

THE EFFECT OF ADSORBATE VOLUME AND DEGREE OF SWELLING ON ADSORPTION OF DYES BY NATA DE COCO AND NATA DE AQUO

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Abstract

Nata de coco is one of the beneficial products of coconut in Indonesia, which is made of cellulose by Acetobacter xylinum. One of the various potential applications is the attempt to make it useful for adsorption purposes. Some investigation using heavy metals for adsorbates are carried out. Some types of dyes are also adsorbed on the surface of the biomass to see the potential of the surface to retain synthetical and natural dyes. Tartrazine and carotenoids pigment are used to investigate the surface ability.

Two types of processes are compared, the one using dried nata in a column elution when the degree of swelling plays role, and the other one is the in situ adsorption while the adsorption takes place from the beginning of network formation. The cellulose type of surface is also investigated, in comparison with nata de aquo.

The analysis is done using some analytical instrumentation, mainly UV-Visible spectrometry to see the adsorption of dyes, as well as SEM to observe the surface, FT-IR to see the possible surface interaction. The variation on dyes concentration and degree of swelling as well as temperature of the system were done to extract information about the physical or chemical adsorption occurring on the surface.

The result indicates the physical adsorption is the dominant process on both surfaces, the degree of swelling and higher temperature increase the dynamics on the surface, there are difference in synthetical and natural dyes pattern of adsorption on both surfaces. Some further investigation would be conducted.

Key words: Adsorption, Adsorbent, Dye, Nata de Coco, Cellulose, Swelling Degree

1. INTRODUCTION

Adsorption is a process of withdrawing component surface of adsorbent. Desorption is reverse from adsorption process in which the adsorbed component is released back to the solution. There are a lot of adsorption process in daily life, for example the adsorption of heavy metals at the carbon surface, textile dyes by paddy straw. The straw of paddy has cellulose as the major component. Straw paddy have major component that is cellulose. Mechanism of adsorb textile dyes is make bind textile dyes with adsorbent by covalent bond and hydrogen bond. Adsorption with adsorbent contain cellulose can happened cause there is group –OH in cellulose and make interaction with adsorbate.

Beside cellulose from plant like wood, cellulose can find from coconut water fermentation process by *Acetobacter xylinum* bacteria called by nata de coco. Nata beside make from water coconut nata can be able from aquades with prepare major component that is sugar and nitrogen. Nata from aquades, produce different impurity with nata de coco caused minerals contain in medium former nata. From the back ground do research effect of adsorbate volume and degree of swelling on adsorption of dyes using adsorbent nata de coco and nata de aquo powder.

2. MATERIALS AND METHODS

2.1. Production and characterization of adsorbent

The nata de coco is made by boiling 30 L of coconut water and 2,25 Kg of sugar 12 g of $(\text{NH}_4)_2\text{SO}_4$ were added. The mixture was stirred and let cooled. On the other hand, nata de aquo was made of 30 L aquades add with sugar 4,5 kg and $(\text{NH}_4)_2\text{SO}_4$ 24 g. The both of solution add glacial acetic acid until pH 4 and added starter 100 mL. After cooling, was incubated for 14 days and formed nata de coco. Nata formed boiled and wash with ethanol and nata crush and dried in temperature 90°C. Characterization adsorbent overwhelm water content, ash content, density and determination of power adsorption metilen blue solute.

2.2. In situ adsorption

2 mL tartrazin dye 10 ppm and 15 ppm added in growth medium nata and then added 100 mL starter contain *Acetobacter xylinum* bacteria. In another system 2 mL carotenoids 2000 ppm and 200 ppm added in growth medium nata and then added 100 mL starter and in another system added extract carrots. Nata formed analyzed with microscope and Scanning Electrons Microscope (SEM).

2.3 Column adsorption

Column adsorption do with variation adsorbate volume. Variation adsorbate volume using volume 3, 6, 9, 12 and 15 mL for tartrazin dye 60 ppm and 9000 ppm for carotenoids. 0,5 g adsorbent come in to column and then added food dye adsorbate and then eluate receive in two fractions and analyzed with spectrophotometers.

2.4. Effect degree of swelling to the adsorption

$\pm 0,25$ g adsorbent mix with ethanol with variation volume ethanol 1, 2 and 3 mL and weigh adsorbent. Adsorbent come in to erlenmeyer and added 25 mL tartrazin and for another system add 25 mL carotenoids then shake with speed 100 rpm, 50 minutes. Filtrate analyzed with spectrophotometers.

3. DISCUSSION

3.1 Production and characterization adsorbent

14,5 Kg wet nata de coco after drying to be 124,542 g dry nata de coco with rendement 0,859 %. 5 Kg wet nata de aquo after drying to be 35,9 g dry nata de aquo with rendement 0,712 %. Characterization adsorbent for to know quality adsorbent.

TABLE 1. Characterization adsorbent

Variety characterization	Nata De Coco	Nata De Aquo
Water content	7,249%	4,663%
Ash content	1,697%	1,096%
Density	1,305	1,420
Determination of power absorption metilen blue	1593,60 mg/g	1860,41 mg/g

Adsorbent nata de aquo have more quality than nata de coco, there is cause water content and ash content more low. Value water content low show that adsorbent have water contain low and value ash content low show that adsorbent have low impurity and then adsorbent have capacity for adsorption more good. Nata de aquo have determination of power absorption metilen blue solute more high than nata de coco to be adsorb big molecule, that is show that nata from aquades have capacity adsorb more good to be adsorbent molecule like carotenoids and tartrazine. Characterization show that different data from adsorbent nata de aquo and nata de coco, cause difference medium for bacterial *Acetobacter xylinum* to produce nata.

3.2 In Situ Adsorption



FIGURE 1. In situ tartrazin adsorption (a) Nata surface (b) A picture of nata after adsorption from a microscope

In situ adsorption with tartrazin dye show that not forming nata like in figure 1. Nata formless cause tartrazin dye destroy the life condition bacteria produce nata, and make bacterial *Acetobacter xylinum* not produce nata. The part of nata formless analyzed with microscope show in figure 1(b)

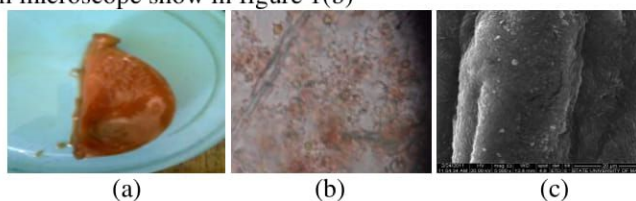


FIGURE 2. In Situ adsorption carotenoids
a. Nata b. Mikroscope picture c. Picture nata with SEM

Added extract carotenoid to medium former nata make change the colour of nata to be brown like in figure 2. Figure 2 show that the colour of nata to be brown and different with general nata with have white colour. Fibre of nata

same with fibre general nata, in figure 2 (c) that show the nata fibre not broken. From the picture can conclusion that *Acetobacter xylinum* bacteria not refuse carotenoid and bacterial manner carotenoid and glucose together to be brown nata.

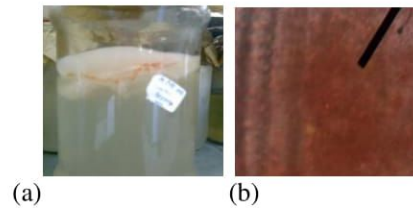


FIGURE 3. In Situ adsorption with extract carrot
a. Nata b. Mikroskop picture of nata

Added extract carrots to in situ adsorption do with two ways. First added extract carrot to medium former nata and make extract carrot accumulation in to part bottom nata like in figure 3 (a). Part of extract carrot analyzed with microscope and show in figure 3 (b) that is fibre of nata have orange colour. The orange fibre possibility when *Acetobacter xylinum* bacteria produce fibre nata together with fibre nata adsorb extract carrot.



FIGURE 4. In situ adsorption with extract carrot

Second, extract carrot added in medium former nata which former nata layer after incubated 5 days. After view day the layer of extract carrot closed with nata layer. Like in figure 4 extract carrot cannot mixed 100% homogeneously with nata layer and happened phase separation caused different characteristic physical and chemistry of nata layer and extract carrot and make not combine.

3.3. Column adsorption

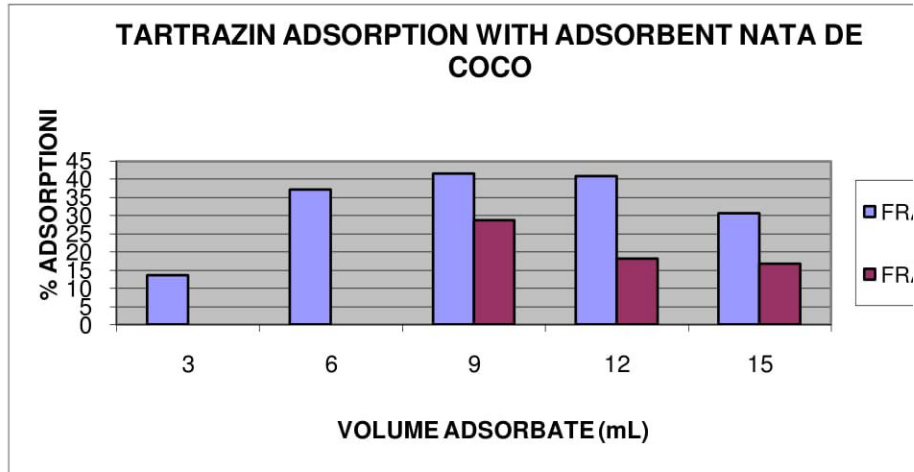


FIGURE 5. Graphics percentage adsorption tartrazin with adsorbent nata de coco

Percentage of tartrazin adsorption at the beginning is low, this is because happened competition to fight space in pore's nata between water as dissolved and tartrazin molecule, and then cause size water molecule more small then tartrazin, water more easy to come in the pore's nata. Percentage of tartrazin adsorption low also cause water can make hydrogen bond between water and cellulose and have power 20 Kj/mol and the binding more strong than binding between cellulose and tartrazin molecule.

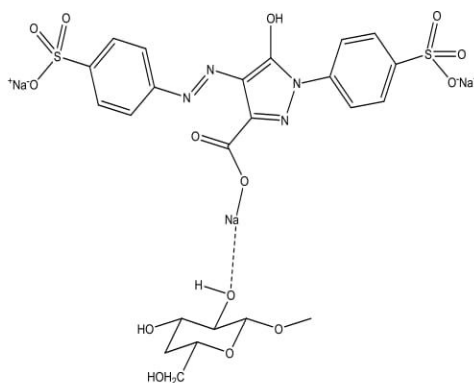


FIGURE 6 . Interaction Ion Dipol in tartrazin

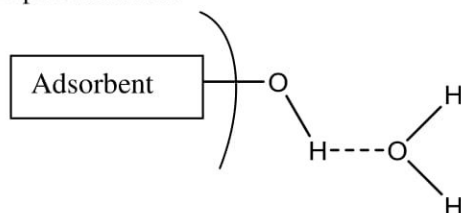


FIGURE 7. Hydrogen bond between water and cellulose

Added adsorbate volume 6 mL percentage adsorption up cause capacity adsorbent to adsorb tartrazin not yet optimum. Added adsorbate volume 9 mL until 15 mL eluate received in two fraction. Fraction 1 have percentage adsorption more high then fraction 2 to cause added adsorbate volume more much make the process like happened desorption.

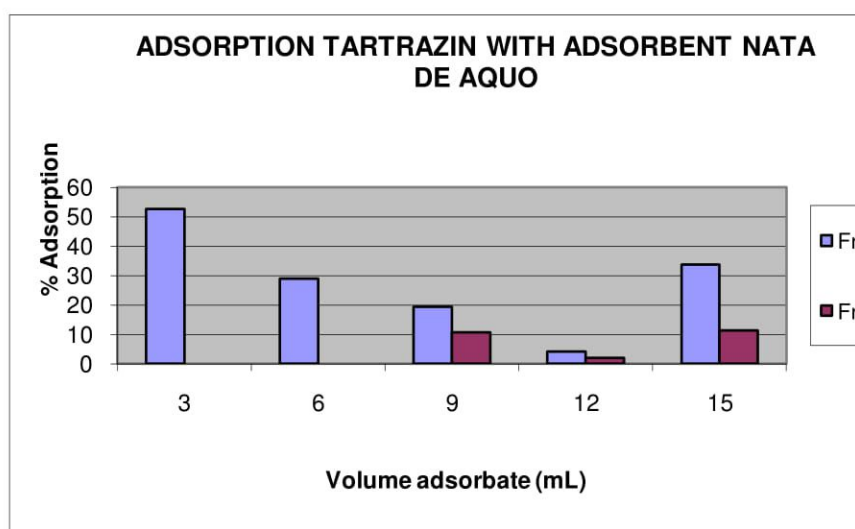


FIGURE 8. Graphics percentage adsorption tartrazin with adsorbent nata de aquo

Adsorption tartrazin with adsorbent nata de aquo show that percentage adsorption to come down with to reach added volume adsorbate like in figure 8 this is cause adsorbent past to reach for balance to adsorb tartrazin. In added volume adsorbate in 15 mL in fraction 1 percentage adsorption high this is cause in fraction 1 volume adsorbate to come out to column 5,2 mL nearly with added volume adsorbate 6 mL so percentage adsorption almost same. Adsorption tartrazin with nata de aquo more good than nata de coco cause connected with purity of adsorbent.

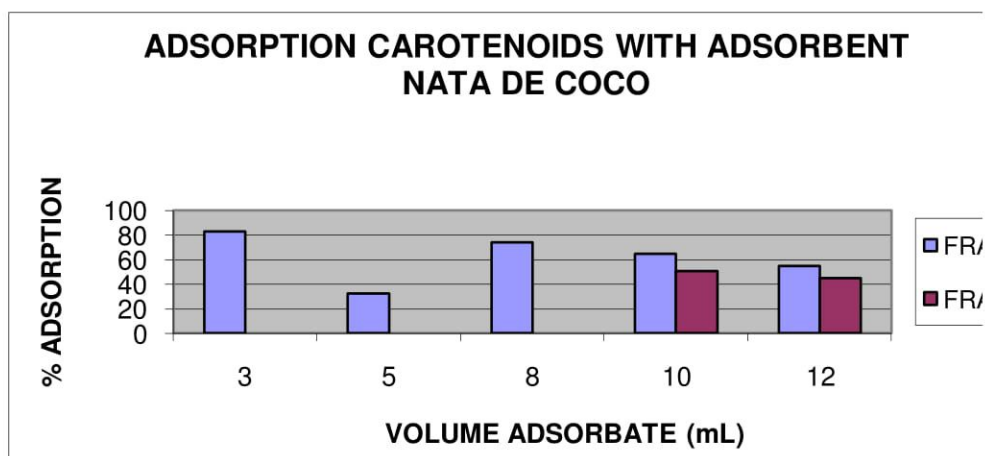


FIGURE 9. Graphics percentage adsorption carotenoids with adsorbent nata de coco

Adsorption carotenoids with adsorbent nata de coco show that percentage adsorption up and down. Added adsorbate 3 mL is maximum percentage adsorption and then added volume 5 mL percentage adsorption down, this is possible happened cause cellulose make binding with ether and have power more high than carotenoid and cellulose.

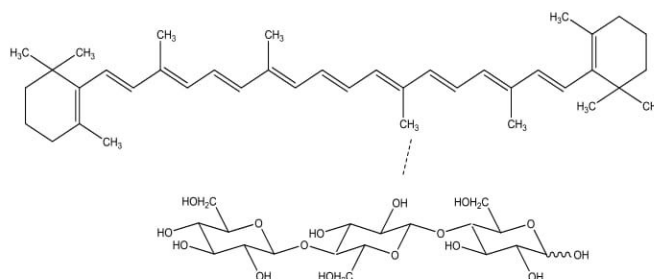


FIGURE 10. Interaction dipol induksian between β -caroten and Cellulose

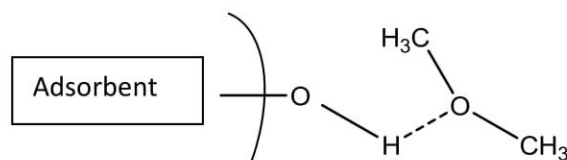


FIGURE 11. Hydrogen Bond between Ether and Cellulose

Added volume adsorbate 8 mL percentage adsorption to come up this is cause size of molecule carotenoids more big so molecule trap in pore's of adsorbent or cause the size of ether as dissolved bulky and can influential adsorption process.

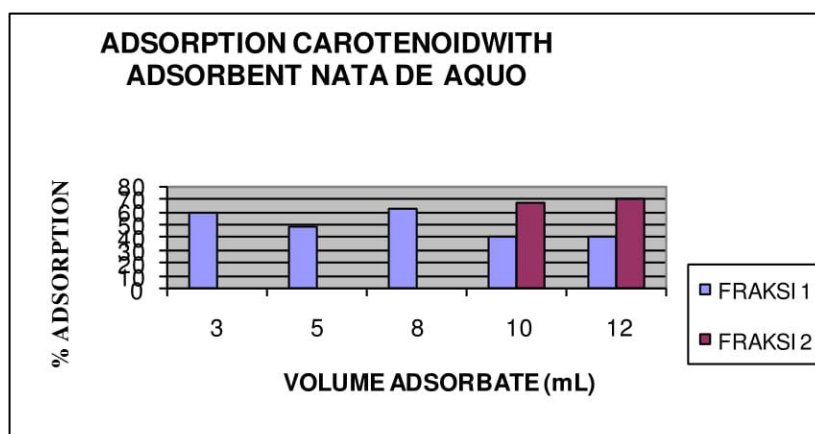


FIGURE 12. Graphic Percentage Adsorption Carotenoid with Adsorbent Nata de Aquo

Adsorption carotenoids with adsorbent nata de aquo have same character with adsorption carotenoids with adsorbent nata de coco, but have difference in percentage adsorption that is percentage adsorption with adsorbent nata de aquo more low. System with added adsorbate volume 10 mL and 12 mL in fraction two have percentage more high then fraction 1 this is show that ascending volume adsorbate caused contact time of adsorbent and adsorbate more lasting and percentage adsorption come up.

3.4 Effect degree of swelling for adsorption

TABLE 2. Effect degree of swelling for adsorption carotenoids

Adsorbent	Volume ethanol (mL)	Degree of swelling (%)	Concentrate filtrate (mL)
Nata de Aquo	1	281,39	7060
	2	564,98	6485
	3	551,2	6200
Nata de Coco	1	316,02	5375
	2	605,81	6475
	3	714,51	5625

Like in table 2 show that degree of swelling caused adsorption. Degree of swelling more high caused possibility happened adsorption-desorption process. Effect degree of swelling to be able to look in influence degree of swelling in adsorption tartrazin with adsorbent nata de aquo, that is ascending percentage degree of swelling caused filtrate concentrate up and down.

CONCLUSION

1. Nata de aquo is a better adsorbent than nata de coco due to the purity of the adsorbent.
2. In situ adsorption tartrazin dye caused not forming nata, adsorption extract carrots caused phase separation and adsorption carotenoids can change the colour of nata.
3. Adsorption tartrazin more good with adsorbent nata de aquo and adsorption carotenoids more good with adsorbent nata de coco.
4. Degree of swelling more high caused possibility happened adsorption-desorption process.

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