DECOLORIZATION EFFICIENCY OF ACTIVATED CARBON ON SWEET POTATO (*Ipomoea batatas*) BROWN SUGAR SYRUP

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Abstract:

Some raw sugars produced are relatively difficult to decolorize by sugar refiners and tend to develop color during storage. The costs of sugar refining increase with the amount of coloring matter in the raw sugar feedstock. Decolorization of sweet potatoes syrup was studied using activated carbon. From the studies, it was observed that pH, contact time and concentration contribute significantly to the intensity of color produce. The results of this studies show that, the intensity of the color with extraction increase with contact time. The effect of pH on decolorization efficiency increases with increase in pH toward 8.0. Increase in contact time between the brown sugar syrup and the activated carbon enhances the decolorization of the sugar syrup. It was also observed that when the concentration of the absorbate increases the decolorization efficiency of the sugar syrup increases. A reduction of color in raw sugar or a cheap and effective method of removal in processing would lead to lower refining costs.

Keywords: Activated, decolorization, sweet potatoes, syrup

Introduction

Sweet potato provides uses for human consumption, animal feed, industrial products as well as provides great potential to avoid malnutrition and improve food security in developing countries (Ogunrinola *et al.*, 2015). Sweet potato is believed to have potential value same as other food crops in producing starch, reducing sugar (glucose), and ethanol. Researches until recently has proven that sago starch could produce sugars, lactic acid and ethanol (Fan, 2019). Sweet potato (Ipomoea batatas) is a popular root crop in developing countries which contains roughly 16 to 24% starch. Starches play avital role in food product development, for example, as raw material, additives, or texture enhancers (Mohammed, 2021). Recently, the sweet potato has been increasingly used as an industrial crop for the production of glucose and high fructose syrup (Brunson et al., 2013). Gebreselassie *et al.,* (2022) reported the commercial manufacture of sweet potato syrup, with the possibilities for use as table syrup, for baking and cooking purposes, and for blending with other syrups to prevent crystallization. Saska, *et al.,* (2010) developed an engineering system for converting on sugar production from sweet potato developed by purification and crystallization methods sweet potato into glucose syrup. Concentration trials using the system produced syrups with volumes of 100 and70mL with the respective dextrose equivalence of 281 and 213 mg/mL

Sweet potato (*Ipomoea batatas*) belongs to the *Convolvulaceae* (morning glory) family (Al-Achi, 2019). It is a perennial plant that is widely cultivated in the tropics and sub tropics, where it serves as a major food source. Sweet potato could be used as raw material for alternative sugar manufacturing by sugar industries which would have a great health benefit for people suffering from diabetes and also for other industrial processes such as beverages, soft drinks and other activities that require sugar as raw material. However, one of the challenges faced by developing countries such as Nigeria is the lack of storage facilities, some million tons of the tubers are destroyed due to poor storage management. In order to proffer solution to this wastage, value addition to these tubers to produce other useful products is imperative (Afolabi *et al.,* 2022). The processing of starch to glucose can be carried out either by acid or enzymatic hydrolysis. However, the use of enzyme is preferred to acid, because it produces high yields of desired products and less formation of undesired products such as toxic compounds (Sanjust *et al*., 2004).

Materials and Methods

Apparatus used: Conical Flask magnetic stirrer, Oven pH – Meter Water bath Weighing balance, Incubator, Centrifuge

Reagents: Distilled water sweet potatoes (variety; purple skin), Enzymes: Alpha – amylase, /malt

Preparation of Activated Charcoal/ Carbon

Method: Chemical Activation

Chemical activation was used according to the methods described by Kealedia *et al.* (2014) using chemical such as NaOH. The raw charcoal was grounded and the activation was performed in two steps:

Step 1 Impregnation: **Procedure**

I. 30g of crushed raw charcoal were dispersed in 100ml of 1M solution of NaOH.
II. After stirring for 30 mins, the mixture was kept standing for 24 hours.
III. The slurry obtained was filtered and dried in an oven at 105^0C for 24 hours

Step2: Heat Treatment

I. The dry sample (chemical impregnated wood precursor) was then pyrolyzed at temperature ranging from 400 – 900^0C in the absence air.
II. The charcoal again was thoroughly washed with distilled water pH was between 6.5 and 7.
III. The sample was then dried in an oven at 105^0C for 24 hours.
IV. The activated carbon was stored in a sealed container

Sweet Potato Starch Preparation

Freshly harvested mature Sweet Potatoes were obtained from two communities, both in Ukum Local Government Area of Benue State, Nigeria. The tubers were washed to remove dirt, the washed potato tuber was peeled and crushed using grinding machine. The crushed pulp was sieved using a cheese cloth. The slurry is then allowed to stand for 12 hours. The granule settled at the bottom. The super formed liquid was then decanted to obtain the starch cake. The resulting starch was dried. The dried starch was then packed in a container for storage (Nareerat *et al.*, 2014).

Effect of Time on Extraction Syrup decolorization efficiency

200 g/L of sweet potato starch solutions were heated in a water bath at 70 ^{0}C for 2 hours. The samples were withdrawn at predetermine time intervals (30, 60, 90, 120 and 180 minutes respectively). the slurry was filtered through a cheese cloth and centrifuged for 30 mins using (bench top centri. C2041UK series) and the supernatant was decanted. The absorbance of the syrups was measure using UV – Visible spectrophotometer at 420nm. The color was in ICUMSA units (Nareerat *et al.*, 2014).

Syrup decolorization efficiency

The centrifuged syrups from all the experimental parameters were decolorized from the same procedure as, Syrups solution were heated up to 70–75 °C with stirring (Saska, 2010). 0.5 g of AC was added into the solution. At the end of 30 mins, the obtained sample was collected and filtered again in the range of 0–120 minutes to completely remove the activated carbon. The absorbance was determined at a wavelength of 420 nm. The color was shown in ICUMSA (IU) unit by equation below.

Color (IU) = $= (10^8 \times A)/(b \times c)$

where A = absorbance at wavelength 420 nm.

b = length of the absorbent path (cm)

c = concentration of sample (g/ml)

And the decolorization efficiency was calculated by the equation 2 below;

Decolorization efficiency = IU_{initia} - IU_{final} / UI_{initia} × 100

Where: IU-initial = is the sugar syrup color before decolorization

IU-final = is the decolorized sugar syrup solution color

Results and Discussion

Image 1: Extract of brown sugar syrup

Effect of Contact Time

Sweet potato syrups were produced at different time intervals (30, 60, 90, 120 and 180 mins) this shows the different color levels measured in ICUSMA units. The numerical values are illustrated in the graph in figure 1. colour intensity was evaluated from different time of extraction. The evaluation at 30 mins to 120 mins shows a rapid color absorption by the activated carbon. And at 120 mins to 180 mins, the absorbent getting near saturation. Rasika *et al.*, 2018 studied the decolorization of brown sugar by absorption, in case of powdered form of adsorbent, the amount of molasses adsorbed per unit mass of adsorbent first increases gradually and after some tome increases relatively slowly. In case of pelleted form of adsorbent, the contact time required is more for slight increase in amount of molasses adsorbed per unit mass of adsorbent.

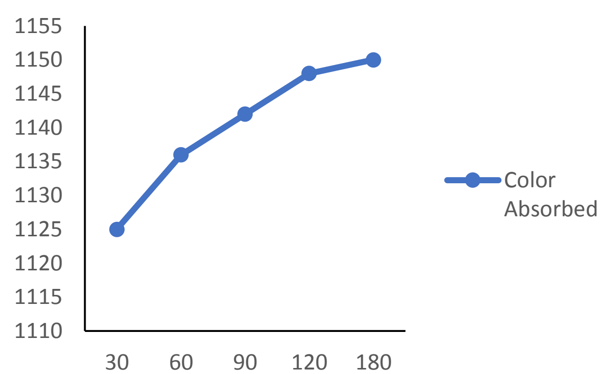

Figure 1: Effect of Contact Time on sweet potato syrup extraction

Decolorization efficiency results

Image 2: Decolorized sugar using activated carbon

Effect of pH on decolorization of the sugar syrup

The decolorization efficiency of the syrups with activated carbon at different pH values in figure 2 show that, there was a rapid color absorption by the absorbent at pH of 5.5 to 5.8, after which, the color absorption processes gradually. The percentage color absorption efficiency was good at pH to neutrality, that from 5.0 to 7.4. Rasika *et al.*, 2018 studied the decolorization of brown sugar syrup by pellet and powered absorbent. He said, by using powdered form of activated charcoal, the amount of molasses adsorbed increase with increase in the initial concentration of sugar solution. But if we are using pelleted form of our adsorbent, molasses adsorbed first remains constant and then increases suddenly.

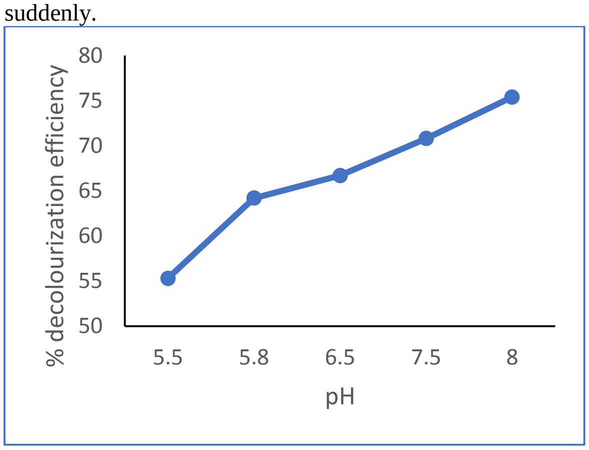

Figure 2: Syrup decolorization efficiency of AC on different pH values.

Effect of contact/decolorization time

The results on figure 3 shows decolorization performance efficiency at different contact time.

The decolorization of the sugar syrup shows and quick increase in color absorption from 30 mins to 90 mins. Above 90 mins, the absorption begins to absorb at slower rate. When contact time increases from 30 to 90 mins at constant sugar solution 200g/L and constant activated carbon dose (0.5g). Nareerat *et al.*, 2014 result of sugar syrup decolorization increases from 91.3% to 93% when the contact time increased from 90 to 180min. Decolorization efficiency was increased when AC loading increases. This may be come from more active sites of adsorbent, therefore, the surface area was directly proportional to the amount of the AC. From our research, filling of AC 2.5 g can give a decolorization efficiency of 51% higher than others (Thummasorn, 2007).

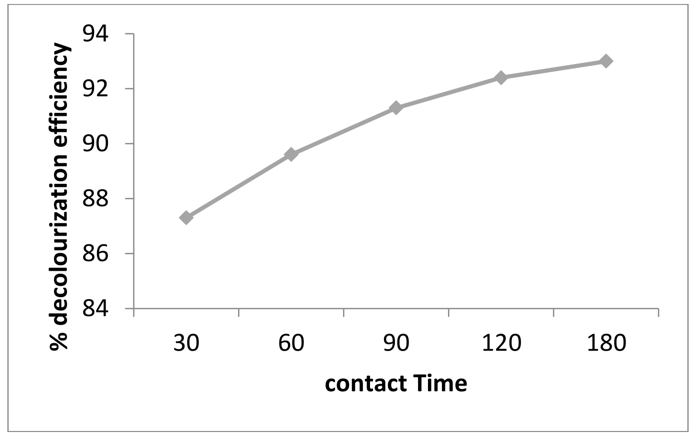

Figure 3: Effect of contact time on decolorization efficiency using WBAC ½ adsorbent.

Effect of concentration on decolorization

To study the influence of sweet potato syrup concentration on the decolorization performance of the adsorbent experiments were done at 40, 80, 120,160, and 200g/L. The results are illustrated on figure 3 above. At the lowest concentration, 40 g/L the color removal performance of the adsorbent was minimum, 80.8 % as compared to the fast absorption rate that shall be observed later. When the concentration increases to 200 g/L, the colorant removal performance increases to 94 %. These results indicated that at lower raw sugar solution concentration, the rate of desorption of colorants, which is the rate at which the adsorbed molecules rebound from the surface of adsorbent, increases. There was a sharp increase of color absorption by the absorbent at mark of 82 to 160 and further gradual absorption was observed to the mark 200.

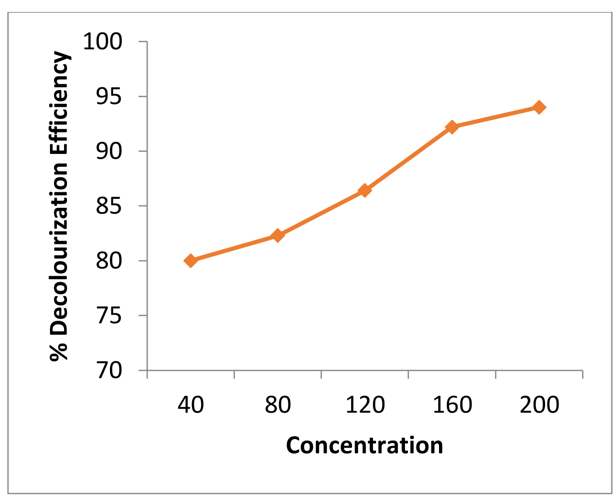

Figure 4: Effect of concentration on decolorization efficiency using WBAC ½ adsorbent

Conclusion

Decolorization was carried out on these process variables to examine the efficiency of AC used and to determine the level of process variables those provides maximum decolorization performance. The process variables checked in this work were contact time, pH and concentration. The individual process variables and their interaction effects on decolorization performance have been studied using 0.5g WBAC. This result showed that wood based activated carbon is good and effective for decolorization of sweet potato syrup hence it can be used as an alternative sugar for sugar processing industries. This work mainly focusses on decolorization of sweet potato sugar syrups by using activated carbon. Decolorization performance of AC was checked on experimental parameters as pH was checked in a range of 5.5 to 8.0 and the contact time was also limited between 30 min and 180 min. the maximum decolorization efficiency was obtained at the upper limits of pH value and contact time.

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