A VEGETABLE CLARIFYING AGENT FOR CANE JUICE CLARIFICATION

By

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Abstract

There is a continuous quest for biologically-derived flocculants to avoid chemically manufactured flocculants for cane juice clarification. Attempts were made to investigate vegetable-derived clarifying agents which are substitutes for the imported flocculants and cheaper. A comparative study was made with chemical flocculant used normally in sugar factories on settling characteristics, juice clarity and the compactness of mud. It was observed that the use of 3 ppm of *Hibiscus lunarifolius* extract provides a similar performance to 2 ppm of chemical flocculant. This plant extract has a peculiar property which helps in reducing the unwanted colours in the juice. The plant extract assumes a significant role as an alternative for chemical settling agents. The plant has wider adoptability in terms of its agro-climatic requirements and can be grown as a sole crop or as an intercrop in sugarcane having wide or paired row planting system. Thus an environmentally friendly plant extract is made useful to replace chemicals in the sugar industry.

Introduction

Most of the sugar mills are importing expensive settling aids for settling mud and to improve the clarity of the clear juice .The settling agents are added to the heated juice before entering the clarifiers.

To avoid these costly chemicals, it is preferable to introduce alternatives which can be environmentally friendly, less expensive and easily adopted.

In the manufacture of Khandasari and Gur sugars, the cane juice is clarified with plant extracts *viz.* 1. *Hibiscus ficulneus* (Deola), 2. *Hibiscus esculentus* (Bhindi), 3. *Cadia celsina* (Sukhlai), 4. *Bombax malabarium* (Semal Bark), 5. *Grewia asiatica* (Falsa), 6. *Arachis hypogea* (Ground Nut), 7. *Recinus communis* (Castor Seed), 8. *Aloe vera* (Indian Aloe), 9. *Moringa oleifera* and *Cordia myxa* etc.

Based on these, it was postulated that the extract from such plants could be used in the process of clarification of cane juice for better flocculation and faster settling. In this paper, the details of the experiments conducted with *Hibiscus lunarifolius* and the results obtained are discussed.

Details of the plant

Hibiscus lunarifolius belongs to the Malvaceae family of the plant kingdom. It is herbaceous and 2–3 metres high. Physically, it resembles the Ladies Finger plant with the main difference being the length of the fruit which is 1/5 of the real Ladies Finger. The seeds are brown and minutely tubercled. The name of the plant in English is Van kapas.

The Van kapas plant is cultivated in the same way as Ladies Finger using seeds and can also be propagated by stem cuttings. Within 30 days after sowing, the plant will bear flowers and fruits. The leaves contain a sticky substance called mucilage which contains an albumin-like substance responsible for coagulating and bleaching characteristics.

The ideal time for picking the leaves to obtain the extract which can be used as a flocculant for cane juice clarification is before 30 days. Leaves will be broader before bearing of fruit bodies. If entire leaves are plucked, secondary leaves will develop within a few days. The plant can be irrigated once a week. It is a wild variety and can be grown in red and loamy or black and black loamy soil. Extracts can be obtained from the entire plant. The approximate crop duration is 3–4 months. The Van kapas plant can be found in tropical Africa, Australia, Sri Lanka and India.

Experimental procedure

Extraction of plant material

Matured leaves of the plant were collected and washed with water. The leaves were soaked in water and squeezed to obtain the extract. The extract was then filtered through a cloth.

Preparation of solution

A 0.05% solution of *Hibiscus lunarifolius* extract was prepared by taking 0.5 g of the extract in a 100 mL volumetric flask. About 80 mL of distilled water was added. The flask was stopped and shaken well to dissolve the extract. The volume was then made to 100 mL using distilled water and further diluted ten times with distilled water to give 0.05% solution.

Use of the extract for clarification

Raw juice was obtained from processing sugarcane in a laboratory crusher. The juice was analysed for brix, pol, purity and pH and then heated to 70˚C and limed to pH 7.2 and then heated to 100˚C.

A series of 6 × 1 L measuring jars was prepared by adding the *Hibiscus lunarifolius* at 1 ppm, 2 ppm, 3 ppm, 4 ppm and 5 ppm, respectively. The sixth jar was empty as a blank.

One litre of the boiled juice was added to each jar. Each jar was stirred well and the contents allowed to settle. The settling rate was observed at regular intervals and recorded using a stop watch. The clarity of the clear supernatant liquid from all the measuring jars was measured using the Kopke turbidity meter (Meade and Chen, 1982) and recorded in Table 1.

Table 1—Use of *Hibiscus lunarifolius* extract in raw juice clarification.

Juice analysis:
Brix = 20.00
Purity = 84.00
Initial pH = 5.2; Final pH = 7.2
Volume of 12°Bé milk of lime = 2%

Time (min)	Mean mud volume (mL)					
	Blank	1 ppm	2 ppm	3 ppm	4 ppm	5 ppm
0	1000	1000	1000	1000	1000	1000
3	860	700	680	600	620	650
5	540	410	400	370	390	400
10	340	300	280	250	270	290
15	290	250	240	200	230	240
20	270	230	180	160	170	180
25	250	200	160	130	140	150
30	230	190	120	110	130	140
60	200	140	110	90	120	130
Brix	20.00	20.10	20.12	20.10	20.05	20.03
Purity, %	84.05	84.06	84.08	84.10	84.06	84.02
Rise in Purity	0.05	0.06	0.08	0.10	0.06	0.02
Clarity	80	270	300	370	260	180
Colour, IU	18 500	14 500	12 000	11 000	14 000	16 000

In a similar way experiments were conducted with treated juice going to clarifier and the results recorded in Table 2.

Table 2—Use of the *Hibiscus lunarifolius* extract with sulfited juice.

Juice analysis: Brix = 20.50 Purity = 85.00 Initial pH = 5.4; Final pH = 7.2 Volume of 12°Bé milk of lime = 2%						
Time (min)	Mud volume (mL)					
	Blank	1 ppm	2 ppm	3 ppm	4 ppm	5 ppm
0	1000	1000	1000	1000	1000	1000
5	580	450	400	350	410	450
10	440	340	300	240	330	300
15	360	280	240	210	250	280
20	300	260	180	170	220	200
25	280	250	160	150	190	190
30	260	240	140	120	150	170
60	230	180	130	100	140	150
Bx	20.18	20.16	20.14	20.16	20.16	20.10
Purity, %	85.03	85.04	85.13	85.09	85.06	85.04
Rise in Purity	0.03	0.04	0.13	0.29	0.06	0.04
Clarity	70	260	280	360	260	270
Colour, IU	18 000	14 400	13 000	11 000	12 800	14 000

Comparison of the extract with chemical flocculant

A 0.05% of solution of the chemical flocculant Magnafloc LT27, having a molecular weight of about 18 million, was prepared in a similar manner to the plant extract.

Tests on raw juice using chemical flocculant were conducted using the same method that was used for the plant extract so that the two could be compared. For these tests the settling rates were recorded in Table 3.

Table 3—Use of the LT27 with raw juice clarification.

Juice analysis: Brix = 20.40 Purity = 84.10 Initial pH = 5.2; Final pH = 7.2 Volume of 12°Bé milk of lime = 2%						
Time (min)	Mud volume (mL)					
	Blank	1 ppm	2 ppm	3 ppm	4 ppm	5 ppm
0	1000	1000	1000	1000	1000	1000
5	870	660	640	730	720	790
10	760	470	500	560	560	570
15	580	400	440	450	450	460
20	510	250	400	410	420	430
25	450	210	360	380	380	390
30	420	100	330	340	360	340
60	340	80	250	270	290	300
Bx	20.60	20.40	20.10	20.42	20.38	20.18
Purity, %	84.14	84.16	85.00	84.78	84.54	84.19
Rise in Purity	0.04	0.06	0.90	0.66	0.44	0.18
Clarity	65	110	290	270	140	110
Colour, IU	18 000	14 200	11 000	12 000	14 000	14 000

Comparative study

The juice obtained from the laboratory crusher was analysed for brix, pol, purity and pH. The juice was heated to 70°C. It was limed and the pH was adjusted to 7.2 by using sulfur dioxide gas and, to complete the reaction, the treated juice was heated to 100°C.

Three 1 L measuring jars were used. The first one was kept as a blank. In the second and third jars, 3 ppm of extract and 2 ppm of chemical flocculent respectively were added. The boiled

juice was poured into each of the three measuring jars and the volume was adjusted to 1 L mark. The contents of the measuring jars were stirred and the precipitate was allowed to settle. The data are recorded in Table 4.

Table 4—Comparative study of the effect of *Hibiscus lunarifolius* extract with chemical flocculant with raw juice clarification.

Juice analysis:
Brix = 20.83
Purity = 85.28
Initial pH = 5.4; Final pH = 7.2
Volume of 12°Bé milk of lime = 2%

Time (min)	Mud volume (mL)		
	Blank	3 ppm extract	2 ppm flocculant
0	1000	1000	1000
5	890	750	710
10	780	600	590
15	570	410	380
20	450	200	210
25	400	150	100
30	350	110	90
60	340	90	70
Bx	20.80	20.40	20.62
Purity, %	85.58	86.00	86.10
Rise in Purity	0.34	0.12	0.82
pH	7.1	7.0	7.0
Clarity	85	300	290
Colour, IU	18 000	11 400	12 000

Observations and discussion

From the analytical data, the optimum dosage of *Hibiscus lunarifolius* extract and chemical flocculant were found to be 3 ppm and 2 ppm respectively from Tables 1, 2 and 3. The results showed that the addition of *Hibiscus lunarifolius* resulted in faster mud settling rates and the mud volume was more or less equal in the case of chemical flocculant and the blank. The clarity analysis revealed that the supernatant juice obtained by the addition of *Hibiscus lunarifolius* extract was found to be similar to the juice obtained by the addition of LT27. The colour of clear juice obtained using LT27 at 2 ppm level was 11 000 IU, the same level as that obtained with the plant extract at 3 ppm. Due to the higher expenditure the colour analysis was not continued.

Table 4 reveals that the plant extract at 3 ppm gave a similar mud volume compared to the chemical flocculant at 2 ppm. Other parameters like brix, purity rise, pH, clarity and colour of the juice also showed similar results with these treatments.

Experiments are under way to analyse the constituents of *Hibiscus lunarifolius* extract that may be responsible for its flocculating characteristics and bleaching action. The effect of *Hibiscus lunarifolius* extract with the cane juice at different stages of processing will also be studied. Attempts are also made to crystallise *Hibiscus lunarifolius* extract to make it suitable for storage and marketing.

Conclusion

The comparative results of *Hibiscus lunarifolius* plant extract and the chemical flocculant reveal that 2 ppm of chemical agent produced similar results as 3 ppm of plant extract for settling of the mud in the juice. In addition, the formation of the floc is quicker and the flocs are larger with *Hibiscus lunarifolius.*

In view of these benefits, the extract assumes a significant role and is an ideal substitute for the traditional settling aid. The plant has a wide adaptability in terms of its agro-climatic

requirements and can be grown as a sole crop or as an intercrop in sugarcane having wide or paired row planting system. Even though the plant belongs to the same family of Malvaceae, unlike Ladies finger, it is not widely used. Rather, it is considered ornamental.

The plant extract is environmentally friendly. The cultivation of the plant may provide for an extra income for the farmers.

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REFERENCE

Meade, G.P. and Chen, J.C.P. (1982). Cane Sugar Handbook. 10th ed., 625.

UN AGENT VEGETAL DE CLARIFICATION POUR LA CLARIFICATION DU JUS DE CANNE

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MOTS CLEFS: Clarification, Floculant, Décantation, Boue, Clarté, *Hibiscus lunarifolius.*

Résumé

L'INDUSTRIE recherche continuellement un floculant biologique pour éviter les floculants fabriqués chimiquement pour la clarification du jus de canne à sucre. Des tentatives ont été faites pour trouver des agents végétaux pour remplacer les floculants importés et réduire le coût. Une étude comparative a été faite avec des floculants chimiques utilisés normalement dans les usines sucrières sur les caractéristiques de la décantation, sur la clarté du jus et la compacité de la boue. On a observé que l'utilisation de 3 ppm d'un extrait de *Hibiscus lunarifolius* fournit une performance similaire à celle obtenue avec 2 ppm d'un floculant chimique. Cet extrait de plante possède une propriété particulière qui contribue à réduire les couleurs indésirables dans le jus. L'extrait de plante assume un rôle important comme alternative pour les agents chimiques de décantation. La plante s'adapte bien aux conditions climatiques et peut être cultivée comme une culture unique ou en entre ligne avec la canne à sucre. Ainsi un extrait végétal bon pour l'environnement remplace les produits chimiques dans l'industrie du sucre.

UN AGENTE CLARIFICANTE VEGETAL PARA CLARIFICACIÓN DE JUGO DE CAÑA

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PALABRAS CLAVE: Clarificación, Floculante, Sedimentación, Lodo, Turbiedad, *Hibiscus lunarifolius.*

Resumen

HAY una continua búsqueda de floculantes biológicamente derivados para eliminar los obtenidos químicamente, usados en la clarificación de jugos de caña. Se han hecho esfuerzos para investigar agentes clarificantes de origen vegetal como sustitutos de floculantes importados y mas baratos que estos. Se hizo un estudio comparativo con floculantes comerciales en cuanto a características de sedimentación, turbiedad y densidad de lodos. Se observó que el uso de 3 ppm de un extracto de *Hibiscus lunarifolius* proporcionó un desempeño similar a 2 ppm de un floculante químico. Este extracto tiene una propiedad peculiar que ayuda en la reducción de colores no deseados en el jugo. El extracto de la planta juega un rol significativo como una alternativa a los agentes sedimentadores químicos. La planta tiene una amplia adaptabilidad en términos de sus requerimientos agroclimáticos y puede cultivarse como único producto o como un cultivo asociado con la caña en un sistema de surco alterno. De esta manera un extracto de planta, ambientalmente amigable, es planteado como útil en el reemplazo de químicos en la industria azucarera.