A COMPARATIVE ANALYSIS ON THE CLARIFICATION EFFICIENCY OF LIME AND MORINGA OLEIFERA ON CANE SUGAR JUICE

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Abstract

A comparative analysis of the clarification efficiency of lime and moringaoleifera on cane sugar juice was investigated. Moringa pods were collected and their seeds ground into powder. The seed oil was extracted using a crude method. Calcium oxide and moringaoleifera seed cake were used to effect colloid coagulation in sugarcane juice. The dosages by weight were varied. The settling time was also varied. Clarification was measured as a function of absorbance. The absorbance was measured at different wavelengths. A wavelength of 600nm was used in the results and discussion. The absorbance of the clarified sugarcane juice over a period of five hours was obtained. A cost analysis was also investigated. The results suggest that Moringaoleifera is a more efficient coagulating aid at 1g Moringa/100ml of sugarcane juice with an absorbance of 1.803 after one hour although calcium oxide (lime) is cheaper.

Keywords: Clarification, Moringa oleifera, Lime, Cane sugar juice, Calcium oxide

1. Introduction

Saccharumofficinarum commonly known as Sugar cane is a species of herb, a perennial plant that can grow up to 4.25metres. It is a grass that grows well in warm and tropical areas. For its growth, it requires a lot of sunlight, large quantities of water, fertile soil, high temperatures and good drainage. It requires at least 1500mm of rain per year unless grown with irrigation. The crop cycle is between 10 and 24 months (Verheye, 2010). Sugar cane juice is the liquid obtained

from the pressing of sugar cane stalks (Satran,2013). Sugar cane juice is very rich in antioxidants which serve as a basis for its ability to aid in the combat against infections and also to boost the immunity of body systems. It is abundant in calcium, iron and other electrolytes which aid in its effects against dehydration. (Staff, 2016). If stored, sugar cane juice must be clarified since it darkens minutes after extraction due to the oxidation of some of its components (especially chlorophyll and polyphenolic compounds), which can negatively affect its consumption (Prati & Moretti, 2010).

In the sugar production process, the clarification stage is a very important stage as the clarity/purity of the sugar produced is dependent on the sugarcane juice from the clarification unit. Over the years, only calcium oxide has been commercially used in the production of sugarcane(Zhao & Li, 2015). The purchasing and utilization of this chemical in the clarification process has proven quite expensive and is also more expensive to import to nations who do not have calcium oxide manufacturing plants. The optimization of this unit operation by providing an alternatively better clarifying agent would not only reduce the cost of production but also provide an alternate means which could prove faster hence cutting short the production time.The process involved in clarification of cane sugar juice include coagulation, flocculation and precipitation of the colloids and pigmented substances, which are later removed by filtration(Chong, 2012). Flocculation can be completed by changing the pH, utilizing concoction reagents, or through warming (Lee, 2014b).

On the study of clarification process of sugar cane juice for consumption, Prati & Moretti, 2010carried out the clarification of sugarcane juice using aluminum polychloride and a negatively charged polyelectrolyte (“magnofloc”), testing three different concentrations of each. It was concluded that the treatment 4 was the most adequate for the clarification of sugarcane juice for consumption. In 2012, a work on the clarification of sugarcane juice for syrup production by Laksameethanasan et al studied the process of sugarcane syrup production. Turbidity, color, pH and sensory evaluation were analyzed to determine the clarification effect due to three agents: lime, bentonite and activated carbon. The clarification using lime showed that adding lime to pH 7 led to less turbid juice than those of pH 8 and 9. The clarification using bentonite, showed similar results using bentonite amount of about 3%, 4%, and 5%. The color likeness of syrup was the highest in the sample treated with only lime and the lowest in the

sample treated with only bentonite. (Laksameethanasana et al, 2012). This experiment aims to determine the clarification efficiency of moringaoleifera seeds versus the efficiency of lime on cane sugar juice used in the production of sugar from sugar cane.

2. Materials and Methods

2.1. Materials/ Equipments

The raw materials and reagents used in the experiment are as follows; Sugarcane, *Moringaoleifera*, Calcium oxide, Citric acid, Distilled water.The equipment used in the experiment include; UV spectrophotometer, Crusher, pH meter, Weighing balance, Mortar and pestle, Magnetic stirrer, Bottle containers, Beakers (250ml), Heating mantle, Cotton filter cloth, Airtight plastic bags, 0.8mm mesh, Pipette, Pipette sucker, Thermometer, Plastic bucket with cover, Funnel, Filter paper, Measuring cylinders (500ml), Blender, Stirrer, Round bottom flask, Skillet, Stove.

2.2. Methods

The sugarcanes were washed thoroughly, peeled and cut into pieces. The sugarcane was then crushed using an automated crusher and pressed/squeezed to extract the high concentrated sugarcane juice. The sugarcane juice thus obtained was decanted to remove impurities and sugarcane shaft pieces that may have escaped the sieve cloth.The procedure comprised of altering the pH to 7 and 8, a range appeared to be proficient for clarification as indicated by Koblitz and Moretti (1999), and including clarification agents. The clarification aids tested were calcium oxide and moringaoleifera.Acid was added again to pH values with the same or lower than pH 4.0 to repress the development of pathogenic microorganisms. This technique likewise added to the clarification of the juice. The sample was fermented with 10% citrus extract.

The brown moringa pods were harvested from adult tree branches. The greener pods collected were exposed to direct sunlight to further dry them. This is to ensure that the seeds obtained are dry. The brown pods were cracked open along the seam and the seeds were plucked out by hand.

The measurement of turbidity in a color spectrophotometer in was carried out to evaluate the efficiency of the clarification and compare results between the samples containing calcium oxide versus Moringaoleifera.

3. Results and Discussion

The resultcompared all the dosages of both moringa seed and that of lime at the different times for which the level of clarity (absorbance) was measured and the level of clarity was checked for five hours.Different dosages within the same coagulant type were also compared. An unadulterated sample (no coagulant aid added) of sugarcane juice was recorded to have an absorbance of 2.800. This sample served as the control experiment.

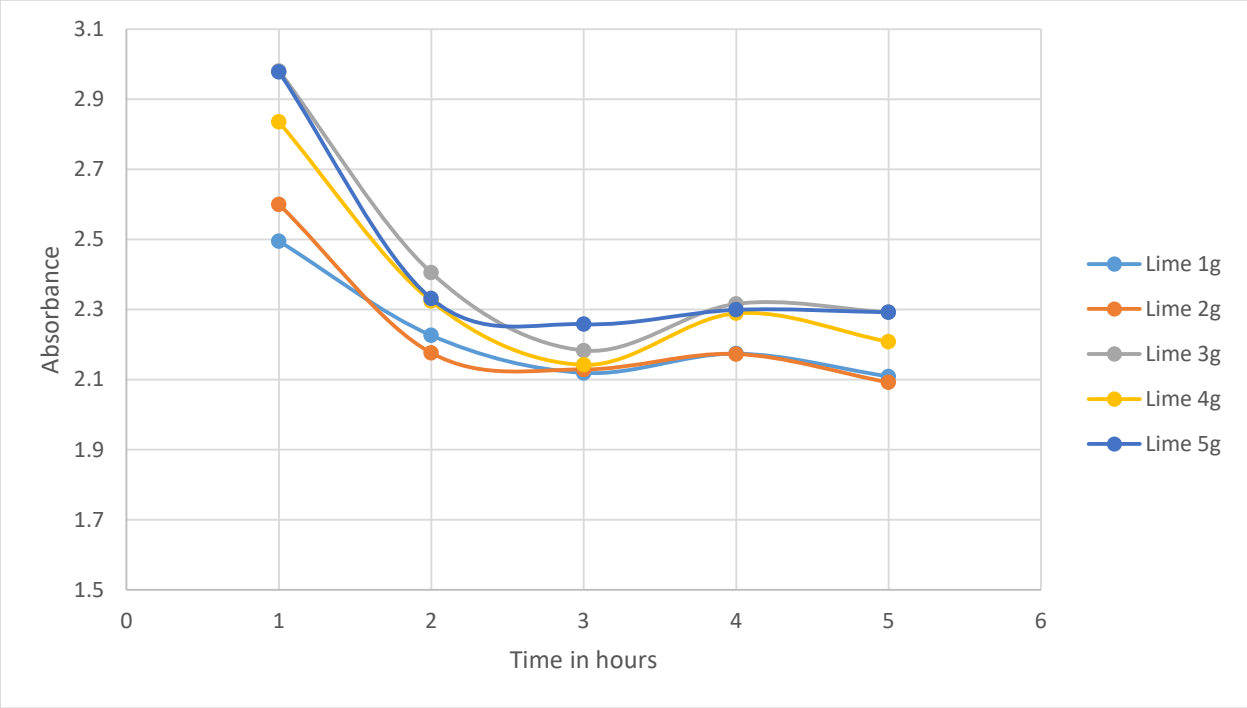

Figure 1.Variations of absorbance (600nm) against settling time at different dosages of lime.

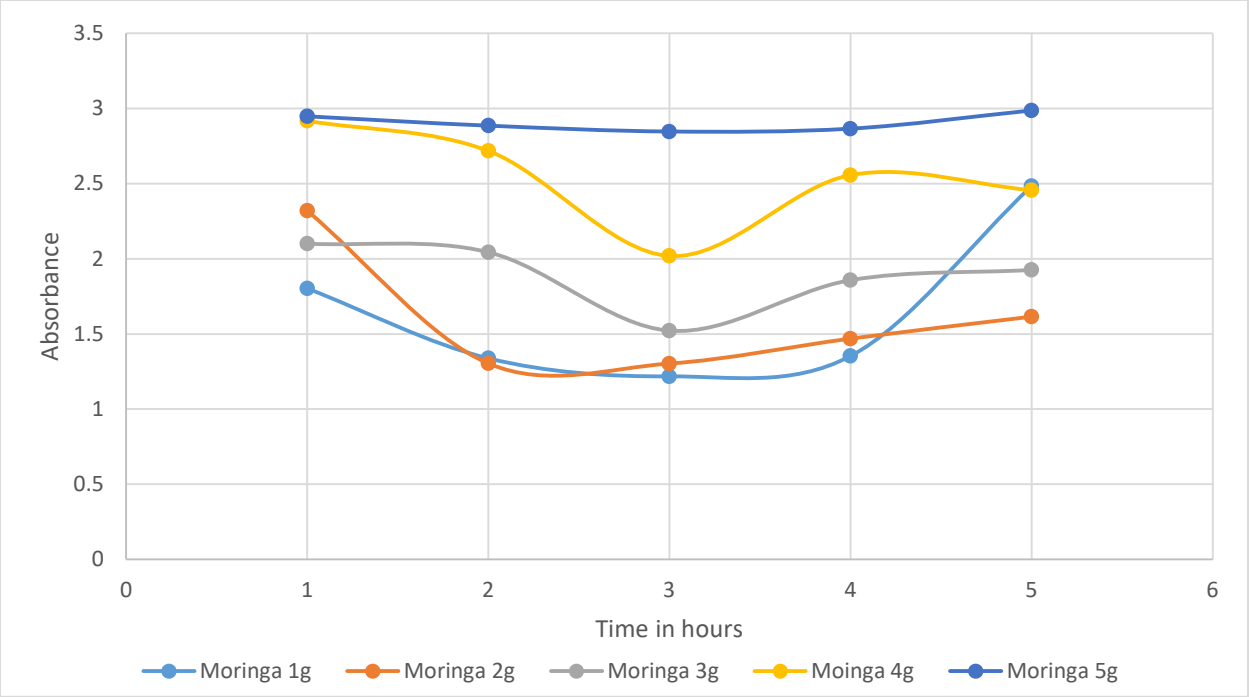

Figure 2. Variations of absorbance (600nm) against settling time at different dosages of moringaoleifera seedcake

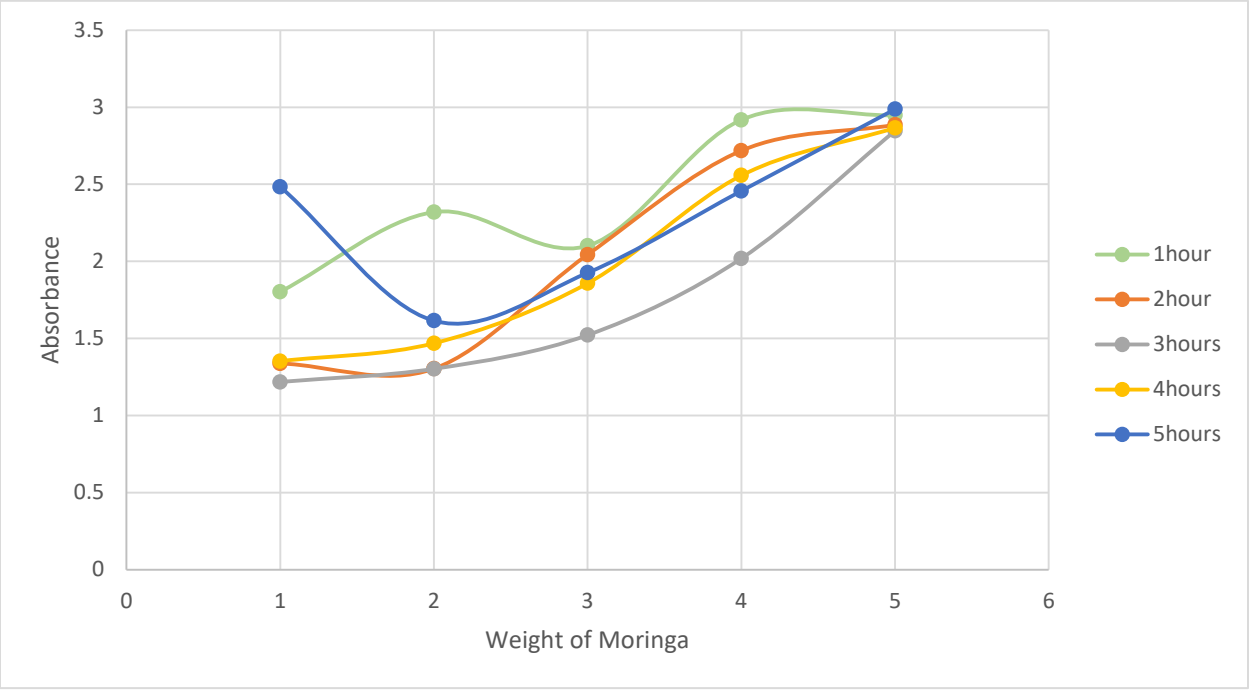

Figure 3. Variation of absorbance with respect to weight of Moringa

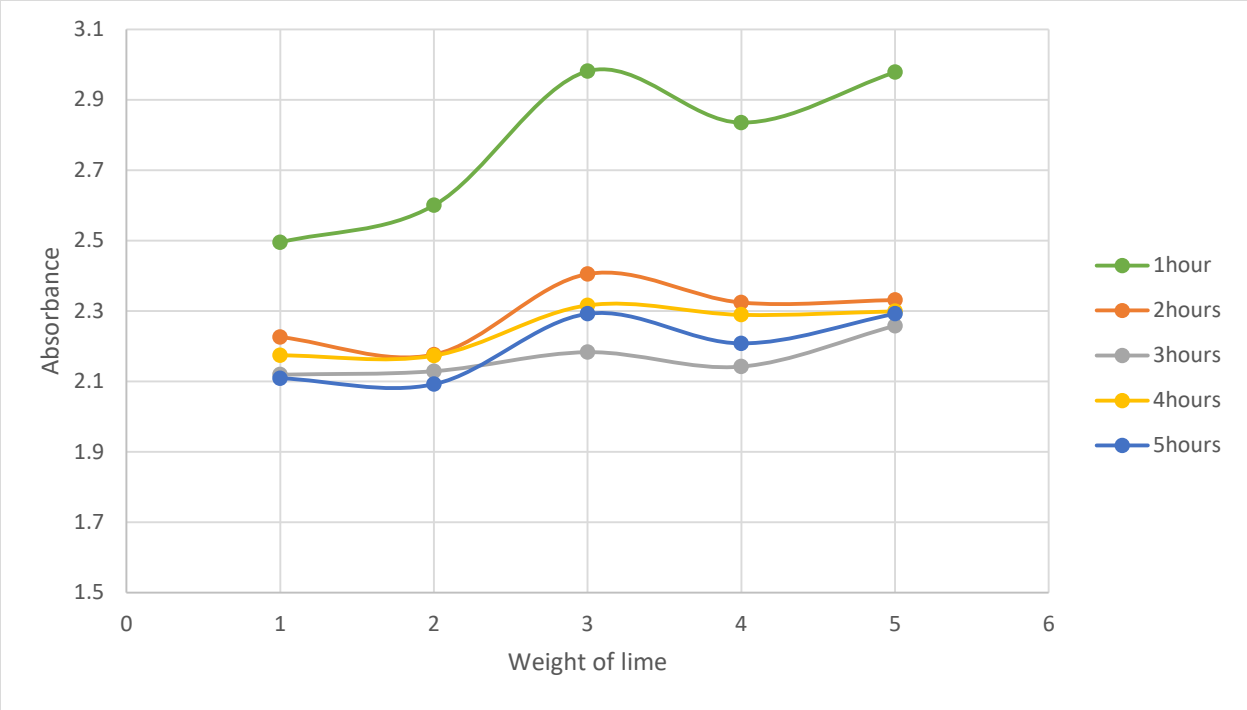

Figure 4. Variation of absorbance with respect to the weight of lime

Effect of Moringa and Lime on the clarification of cane sugar juice with respect to time

Effect of lime dosages on absorbance of cane sugar juice after 1hour

From the graph in figure 1, at one hour, It was observed that the sample with 1g lime had clarified the juice reducing the absorbance from 2.800 to 2.495. In the sample containing 2g of lime, the absorbance had reduced from 2.800 to 2.600. In the third sample containing 3g of lime, it was observed to have an even higher absorbance than the control sample, having an increase in absorbance from 2.800 to 2.981. The fourth sample containing 4g of lime also showed what will be termed as 'reverse absorbance' having an absorbance of 2.835 (higher than the control). The fifth sample containing 5g of lime also had a higher absorbance at 2.978. The higher absorbance readings signified a cloudier liquid than the control which could have been due to the liquid containing too much coagulant aid added causing an even cloudier solution.

Effect of Moringa dosages on absorbance of cane sugar juice after 1hour.

From the graph in figure 2, at one hour, it was observed for 1g moringa sample a decrease in absorbance from 2.800 to 1.806. This is very impressive compared to the absorbance obtained

for the sample containing 1g lime. In the second sample containing 2g of moringa the level of clarification is not as high, having an absorbance of 2.320 which although is also a decrease from 2.800 was not as impressive as that of 1g/100ml. In the third sample, the absorbance was recorded to be 2.101 which is also less than 2.800 obtained in the control sample. In the fourth, the absorbance was recorded as 2.918 which is greater than the control absorbance at 2.800. In the fifth, the absorbance is 2.948 which again is higher than the control. These higher absorbance values could also be due to too much coagulant aid in the sample amount which is 100ml of sugarcane juice.

Effect of lime dosages on absorbance of cane sugar juice after 2hours.

As shown in the graph in figure 1, the five samples continued to undergo clarification with their absorbance values still decreasing. The first sample containing 1g lime had an absorbance reduction from 2.495 to 2.226. The second sample with 2g lime from 2.600 to 2.176. The third containing 3g lime from 2.981 to 2.405. The fourth containing 4g from 2.835 to 2.324.And lastly the fifth containing 5g of lime from 2.978 to 2.331. This hour experienced a rather rapid decrease in absorbance which implied that at this stage most of the colloidal particles had agglomerated due to aid from the coagulating aid, lime.

Effect of Moringa dosages on absorbance of cane sugar juice after 2hours.

From figure2, it was observed that the samples containing Moringa were still undergoing clarification as the values for absorbance across the different dosages of Moringa are still on the decrease. In the first sample with 1g moringa, the absorbance further decreased from 1.806 to 1.338. In the second sample with 2g moringa, absorbance decreased from 2.302 to 1.304. In the third with 3g moringa, absorbance reduced from 2.101 to 2.044. For the fourth, with 4g, absorbance reduced from 2.918 to 2.718. And lastly the fifth with 5g moringa, absorbance decreased from 2.948 to 2.886. In the fifth, the absorbance was still higher than the control which further buttressed the suspicion that the moringa added as a coagulant aid was simply too much in ratio to the sample sugarcane juice.

Effect of lime dosages on absorbance of cane sugar juice after 3hours.

In figure 1 it was observed that at the third hour the samples achieved their lowest absorbance values. Thus implying maximum clarification at that hour was achieved. The absorbance of the first sample further decreased from 2.226 to 2.1191. The second sample experienced a decrease from 2.176 to 2.129. The third from 2.405 to 2.183.The fourth from 2.324 to 2.142 and the fifth from 2.331 to 2.258. At this hour, the clearest liquid was gotten with most of the colloidal particles at the bottom of the containers.

Effect of moringa dosages on absorbance of cane sugar juice after 3hours.

In figure 2 it was observed that the third hour also for samples with moringa had the lowest absorbance values across the dosages of moringa, implying that at this hour the best clarification had been achieved. The absorbance values of the first sample experienced a decrease from 1.338 to 1.218. The second sample absorbance values changed from 1.304 to 1.303. The third from 2.044 to 1.522.The fourth from 2.718 to 2.019 fifth and last from 2.886 to 2.847. The absorbance values of the fifth sample were steadily decreasing but were still above that of the control. This leads to confirming the theory that there is indeed too much moringa in the sugarcane sample.

Effect of lime dosages on absorbance of cane sugar juice after 4hours.

In figure1. It was observed that the absorbance values for all the dosages of lime increased at the fourth hour. This could have been due to the inability of particles which had settled to the bottom to remain at the bottom because they weren’t heavy enough. The first sample had an increased absorbance from 2.1191 to 2.174. The second sample also had an increase from 2.129 to 2.173. The third from 2.183 to 2.316.The fourth from 2.142 to 2.289 and the fifth from 2.258 to 2.299.

Effect of moringa dosages on absorbance of cane sugar juice after 4hours.

From the figure 2, it was also noticed here that the absorbance values were on the increase. The first sample with 1g moringa had an absorbance increase from 1.218 to 1.353. The second with 2g moringa had an increase from 1.303 to 1.469 and the third from 1.522 to 1.858. The fourth from 2.019 to 2.557 and the fifth with 5g from 2.847 to 2.866.

The decrease in absorbance thus far had been due to the relative strength of the flocs that was being formed in relation to the charges involved. As earlier stated, the flocs that were formed

were not strong enough to override the power of the repulsive charges at the bottom of the containers. Generally, after four hours, the settled flocs began to disperse into the liquid returning to impurities in the liquid. This is the reason for the increased absorbance as shown in both figure 4.1 and the figure 4.2.

Effect of weight dosages on the clarification of sugarcane juice

Effect of the weight of moringa on the clarity of sugarcane juice.

From the graph in figure 3, it is observed that the weight of the dosages of moringa has a direct relationship with how well clarified the liquids are. From the plot, the 2g/100ml dosage gave the lowest absorbance four out of five times. These times are 2hours, 3hours, 4hours, and 5hours.

The only abnormality in the graph was when 1g/100ml gave the lowest absorbance in the first hour. Assuming in the factory, the clarification is 1hour then the best ratio to use would be 1g moringa/100ml sugarcane.

Effect of the weight of lime on the clarity of sugarcane juice.

From the graph in figure 4, the lowest absorbance was gotten at 2g lime/100ml sugarcane for three out of five times. At times 2hours, 4hours and 5hours. At the 3hours, the lowest absorbance was gotten to be 1g/100ml and also at 1 hour. Also assuming in the factory, the clarification process is for 1hour then the best dosage by weight would be 1g lime/100ml sugarcane.

Furthermore, in the production of sugar from sugarcane in most factory processes, the pH of the sugarcane juice after clarification is preferably high. The use of lime ensures the pH is raised due to the basic nature of calcium oxide. On the other hand,moringa do not affect the pH of the sugarcane juice. This inability to raise the pH counts as a disadvantage here. Since both at one hour efficiently clarify sugarcane juice using a dosage of 1g/100ml. In the course of the experiment it was observed from the results obtained that at one hour which is being used as the assumed clarification time utilized by sugar processing companies. Both lime and Moringarequire the same amount in weight of dosages in 100ml of lime to obtain their best absorbance values. Although the absorbance gotten from that of Moringa is lower than that of lime.

Conclusions

In the study, the clarification efficiency of moringaoleifera seeds was compared with the efficiency of lime on cane sugar juice used in the production of sugar from sugar cane. It was observed that Moringa seed cake can effectively clarify sugarcane juice. The best dosage ratio for the clarification of sugarcane juice using moringa is 1g moringa/100ml sugarcane for an hour. Moringa is a more effective coagulating agent for the clarification of sugarcane juice.

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