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Proximate Composition, Phytochemical Analysis and Invitro Antioxidant Potentials of Aqueous Extract of Coconut Sugar

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Abstract

Coconut sugar is produced by heating freshly collected coconut sap. The brown color of sugar is derived from non-enzymatic browning reaction. It is strongly influenced by pH and temperature. In this study, the proximate composition of coconut sugar, phytochemical screening and antioxidant activity of coconut sugar were examined. The proximate composition of coconut sugar was high in sucrose content (49.41) than the glucose (15.60) and fructose content (14.15%). The phytochemicals present mainly are alkaloids, phenols, steroids and phytosterols. Coconut sugar is rich in vitamin C (110mg), phosphorous (54.7mg), magnesium (23.13mg), calcium (5.6mg), iron (5mg) and protein (0.42g). It has an excellent antioxidant activity with DPPH radical scavenging activity than superoxide and hydrogen peroxide radical scavenging activity. The organoleptic evaluation of coconut sugar was compared with cane sugar among beverages such as black tea, black coffee, milk tea, milk coffee and milk to show their acceptance. Among all the beverages the overall acceptability of appearance, taste, flavor and color was superior to that of cane sugar. It can be concluded that in addition to their good mineral and phenolic content, coconut sugar could be useful as an antimicrobial substance to prevent various diseases. Future investigation is needed for the assessment of medicinal properties of coconut sugar.

Keywords: Antioxidant Activity, Coconut Sugar, Phytochemical Analysis, Physico-Chemical Parameters, Organoleptic Evaluation

1. Introduction

Coconut sugar is also called coconut palm sugar produced from the sap of the flower bud stem of the coconut palm. Coconut sap (neera) is traditionally tapped from the coconut tree in an organized manner, and consumed largely by the rural population. It is reported to be highly nutritive and a good digestive agent[1]. Coconut sugar is prepared by boiling the already strained fresh sap in a casting iron wok at 105°C for about 3 hours or until the syrup reaches about 65° Brix and cooled down by continuous stirring to get a granulated coconut sugar[2]. Consumers often try to replace refined sugars with alternative sweeteners such as coconut blossom sugar, because of an increased interest in healthy diets and the negative public attention focused on high sugar consumption. The sugar contains little fructose and has a lower glycemic index than conventional refined cane or beet sugar[3]. American Diabetes Association (ADA) stated that, production of natural sweeteners with low Glycemic

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Index (GI) can be a solution to diabetes problem. As coconut sugar has a GI value of 35 it can be a better source of healthier sugar[4]. Based on the above research, in the present study coconut sugar was developed from fresh coconut sap and value added products were developed with the following objectives.

- To collect and process the coconut sugar from coconut sap.
- To analyze the phytochemicals, physico-chemical and nutrient analysis of coconut sugar.
- To estimate the in vitro antioxidant activity of coconut sugar.
- To evaluate the acceptability of coconut sugar added beverages.

2. Materials and Methods

2.1 Collection of Coconut Sap

Fresh coconut sap was collected from the coconut plantation in the area of Anumanpalli, Erode Dt., Tamil Nadu. The fresh samples were taken at random in the early morning tappings in a container without addition of preservative. As soon as the collected fresh sap was brought down, it was filtered using filter cloth and approximately 200 ml was filled in a sterilized bottle, transported in a cool box and before analysis, the samples were stored in refrigerator at about 4°C[5].

2.2 Processing and Preparation of Coconut Sugar

The transformation of sap into coconut sugar was carried out by open heat method. The filtered sap was boiled at the temperature of 100°C-110°C for 3 hours until the sap becomes a thick liquid. A few drops of cooking oil were added to the mash to prevent excessive foam formation. The sap has to be stirred continuously and in simmered flame. The pan was then removed from the fire on to a wooden table; cooled slowly for 10 minutes by slow continuous stirring. To make granulated sugar, the stirring has to be done slowly first and more intensely after the crystals start to form. Towards the end of this processing, there was simultaneous crystallization throughout the entire contents, giving rise to regular shaped small crystals. Sugar is cooled down at room temperature and then packed in plastic bags in packs of 1/2-1 kg, depending on the market needs[6].

2.3 Analysis of Parameters

The physicochemical parameters like moisture content, ash content, yield and sugar components such as glucose, fructose and sucrose was analyzed in coconut sugar using standard procedures. The qualitative analysis of phytochemical was carried out in the aqueous extract of coconut sugar using standard procedures.

The nutrients like protein, iron, calcium, phosphorous, vitamin C and magnesium were estimated in the coconut sugar using standard method.

The *in vitro* antioxidant activity such as DPPH radical scavenging activity, Superoxide radical scavenging activity and Hydrogen peroxide radical scavenging activity of aqueous extract of coconut sugar was studied.

2.4 Organoleptic Evaluation of Coconut Sugar

The organoleptic evaluation of coconut sugar added beverages was compared with cane sugar. The beverages such as black tea, black coffee, milk tea, milk coffee and milk were prepared to show their acceptance. Among all the beverages the overall acceptability of appearance, taste, flavor and color were tested and the results obtained were statistically analyzed.

3. Results and Discussion

3.1 Proximate Composition of Coconut Sugar

The physico chemical properties of coconut sugar were given in Table 1.

Table 1. Physico-chemical properties of coconut sugar

Sl. No.	Physico-Chemical Properties	Values (%)
1.	Moisture content	1.3
2.	Ash content	1.25
3.	Fructose	14.15
4.	Sucrose	49.41
5.	Glucose	15.60

Table 1, it is revealed that the physico-chemical properties such as moisture content and ash content of coconut sugar obtained by traditional method are 1.3 and 1.25 percent respectively. Among the sugar components of coconut sugar, the sucrose content of coconut sugar produced from fresh coconut sap was higher (49.41%) than fructose (14.15%) and glucose (15.60%).

3.2 Phytochemical Screening of Coconut Sugar

The preliminary phytochemical screening was extended to identify the presence of phytochemicals in aqueous extract of coconut sugar. It was revealed that the phytochemical compounds such as alkaloids, phenols, steroids and phytosterols were present in aqueous extract of coconut sugar whereas the flavonoids and tannins were absent.

3.3 Nutrient Content of Coconut Sugar

The estimation of nutrient content of crystalline coconut sugar obtained by traditional method was found to contain protein (0.80g), ascorbic acid (42.5g), iron (5mg), phosphorous (54.7mg), magnesium (23.13mg) and calcium (5.6mg).

3.4 Invitro Antioxidant Scavenging Activity of Coconut Sugar

The *in vitro* antioxidant scavenging activity of coconut sugar was carried out and the results are given in Table 2.

The *in vitro* antioxidant activity of coconut sugar was carried out by three different methods. The calculated inhibition concentrations for DPPH scavenging activity of coconut sugar compared to the standard ascorbic acid for the concentrations ranging from 50 and 100 µg/mL. The results revealed that the percentage inhibition of ascorbic acid was found to be 55.3 and 72.48 percent at 50 and 100 µg/mL concentrations respectively and the sugar extract inhibition concentrations was more potent than the standard.

The superoxide radical scavenging activity of aqueous extract of coconut sugar showed a percentage inhibition of 42.3 and 60.02 percent whereas the percentage inhibition of ascorbic acid was found to be 58.5 and 80.2 percent at the concentration of 50 and 100µg/mL respectively. Hydrogen peroxide scavenging activity of aqueous extract of coconut sugar showed a percentage inhibition of 38.5 and 58.2 percent whereas the percentage inhibition of ascorbic acid was found to be 52.0 and 78.3 percent at the concentration of 50 and 100 µg/mL respectively. The observations revealed that the aqueous extract of coconut sugar shows a strong antioxidant activity.

3.5 Organoleptic Evaluvation of Coconut Sugar Added Beverages

3.5.1 Mean Scores for Organoleptic Evaluation of Cane Sugar Replaced with Coconut Sugar Added Black Tea

From the results, it was noted that the mean difference of appearance, color, flavor, taste and overall acceptability

Table 2. Antioxidant scavenging activity of coconut sugar

Concentration of sample (µg/ml)	% of inhibition					
	DPPH scavenging Activity		SOS scavenging activity		H_2O_2 scavenging activity	
	Standard –Ascorbic acid	Aqueous extract	Standard – Ascorbic acid	Aqueous extract	Standard –Ascorbic acid	Aqueous extract
50	55.3	51.5	58.5	42.3	52.0	38.5
100	72.48	68.3	80.2	60.02	78.3	58.2

Table 3. Two sample difference test for cane sugar replaced with coconut sugar added black tea

Criteria	Degree*	Score	Direction	Number of subjects	Percentage (%)
Appearance	1 2 3 4	0 1 2 3	I E S	5 5 10	25 25 50
Color	1 2 3 4	0 1 2 3	I E S	4 5 11	20 25 55
Flavor	1 2 3 4	0 1 2 3	I E S	4 5 11	20 25 55
Taste	1 2 3 4	0 1 2 3	I E S	3 5 12	15 25 60
Overall acceptability	1 2 3 4	0 1 2 3	I E S	4 5 11	20 25 55

*1 - No difference, 2 - Very slight difference, 3 - Moderate difference, 4 - Large difference, I – Inferior to standard, E – Equal to standard, S – Superior to standard.

of black tea made with coconut sugar showed maximum score than the black tea made with cane sugar. Statistical analysis of "t" value showed that except the appearance and color, the taste and overall acceptability exhibit 1 percent level of significance and the flavor exhibit 5 percent level of significance.

The sensory evaluation of coconut sugar obtained by degree of difference test among different panelist showed that large degree of difference in relation to appearance, color, flavor, taste and overall acceptability is revealed in Table 3. Among them the major results for taste was superior to standard and appearance was inferior to that of standard. In general, the degree of liking for black tea with coconut sugar was higher than the score given to black tea with cane sugar.

3.5.2 Mean Scores for Organoleptic Evaluation of Cane Sugar Replaced with Coconut Sugar Added Milk Tea

From the results, it was noted that the mean difference of appearance, color, flavor, taste and overall acceptability of milk tea made with coconut sugar showed maximum score than the milk tea made with cane sugar. The overall acceptability of coconut sugar was 4.91±0.24 which was superior to that of cane sugar. Statistical analyses of "t" value showed that color, flavor, taste and overall acceptability exhibit 1 percent level of significance and appearance exhibit 5 percent level of significance.

Table 4, the sensory evaluation of coconut sugar obtained by degree of difference test among different

Table 4. Two sample difference test for cane sugar replaced with coconut sugar added milk tea

Criteria	Degree*	Score	Direction	Number of subjects	Percentage (%)
Appearance	1 2 3 4	0 1 2 3	I E S	2 3 15	10 15 75
Color	1 2 3 4	0 1 2 3	I E S	6 5 9	30 25 45
Flavor	1 2 3 4	0 1 2 3	I E S	6 7 7	30 35 35
Taste	1 2 3 4	0 1 2 3	IES	3 4 13	15 20 65
Overall acceptability	1 2 3 4	0 1 2 3	I E S	4 5 11	21 23 55

*1 - No difference, 2 - Very slight difference, 3 - Moderate difference, 4 - Large difference, I – Inferior to standard, E – Equal to standard, S – Superior to standard.

panelist showed that large degree of difference in relation to appearance, color, flavor, taste and overall acceptability. Among them the major results for appearance and taste was superior to standard. In general, the degree of liking for milk tea with coconut sugar was higher than the score given to milk tea with cane sugar.

3.5.3 Mean Scores for Organoleptic Evaluation of Cane Sugar Replaced with Coconut Sugar Added Black Coffee

From the results, it was noted that the mean difference of appearance, color, flavor, taste and overall acceptability of black coffee made with coconut sugar showed maximum score than the black coffee made with cane sugar. The overall acceptability of coconut sugar was 4.93±0.13 which was superior to that of cane sugar. Statistical analyses of "t" value showed that the taste exhibit 1 percent level of significance and overall acceptability exhibit 5 percent level of significance. Appearance, color and flavor showed no significance.

Table 5, the sensory evaluation of coconut sugar added black tea obtained by degree of difference test among different panelist showed large degree of difference in relation to appearance, color, flavor, taste and overall acceptability. Among them the major results for taste is superior to standard and overall acceptability is inferior to that of standard. In general, the degree of liking for

Table 5. Two sample difference test for cane sugar replaced with coconut sugar added black coffee

Criteria	Degree*	Score	Direction	Number of Subjects	Percentage (%)
Appearance	1 2 3 4	0 1 2 3	I E S	7 6 7	35 30 35
Color	1 2 3 4	0 1 2 3	I E S	9 6 5	45 30 25
Flavor	1 2 3 4	0 1 2 3	I E S	8 6 6	40 30 30
Taste	1 2 3 4	0 1 2 3	I E S	6 5 9	30 25 45
SS Overall acceptability	1 2 3 4	0 1 2 3	I E S	7 6 7	37 29 34

*1 - No difference, 2 - Very slight difference, 3 - Moderate difference, 4 - Large difference, I – Inferior to standard, E – Equal to standard, S – Superior to standard.

black coffee with coconut sugar was higher than the score given to black coffee with cane sugar.

3.5.4 Mean Scores for Organoleptic Evaluation of Cane Sugar Replaced with Coconut Sugar Added Milk Coffee

It was noted that the mean difference of appearance, color, flavor, taste and overall acceptability of milk coffee made with coconut sugar showed maximum score than the milk coffee made with cane sugar. The overall acceptability of coconut sugar was 4.95±0.13 which was superior to that of cane sugar. Statistical analysis of "t" value showed that color, taste and overall acceptability exhibit 1 percent level of significance whereas appearance and flavor showed no significance.

Table 6, the sensory evaluation of coconut sugar obtained by degree of difference test among different panelist showed large degree of difference in relation to appearance, color, flavor, taste and overall acceptability. Among them the major results for color and taste was superior to standard. In general, the degree of liking for milk tea with coconut sugar was higher than the score given to milk coffee with cane sugar.

3.5.5 Mean Scores for Organoleptic Evaluation of Cane Sugar Replaced with Coconut Sugar Added Milk

In regard with organoleptic evaluation of cane sugar added milk, the results showed that the mean difference

Table 6. Two sample difference test for cane sugar replaced with coconut sugar added milk coffee

Criteria	Degree*	Score	Direction	Number of subjects	Percentage (%)
Appearance	1 2 3 4	0 1 2 3	I E S	4 4 12	20 20 60
Color	1 2 3 4	0 1 2 3	I E S	2 4 14	10 20 70
Flavor	1 2 3 4	0 1 2 3	I E S	3 4 13	15 20 65
Taste	1 2 3 4	0 1 2 3	I E S	2 3 15	10 15 75
Overall acceptability	1 2 3 4	0 1 2 3	I E S	3 4 13	14 19 67

*1 - No difference, 2 - Very slight difference, 3 - Moderate difference, 4 - Large difference, I – Inferior to standard, E – Equal to standard, S – Superior to standard.

of appearance, color, flavor, taste and overall acceptability of milk made with coconut sugar showed maximum score than the milk made with cane sugar. The overall acceptability of coconut sugar was 4.96±0.12 which was superior to that of cane sugar. Statistical analysis of "t" value showed that color, taste and overall acceptability exhibited 1 percent level of significance. Appearance and flavor exhibited 5 percent level of significance when compared with cane sugar added milk.

Table 7, the sensory evaluation of coconut sugar obtained by degree of difference test among different panelist showed large degree of difference in relation to appearance, color, flavor, taste and overall acceptability. Among them the major results for color, flavor and taste was superior to standard and appearance was inferior to that of standard. In general, the degree of liking for milk with coconut sugar was higher than the score given to milk with cane sugar.

4. Conclusion

From the above results, it has been concluded that the proximate composition of coconut sugar was high in sucrose content than glucose and fructose content. The phytochemical screening of coconut sugar reveals the presence of alkaloids, phenols, steroids and phytosterols in the aqueous extract. The nutritional composition of coconut sugar was low in glycemic index and a rich source of ascorbic acid and other minerals like phosphorous, magnesium, calcium and iron. Ascorbic acid was also

Table 7. Two sample difference test for cane sugar replaced with coconut sugar added milk

Criteria	Degree*	Score	Direction	Number	Percent
Appearance	1 2 3 4	0 1 2 3	I E S	6 5 9	30 25 45
Color	1 2 3 4	0 1 2 3	I E S	4 4 12	20 20 60
Flavor	1 2 3 4	0 1 2 3	I E S	3 4 13	15 20 65
Taste	1 2 3 4	0 1 2 3	I E S	3 4 13	15 20 65
Overall acceptability	1 2 3 4	0 1 2 3	I E S	4 4 12	20 21 59

*1 - No difference, 2 - Very slight difference, 3 - Moderate difference, 4 - Large difference, I – Inferior to standard, E – Equal to standard, S – Superior to standard.

found to be the main contributor to the total antioxidant capacity. In the present study the *in vitro* antioxidant activity of aqueous extract of coconut sugar showed the best DPPH radical scavenging activity followed by hydrogen peroxide and superoxide radical scavenging activity. Organoleptic evaluation of coconut sugar added beverages such as black tea, black coffee, milk tea, milk coffee and milk when compared with cane sugar the appearance, taste, flavor and color was superior to that of cane sugar. Though the coconut sugar is expensive it has low glycemic index and is rich in nutritional value. Hence, coconut sugar could be used as a therapeutic agent for various conditions.

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