PROCEEDINGS

2nd International Conference on Adaptive and Intelligent Agroindustry (ICAIA)

September 16 - 17, 2013

IPB International Convention Center
Bogor - Indonesia

Organized by:

Department of Agroindustrial Technology

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Indonesian Agroindustry Association

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Organized by :

Departement of Agroindustrial Technology, Faculty of Agricultural Engineering and Technology Bogor Agricultural University

George Mason University, Fairfax, Virginia, USA

Indonesian Agroindustry Association (AGRIN)

Bogor, Desember 2013
Frekwensi Terbitan : 1 Tahunan
Nomor ISSN : 2354-9041

9 772354 904006

WELCOMING ADDRESS

Prof. Dr. Ir. Nastiti Siswi Indrasti
Head of Agroindustrial Technology Department
Faculty of Agricultural Engineering and Technology
Bogor Agricultural University
On
Second International Conference on Adaptive and Intelligence Agroindustry (2nd ICAIA)
Bogor, September, 16 – 17, 2013

Assalamu'alaikum Warohmatullahi Wabarokatuh
In the name of Allah, the beneficent and the merciful,

Distinguish Guest, Ladies and Gentlemen
Let me first thank you all for accepting the invitation to participate in this 2nd International Conference on Adaptive and Intelligence Agroindustry (ICAIA). In particular I would like to thank Rector of IPB (Institut Pertanian Bogor/Bogor Agricultural University) Prof. Herry Suhardiyanto for supporting this event as part of the series academic event in celebrating the 50th Anniversary of Bogor Agricultural University.

In fact, the idea of organizing this conference was the continuation of the International Workshop on Computational Intelligence and Supercomputing Technology for Adaptive Agroindustry held by the Department of Agroindustrial Technology, Bogor Agricultural University last year.

Professor Kenneth A De Jong from George Mason University, US has successfully conducted joint international research with some staff from the Department of Agroindustrial Technology and Department of Computer Science, Bogor Agricultural University. The research aims to develop an integrated and intelligent system (namely SMART-TIN©) for the design of adaptive agroindustrial system in order to achieve a sustainable agroindustry that can mitigate global climate change and at the same time secure food, water, energy and natural medicine supply.

We are certainly proud to have been able to assemble this event in IPB, Bogor. The range of participants and audience at this conference is precisely something I would like to stress. The main goal of the conference is to provide an effective forum for distinguished speakers, academicians, professional and practitioners coming from universities, research institutions, government agencies and industries to share or exchange their ideas, experience and recent progress in Adaptive and Intelligent Agroindustry.

Distinguish Guest, Ladies and Gentlement,
Global climate change is the most challenging problems for us today and in the near future. This global change in our climate can lead to the shortage of the food, water, bioenergy and natural medicine that will affect the quality of human life. Many studies indicate that the threat of food, water, bioenergy and natural medicine crisis due to global climate change still worries our society. This problem can be solved by the development of agroindustry, i.e. an interrelated value chain entities from farming, to agro-processing industry and then to the end-customers. In fact, the design of agroindustry is complex and involves many factors and large data bases and more importantly, needs a good intelligence to process data and information to good decisions. Therefore, the way to design and manage agroindustry should be improved in order to meet the design objectives.

Agroindustries consume quite significant amount of energy on one side, on the other side they generate sizable amount of industrial wastes and its utilization as a captive energy resource is a kind of potential. Based on our study, a plywood industry with the production capacity of 200.000 m^3/year could generate 32 percentage of solid waste. If this amount of waste used as an energy alternative, it may result on the saving of 131.037.768.597 rupiah per month. Similar to plywood industry, sugarcane industry with the production capacity of 480 ton per hour could generate 154 ton per hour of waste (bagasse) and this amount of waste contribute to the saving of energy consuming by 19.250 Kwh. Recent study we conducted, indicated that cassava starch industry may contribute to a significant amount of waste. It has also potential usage as an energy resource. Based on our study the conversion of its waste into energy will contribute to the saving of energy usage of 4100 liter biogas per ton material.

The three industries mentioned is only examples of how potential the role of agroindustrial waste as an alternative resource in replacing the conventional energy resource as its presence will be significantly reduced. The new, incremental energy contributions that can be obtained from waste biomass will depend on future government policies, on the rates of fossils fuel depletion, and on extrinsic and intrinsic economic factors, as well as the availability of specific residues in areas where they can be collected and utilized. All of these factors should be in detail examined to evaluate the development of the industrial waste contribution. Hope this conference will also discuss this issue in more detail as it is an important matter for all of us. We should no more think just how to produce high value product but it is also necessarily important how to keep our live in good quality by understanding following old saying…" only when the last tree has been cut, only when the last fish has been angled, and only when the last river has been polluted, then we realized that we could not eat money".

I do not to take up any more of your time with these opening remarks. Let me simply thank you once again for sharing your thoughts with us. Here's wishing every success for the conference. May Allah bless all of us.

Thank you for your kind attention,
Wassalamu'alaikum Warohmatullahi Wabarokatuh

AGENDA of
2nd International Conference on Adaptive and Intelligent Agroindustry (ICAIA)

Time	Activities	Room
Day 1 (16 September 2013)		
08.00 – 09.00 (60’)	Registration	
09.00 – 10.00 (60’)	Opening Ceremony • Welcoming Address: Prof. NastitiSiswiIndrasti (Head of Dept TIN, Fateta, IPB) • Conference Opening: Prof. HerrySuhardiyanto(Rector of IPB) o ABET Certification announcement and short ceremony o Launching International Double Degree Master Program in Innovation and Technopreneurship in Cooperation with University of Adelaide, Australia o Soft-launching Master in *Logistik Agroindustri* (Agroindustrial Logistics)	Ballroom
10.00 – 10.45 (45’)	Opening Speeches: Prof. IrawadiJamaran (Agroindustry Guru, IPB: 25’) Prof. Eriyatno (Industrial and System Engineering, IPB: 20’)	Ballroom
Session 1		
10.45 – 11.15 (30’)	Keynote Speech Dr. YandraArkeman (IPB)	Ballroom
11.15 – 12.00 (45’)	Keynote Speech Prof. Kenneth De Jong (George Mason University, USA)	Ballroom
12.00 – 13.30 (90’)	Lunch Break	
Session 2		
13.30 – 15.15 (105’)	Moderator: Prof. EndangGumbiraSa’id (IPB) Invited Speakers (1-4) (4 x 20 minutes) Discussion (25 minutes) Tentative Schedule: Prof. Kim Bryceson (Australia), Prof. SyamsulMa’arif (IPB), Prof. KudangBoro Seminar (IPB), Prof. HaruhiroFujita (Japan)	Ballroom
15.15 – 15.45 (30’)	Break	
15.45 – 17.30 (105’)	Moderator: Prof. Marimin (IPB) Invited Speakers (5-8) (4 x 20 minutes) Discussion (25 minutes) Tentative Schedule: Dr. Gajendran (UK), Prof. Noel Lindsay (University of Adelaide), Dr. KuncoroHartoWidodo (UGM), Prof. UtomoSarjonoPutro (ITB)	Ballroom
Day 2 (17 September 2013)		
08.00 – 08.30 (30’)	Registration	
08.30 – 10.15 (105’)	Moderator: Prof. KudangBoro Seminar (IPB) Invited Speakers (9-12) (4 x 20 minutes) Discussion (25 minutes) Prof. Egum (IPB), Prof. Marimin (IPB), Dr. AgusBuono (IPB), Dr. HeruSukoco (IPB)	
10.15 – 10.30 (15’)	Coffee Break	
10.30 – 12.30 (120’)	Parallel Session 1 Moderator: Prof. Fujita (7 paper @ 15 minutes) Discussion (15 minutes) Parallel Session 2 Moderator: Prof. Ono Suparno (7 paper @ 15 minutes) Discussion (15 minutes) Parallel Session Moderator: Prof. Suprihatin (7 paper @ 15 minutes) Discussion (15 minutes)	

12.30 – 13.30 (60’)	Lunch Break	
13.30 – 15.00 (90’)	Open Discussion (Open Forum) with Prof. Kenneth De Jong Topic: Foundations and Applications of Genetic/Evolutionary Algorithms	Ballroom
15.00 – 15.30 (30’)	Conference Closing	Ballroom
15.30 – 17.00 (90’)	Indonesian Agroindustry Association (AGRIN) National Congress (PIC: Prof. Suprihatin)	Ballroom
17.00 – 17.45 (45’)	Refreshment and Closing of AGRIN National Congress	Ballroom

CONTENT LIST

Adsorption Of Carotenoid From Palm Oil Methyl Ester By Using Attapulgite And Synthetic Silica Magnesium As Adsorbent

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ABSTRACT

Attapulgite and synthetic silica magnesium are used as adsorbents to purify the palm oil methyl ester from the impurities such as carotenoid, catalyst residue, and free fatty acid. Temperature, adsorbent ratio and reaction time were chosen as factors. The results of the research indicate that attapulgite were more effective to absorb the carotenoid than synthetic silica magnesium. The dominant adsorption was the physical adsorption, where siloxan group adsorbent interacted with the seventh carbon atom from carotenoid molecules. The optimum adsorption condition was determined with respond surface method. The quadratic equation was $Y = 22.8183 + 1.8503X_1 + 2.0206X_2 - 1.167\ X_1^2 - 0.7006X_1X_2 + 0.2302X_2^2$. The best adsorption was 21.95% with the factors, reaction temperature of 94.5 °C, adsorbent ratio of 2.09 and reaction time of 60 minutes.

Keywords: attapulgite, synthetic silica magnesium, adsorption, carotenoid, response surface.

1. INTRODUCTION

Bleaching process in the refining industry of palm oil is needed to remove the red colour of a carotenoid pigment from crude olein oil to obtain a cooking oil more colorless as desired by the consumer. The necessity separation and purification process for β-carotene in the oil refining industry because of the sensitivity of this component toward high temperature or oxidation and nutritional value of the potential active components β-carotene in Crude Palm Oil.

The use of adsorbent was generally proposed to adsorb the components in the olein oil. Attapulgite (magnesium aluminum silica) is a mineral that potentially used as an adsorbent for β-carotene from Crude Palm Oil.

Nowadays, attapulgiteis only used as the active ingredient in the medicine or pharmaceuticindustry. Non-polar adsorbent is used for the separation process of β-carotene (Baharin *et al.*, 1998)[1]. Attapulgiteisan adsorbent that is not easily saturated, has temperature resistant up to 500ºC. Furthermore,the attapulgite has the ability to choose the components in the adsorption process which areabsorbedeasily (Lansbarkis, 2000)[2]. The type, combination and ratio of adsorbent incrude palm oilprocessing give affects to the results of adsorption. In this case, β-carotene performed at a temperature of 50-55ºC (Latip *et al.*, 2001)[3]. Tocopherol adsorption process could be done until the temperature of 80ºC (Sanagi *et al.*, 2005)[4]. Kinetics are needed in an adsorption process to show the relation between the velocity parameters adsorption and pore adsorbent diameter (Kadirvelu *et al.*,2000)[5]. Langmuir and Freundlich isotherm are used to indicate a suitable model for the kinetics of an adsorption process (Ribeiro *et al.*,2001)[6].

Methyl ester produced in the biodiesel based palm oil production is still containing some “pollutant”, such as catalyst residue, soap, free fatty acid, water and some unsaponified materials, such as tocoferol, sterol, carotenoid and some minerals. Carotenoid as one of unsaponified material in methyl ester will increase cast and mist points (Van Gerpen *et al.*, 1996)[7], which will disturb the combustion system. The high value of cast and mist points produced would cause some imperfect in the combustion process,even in the low temperature carotenoid could be crystallize. According to Nasikin (2004)[8], an incomplete combustion will produce a deposition in the diesel engines. On the other hand, the carotenoid is highly potential to be develope especially in the pharmaceutical and cosmetic. Because of that, it is needed a study in the biodiesel purification to use the carotenoid to valuable products.

The study of β-caroten extraction as the biggest component of methyl ester carotenoid had been undertaken by Ooi *et al.* (1994)[9] by using molecular distillation. It also had been done by Darnoko and Cheryan (2006)[10] by using nano-filtration. However, both proces were needed an uneasy equipment and expensive. Therefore, a simpler and cheaper method is needed.

The adsorption technique in palm oil β-carotene extraction is one of the simpler and cheaper methods. The process had been studied, not only using bleaching clay (Liew *et al.*, 1982)[11], synthetic adsorbent (Latip *et al.*, 2000)[12], but also natural adsorbent, such as rice hulks ashes (Liew *et al.*, 1993)[13].

Attapulgite is one of the *clay* which is oftenly used in the bleaching. Attapulgite is potentially used as β-carotene absorbent. It has been proven by Boki *et al.* (1994)[14], that it isused in soybean and rapeseed oil bleaching.

Synthetic silica magnesium is an adsorbent which commonly used in biodiesel for dry washing biodiesel oil. Synthetic silica magnesium can adsorb free fatty acid (Yates *et al.*, 1997)[15], alkali and glycerol (Gerpen and Menges, 2004)[16].

The research about palm oil methyl ester using attapulgite and synthetic silica magnesium as an adsorbent needs to be done to know the optimum condition of carotenoid removal from unwashed methyl esther. Therefore, the efficiency and effectivity of processing can be gain.

2. EXPERIMENTAL

Materials used in this research were palm oil methyl ester (from LIPI, Serpong, Tangerang, Banten), attapulgite (Engelhard, USA) and synthetic silica magnesium (Dallas, USA). The material used for analysis were β-carotene standard (Sigma-Aldrich). The main equipment in this research was a reactor. Equipment for the analysis was spectrophotometer.

3. RESEARCH METHOD

Variables chosen in this research were temperature, adsorbent ratio, and reaction time. This research was carried out in four stages, i.e, raw material characterization, mixing rate optimization, determination of reaction influence factor and determination of influenced factor for the carotenoid adsorption. The raw material characterization included palm oil methyl ester, attapulgite and synthetic silica magnesium. The analysis parameters of palm oil methyl ester were acid value, water content, refractive index, alkali residue and pH. The analysis parameters of adsorbent were color, shape and particle size. The determination of optimum stirring rate was done using the variables of temperature (80 °C), adsorbent ratio (1:1 b/b attapulgite : synthetic silica magnesium), and reaction time (60 minutes) with stirring rate of 50-450 rpm. The affected factors to the carotenoid adsorption were determined by using *two level factorial designs* with high and low value of each factor (Table 1).

Table 1. Lower And Higher Value Of Reaction Factor

Reaction Factors	Code	Low Value	High Value
Temperature (^oC)	X1	70	90
Adsorbent ratio (b/b attapulgite/magnesol)	X2	1:2	3:2
Reaction time (minutes)	X3	20	60

Factors affected to the selection responses then were processed by Response Surface Method (Box *et al.*, 1978)[17]. Whereas, to know the optimum condition of factor which influenced the carotenoid adsorption was determined using *Statistical Analysis Software Version 9* and also *Software Statistic Version 6* to obtain a response surface picture.

4. RESEARCH PROCEDURE

This research was started with raw materials preparation, i.e, attapulgite activation, then continued with weighing of palm oil methyl ester, activated attapulgite and synthetic silica magnesium. Attapulgite activation was done by drying of attapulgite in oven at temperature of 105 °C for 2 hours, then it was continued by burning it for 30 minutes and calcinated using furnace for 1 hour at temperature of 500 °C. The weight of mixture of attapulgite and synthetic silica magnesium was 3 % of the weight palm oil methyl ester. The mixing of adsorbent into methyl ester was done at the temperature of 70-90 °C with stirring rate of 50-450 rpm. The adsorption was done for 20-60 minutes, then sample was taken, and they were put in vacuum filtered. The filtrates then were analyzed for carotenoid content, acid value, alkali residue, pH and refractive index. The main parameter measured was carotenoid content.

5. RESULT AND DISCUSSION

5.1 Palm Oil Characterizations

Palm oil methyl ester characterization was done to know physicochemical characteristics of the palm oil used (Table 2). The high acid value shows that the methyl ester still contained a lot of free fatty acids. In other case, the water content was higher than that of its standard. Thiswas due to not properly drying process which caused hydrolysis reaction that produced free fatty acid and water.

Table 2. Characteristic Palm Oil Methyl Ester

Parameter	Standard	Value
Acid value (mg KOH/g)	Max 0.8[a]	1.46
Water contain (%)	Max 0.05[a]	0.13
Refractif index 25^oC		1.6201
Alkali Residues	Max 5[b]	814.27
pH		8.05

The presence of free fatty acid influenced the refractif index value. The high free fatty acid content in methyl ester could decrease the refractif index. The alkali residue decreased the refractif index. The alkali would also hydrolyse the methyl ester into free fatty acids. The high value of alkali residue increased the pH value.

Attapulgite and synthetic silica magnesium characterization was undertaken to know the adsorbent condition before they were used as adsorbent. Their characteristics were given in Table 3.

Table 3. Characteristics Of Attapulgite And Synthetic Silica Magnesium

Adsorbent	**Parameter**		
	Colour	**Shape**	**Particle Size**
Attapulgite	Brown	Powder	150 mesh
Synthetic silica magnesium	White	Powder	150 mesh

5.2 Optimum Stirring Rate

Optimum stirring rate was one of external factor influence the adsorbtion process. By the determination of optimum stirring rate, the external factors, especially external diffusion, do not influence the adsorption result. The optimum stirring rate was determined by the correlation between the increasing stirring rate and the increasing of adsorbed β-carotene (*Figure 1*). The stirring rate applied was stirring ratewhere the increasing of stirring rate did not cause any carotene adsorption significantly. That stirring rate was then used for the next steps.

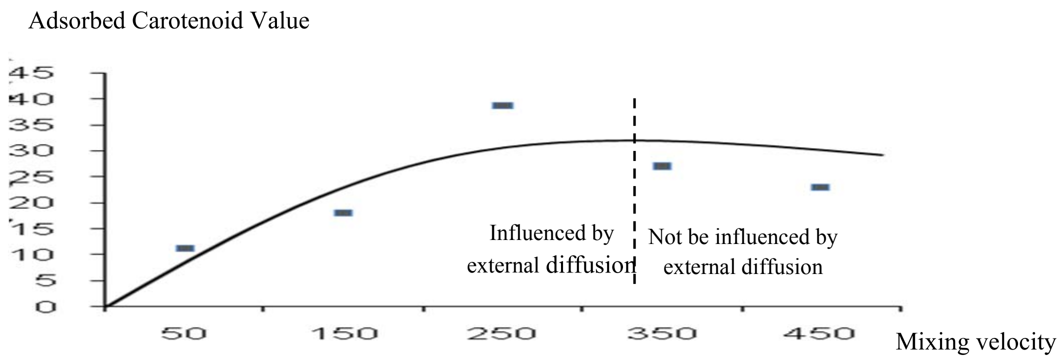

Figure 1. CorrelationbetweenAdsorbed Carotenoid Value with Mixing Velocity

5.3 The Influence of Reaction Factor

The result of statistical analysis shows that the reaction factors which were given such as temperature (X_1), adsorbent ratio (X_2) and reaction time (X_3) gave significant influence in carotene adsorption. Those three factors had influences to reduce the β-carotene content in palm oil methyl ester. The influence of major factor and interaction interfactor to the β-carotene from palm oil methyl ester adsorbtion is showen in Table 4.

The factor which most influenced to adsorbtion of carotenoid from palm oil methyl ester was adsorbent ratio in the highest confidence interval. Increasing the adsorbent ratio used in the adsorption increased the percentage of adsorbed β-carotene. It is showen from the positive value in parameter coefisien. Reaction time and temperaturesignificantly influenced the β-carotene adsorption in high confidence interval.

Adsorbtion occurs because of the bonds between the silica layers in the adsorbent structure and β-carotene molecule. The siloxan group consisted of silica bonding with oxygen (Si-O-Si) in the silica layer, adsorbent interacted with electron cloud in the conjugated double bonds from carotene molecul by dipole-dipole reaction. The mechanism happened can be seen in Figure 2.

Table 4. The Influence Of Major Factor And Interaction Between Factors Toward The Carotene From Palm Oil Methyl Ester Adsorption

Parameter	**Parameter Coefficient**	**Significances (%)**
Intercept	22.8183	99.99
X_1	1.6106	99.39
X_2	2.4102	99.73
X_3	1.8215	99.52
X_1_X_2	-0.6362	96.29
X_1_ X_3	0.143	62.59
X_2 _X_3	0.4179	91.97
R^2		0.9977

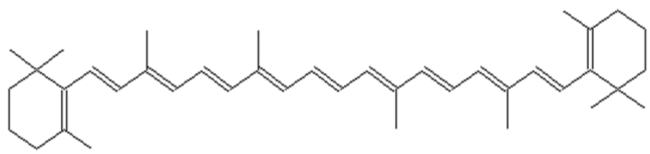

Figure 2 : Mechanism of Physical Carotenoid Adsorption

The high adsorbent ratio means the usage of attapulgite as adsorbent was higher than that of synthetic silica magnesium. In other words, attapulgite could adsorb carotenoid better than synthetic silica magnesium. Eventhough attapulgite contain lesssilica than synthetic silica magnesium, but attapulgite has the oxide Al_2O_3 which potentially bondsβ-carotene with chemical adsorbtion. The form of bonding happens based on Taylor (2005) (*Figure 3*).

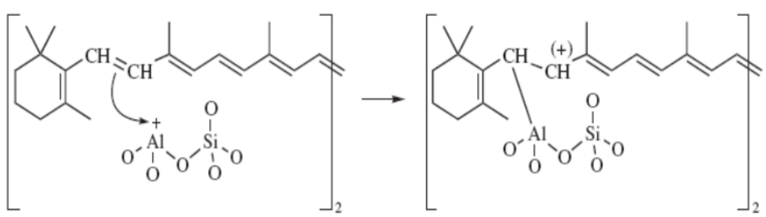

Figure 3 :. Carotenoid Chemical Adsorption in the Adsorbent

The interaction of temperature and adsorbent ratio negatively influenced the carotenoid palm oil methyl ester adsorption in the high confidence interval. The interaction between temperature and reaction time positively influencedthe carotenoid adsorbtion of palm oil methyl ester. The interaction of those two factors significantly influenced in low confidence interval. The result of adsorbent ratio with reaction time to the carotenoid adsorbtion of palm oil methyl ester significantly influenced in the high confidence interval.

5.4 Respond Surface Analysis

The quadratic equation model obtained from the statistic analysis responds surface method was:

$$Y = 22.8183 + 1.8503 X_1 + 2.0206 X_2 - 1.167 X_1^2 - 0.7006 X_1X_2 + 0.2302 X_2^2.$$

The canonic analysis result to responds surface method shows that the responds surface method was a saddle point. The estimation of best result obtained from the carotenoid adsorbtion estimation which reachs the value of 21.95%at temperature of 94.5°C and adsorbent ratio of 2.09. The form of responds surface method produced can be seen in *Figure 4*.

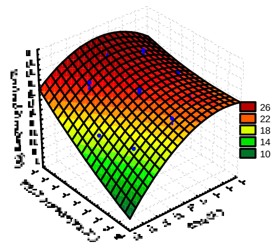

Figure 4 : Responds Surface of Carotenoid Adsorption as Function of Temperature and Adsorbent Ratio

Based on *Figure 4*, can be known that in each temperature condition, the increasing of adsorbent ratio would increase the carotenoid adsorbtion. Moreover, in each adsorbent ratio which was used, the increasing of temperature would increase the carotenoid adsorbtion.

The accuracy of this model can be known from determination coefisien value R^2, which reach the value of 0.9215. From this R^2 value, can be concluded that the value which estimated with this model reached to the value which was achieved from this research. It was appropriate with the optimum condition verification which the value was not significantly different i.e, the carotenoid adsorption of 21.59%.

6. CONCLUSION

The palm oil methyl ester purification using adsorbent attapulgite and synthetic silica magnesium could be done by optimize the adsorbtion condition. The optimum stirring rate for the process was 250 rpm. The adsorbent ratio highly influenced the carotenoid adsorbtion in confidence interval of 99.73%. The temperature reaction influenced the carotenoid adsorbtion in confidence interval of 99.39% and reaction time influenced the carotenoid adsorption in the confidence interval of 99.52%.

Canonic analysis to the responds surface method from the factor which significantly influenced to the adsorption of palm oil methyl ester, namely temperature (X_1) and adsorbent ratio (X_2), shows that the responds surface method which produced muddy point. The optimum condition can be determined by the responds surface model of $Y = 22.8183 + 1.8503 X_1 + 2.0206 X_2 - 1.167 X_1^2 - 0.7006 X_1X_2 + 0.2302 X_2^2$, where the best carotenoid adsorption was 21.95% with the temperature of 94.5 °C, using adsorbent ratio of 2.09 in reaction time of 60 minutes.

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