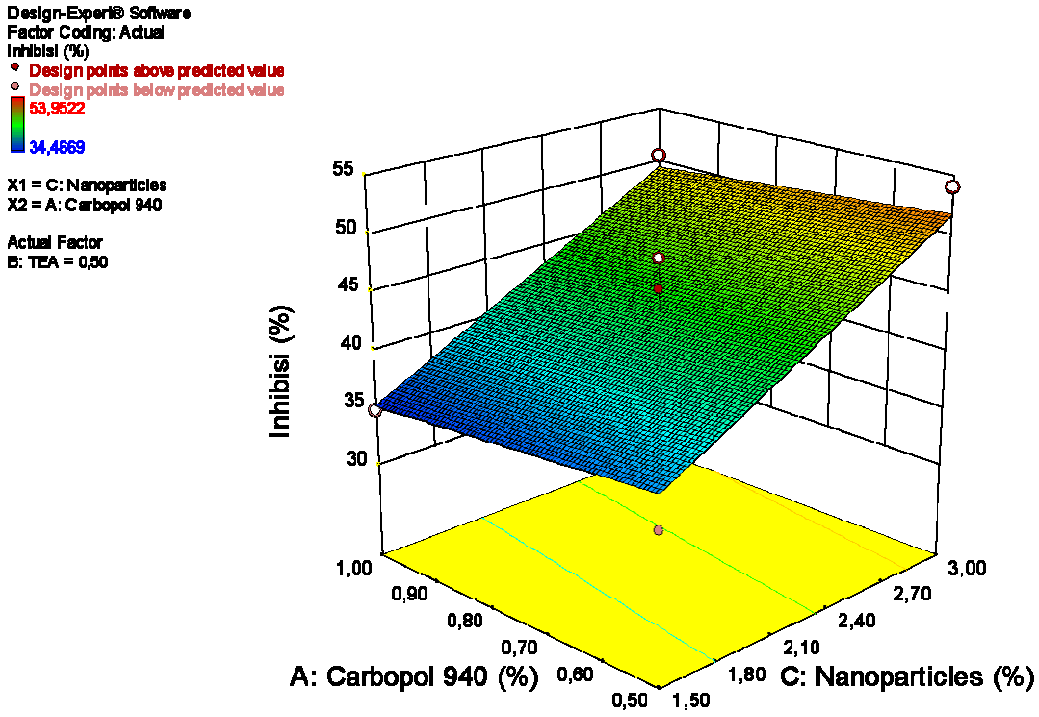

Figure 1. 3D plot of the relationship between carbopol 940 and nanoparticles to percentage inhibition

4. Conclusions

The Arabica coffee grounds nanoparticle gel had an average percentage inhibition of 43.485%. Furthermore, the *linear Box-Behnken* Design model used in this study has significant effect on percentage inhibition with p-value <0.0001 and insignificant *lack of fit* noted by an F-value of 0.60 and p-value of 0.7621. This results therefore proved coffee grounds nanoparticle gel serves as a natural source of antioxidant in pharmaceutical preparation and as a potential resource in health and industrial sectors. The optimal solution produced was 0.50% carbopol 940 formulation, 0.40% TAE and 2,313% nanoparticles produce 45,636% inhibition with 0.812 desirability.

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