Value added products from Neera

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Neera or inflorescence sap of coconut and other sap yielding plants is a healthy nutritious drink. It is the phloem sap collected from the spadix of the coconut plant. As it is rich in sugars, minerals, proteins, vitamins, antioxidants, volatiles etc., if it is left exposed to atmosphere it undergoes both enzymatic and microbial fermentation and become unsuitable for health drink or for value added products. At CPCRI, Kasaragod a simple device is developed to collect unfermented fresh and hygienic neera from coconut tree. The neera so collected can be used either as ready to serve drink or can be used for the preparation of natural coconut honey, jaggary or coconut sugar without the addition of any chemicals. The sequential tapping & nut production (SCTNP) technology i.e., 3/4th of the same spadix is tapped for neera and later it is opened for nut production, will increase the farm income without sacrificing the nut production.

Coconut Sap (Neera)

Coconut sap or neera is one of the important products, is being traditionally tapped from coconut in an un-organized manner and consumed largely by rural population. It is reported to be a good digestive, facilitating clear urination and preventing jaundice. The sap or sugary solution is collected from the inflorescence of coconut. An adult coconut palm produces 12 to 14 inflorescences per year, one inflorescence every month. The inflorescence of coconut is compound spadix where the main axis of peduncle is elongated and branched. The peduncles are pipe like structure through which the sap oozes out from the cut end. In an unopened spadix, the peduncles are closely arranged without much inter-peducle space. From outside, the peduncles are covered by boat shaped woody bracts called as spathe (Fig 1). The coconut spadix is quite large and reaches up to a length of 1 meter.

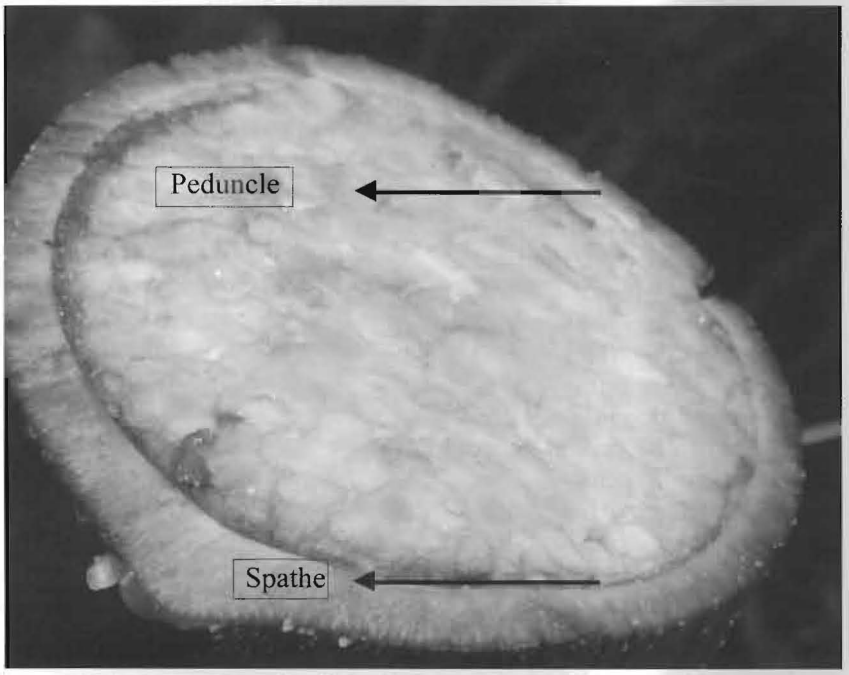

Fig.1 Coconut spadix showing the peduncles and outer spathe

Neera collection

Tapping involves the extraction of exuded sap from the spadix that yields sweet sap. Generally a healthy garden with adequate irrigation facility is chosen for tapping. The spadix is considered ready for tapping when it is 3/4th of its age and is sufficiently grown. The female flowers within the unopened spathe cause swelling at the base and its appearance is an indication of the appropriate stage for tapping.

The spadix to be tapped requires certain preparations before it is being tapped. It is tied with coir/plastic rope from base to 3/4th of tip to prevent it from

Fig. 2 Neera collection methods (a) traditional method and (b) new device developed by CPCRI to collect fresh and hygienic neera

opening. A thin slice is cut off from the top end of the unopened spadix. Daily in the morning and evening the spadix is stroked with a mallet. After 8 to 10 days the sap starts oozing out from the peduncles, which is collected in an open earthen pot/ or bamboo sacs (Fig. 2a).

In coconut the spadix is at an angle of 20° to 45° to the main axis. Hence, the sap oozed from the cut end sometimes flow through the inter-peduncle spaces, the space between peduncles and spathe or drain along the surface of spathe. To avoid this internal seepage, in the traditional method a type of clay soil, a gummy material or leaf extract is pasted on the surface and sides of the cut end. To prevent the movement of sap along the outer surface of spathe, a coconut lamina is tied along the circumference of the cut end through which the sap trickles down to an open earthen pot or bamboo sac. In order to prevent the fermentation, lime is coated from inside the pot. In the above traditional method, in addition to the contamination of sap by chemical and clay, the sap quite often gets contaminated by insects, ants and dust particles and aid in faster fermentation of neera.

In order to collect the sap clean and fresh, a simple device is developed at CPCRI, Kasaragod. It is a hollow pipe of different sizes to fit the inflorescence diameter. One end of it is closed while in the other end groves are made, so as to fit it tightly to the cut side of the inflorescence. The adapter is tightly connected so that there was no inter-peduncle space left and hence there was no seepage of sap as in traditional method. A pipe is connected to the lower side of the connector, while the other end of the pipe is connected to a container. The sap which is oozed out from the cut end of the inflorescence freely flows through the connector to the pipe and into the container. The neera collection container is placed in an ice box with ice, as shown in figure 2b. The whole of this system from the cut end of inflorescence to the neera container is completely closed and hence, free from contaminants. Since, it is kept in cold condition there is no fermentation and hence no coating of lime. Thus, the neera collected is fresh and hygienic and can be used either as ready to serve drink or can be used for the preparation of natural coconut honey, jaggary or coconut sugar without the addition of any chemicals. The device is filed for patenting (2425/Che/2013 dated3/ 6/2013).

Tapping is done twice a day in the morning and evening. Sap yield is highly variable and it varies from day to day, season to season, spadix to spadix and tree to tree. A healthy tree can produce 1.5 to 2.5 litre of sap in a day. Sequential neera & nut production (SCTNP) technology i.e., 3/4th of the same spadix is tapped for neera and later it is opened for nut production, will allow increase in farm income without sacrificing the nut products.

Advantages of the newly developed device

Fresh and hygienic neera is obtained in the morning and evening. The sap can be collected in a fresh and hygienic way. Hence, it is a ready to serve drink and products like sugar, jaggery and honey can be prepared without the addition of lime and other chemicals. Since, all the parts can be separated it is easy to clean.

There is no chance of contamination by insects, ants and dust particles. Moreover, neera contains lot of volatiles hence, it attracts lot of harmful insects of coconut. Since, this device is airtight there is less emission of volatiles. The sap can be preserved in the same way as it is obtained by keeping it in the ice box. The device is not only suitable for the collection of sap from coconut but can also be easily connected to other sap yielding plants. It is a very cheap device and prepared from locally available material. It is easy to handle as compared to the traditional method and hence men and women climbers unskilled in tapping can take it up.

Properties of freshly collected sap

Since, neera is a rich source of nutrients it is highly prone to fermentation both by enzymatic and microbial action. Fresh sap when left exposed to atmosphere undergoes initial lactic acid fermentation, middle alcoholic fermentation and final acetic fermentation consequent on the action of micro organisms. Neera, when it is fresh possesses a tolerable odour which turns harsh on fermentation and makes it unpalatable despite being nutritious. Once fermentation started, the pH of the neera decreases due to the increase in lactic acid and alcohol production. Freshly tapped neera has slight alkaline pH of between 7.0 and 8.0 (Fig.3). The overnight neera collected from the traditional method has a pH of around 4 to 5 while it was 7 to 7.5 in the CPCRI method. The pH has a direct relation with fermentation and sugar content. At pH 8 neera has 12% sugar and it decreases to 4% at pH 4 (Fig.4). On the other hand, the reducing sugar level increases to certain level due to the breakdown of sucrose to glucose and fructose. The neera stored in refrigerator remains fresh and no change in pH is observed.

Biochemical and mineral composition of freshly collected neera (Table 1.)

Biochemical parameters	Range	Average
pH	6.57-7.50	6.98
Total sugar (g)	10.08-14.50	13.18
Reducing sugar (g)	0.439-0.647	0.554
Amino acids	0.123-0.338	0.245
Protein (g)	0.150-0.177	0.165
Sodium (mg)	69.4 – 117.5	90.6
Potassium (mg)	146.1-182.4	168.4
Phosphorus (mg)	2.0-6.4	3.9
Manganese (mg)	0.009-0.014	0.012
Copper (mg)	0.028-0.035	0.031
Zinc (mg)	0.018-0.026	0.020
Iron (mg)	0.049-0.058	0.053

(Source – CPCRI, Kasaragod)

Biochemical constituents

Coconut sap is rich in sugar, minerals and proteins. It is a rich source of ascorbic acid and carbohydrate with sucrose as the major sugar. Coconut sap contains high amounts of essential elements such as N, P, K, Mg and micronutrients (B, Zn, Fe, Cu). The biochemical, minerals and vitamin composition of freshly collected neera is given in Table 1 and 2.

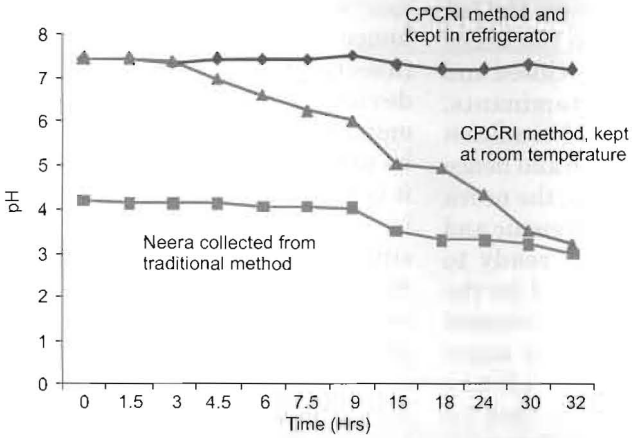

Fig. 3 pH of overnight neera collected either by traditional method or CPCRI method and kept in room temperature or refrigerator

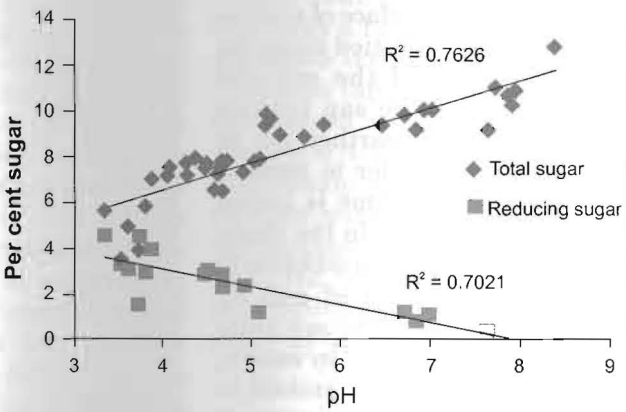

Fig. 4 The relation between the pH and total sugar and reducing sugar content of neera

Vitamin content in freshly collected coconut sap (Table 2.)

Vitamin	Value (mg/dl)
Thiamine	77.00
Riboflavin	12.20
Pyridoxal	38.40
Pantothenic acid	5.20
Nicotinic acid	40.60
Biotin	0.17
Folic acid	0.24
Inositol	127.70
Choline	9.00
Vitamin B12	Trace

Source: Philippine Coconut Authority

Value added products from coconut sap

Coconut sugar

Coconut sap sugar is obtained by boiling freshly harvested neera in moderate heat to evaporate the water at 115 degree Celsius. The scum formed while boiling is removed. When the liquid turns into syrup, it is continuously stirred to avoid burning and to form granulation. At this stage the liquid will change into solid form. When it is cooling, stir and break the lumps. Sieve the sugar to have uniform particle size and to produce quality product.

Coconut sugar is also known as coconut palm sugar, coco sugar or coco sap sugar. It is considered to be one of the best natural sweeteners. It is completely natural coming directly from the inflorescence of coconut and there are no added chemicals. Coconut sugar has been used as a traditional sweetener for thousands of years in the South and South-East Asian regions especially in India, where the coconut palm is in abundant supply. It is truly a perfect and healthier substitute for artificial sweeteners which are toxic to one's health as well as better alternative to other natural sugarcane based sweeteners such as refined white sugar, brown sugar, molasses and others. It is devoid of any anti-nutritional factors if the sap is collected in aseptic condition with specially designed container without adding any artificial chemicals like lime. In order to get sugar with good quality and texture, the pH of the inflorescence sap should be above 7.5.

Coconut Sugar has high mineral content. It is a rich source of potassium, magnesium, zinc and iron (Table 3). In addition to this, it contains all essential amino acids required for protein synthesis, and is rich in B complex Vitamin like B1, B2, B3 and B6. When compared to brown sugar (prepared from sugar cane molasses), coconut sugar has twice the iron, four times the magnesium and over 10 times the amount of zinc.

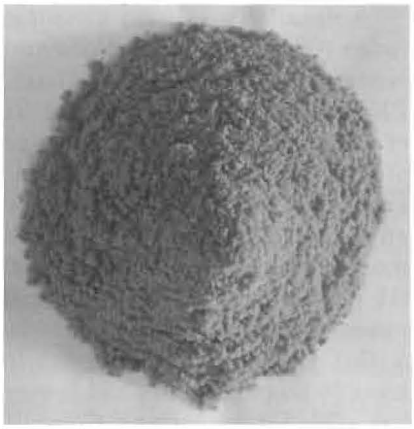

Fig. 5 Natural Coconut sugar

Comparison of mineral nutrients composition of coconut sap sugar with brown sugar and refined cane sugar (Table 3.)

	Coconut Sugar	Brown Sugar	Refined White Sugar
Macro-minerals (mg/100g dry weight)			
Nitrogen (N)	202.0	10.0	0
Phosphorus (P)	79.0	3.0	0.07
Potassium (K)	1,030.0	65.0	2.5
Calcium (Ca)	6.0	24.0	6.0
Magnesium (Mg)	29.0	7.0	1.0
Sodium (Na)	45.0	2.0	1.0
Sulfur (S)*	26.0	13.0	2.0
Micro-minerals			
(µg/100g dry weight)			
Boron (B)*	30	0	0
Zinc (Zn)	2,100	200	120
Manganese (Mn)	130	200	0
Iron (Fe)	2,190	1,260	120
Copper (Cu)	230	60	6

*(Source: CPCRI, Kasaragod & *Philippines Coconut Authority)*

A detailed study on glycemic index (GI) conducted at Food and Nutrition Research Institute, Philippines, revealed that the GI of coconut sugar is in the range of 35 to 54 GI per serving. Other sugars such as refined white sugar, muscovado sugar, and molasses have a range of 65 to 100 GI per serving. Other natural sweetener such as date sugar has a 100 GI per serving, Maple Syrup has 69+ GI per serving and Honey has a 70+ GI per serving. Coconut sugar has a low glycemic index and a low glycemic load. Thus, coconut sugar is a promising sugar for diabetics.

Coconut jaggery

Coconut sap jaggery is a by-product of coconut inflorescence sap with pH 6.5 to 7.0. Fresh sap is slowly boiled and evaporated in small batches. This minimal processing is done without the aid of sophisticated equipment such as vacuum evaporators and does not require any additives or enzymes. The biochemical and mineral composition of coconut jaggery prepared from the sap collected freshly without adding lime and the sap collected with lime is compared with the sugar cane jaggary available in the market (Table 4).

Fig 6. Coconut jaggery

Comparison of biochemicals & mineral constituents in coconut jaggery and sugarcane jaggery (Table 4.)

Biochemical / Minerals	Coconut jaggery from sap adding lime	Coconut jaggery from sap without adding lime	Sugarcane jaggery
Total sugar	84.013±4.2	82.454 ±1.0	84.134 ±0.5
Reducing Sugar	2.809 ±0.04	5.270 ±0.03	12.499 ±1.3
Protein	2.567 ±0.22	2.863 ±0.09	6.537 ±0.4
Na	0.516 ±0.07	0.563 ±0.09	0.373 ±0.1
K	0.913 ±0.02	1.107 ±0.01	0.065 ±0.04
P	0.129 ±0.01	0.077 ±0.003	0.162 ±0.03

Coconut honey

Coconut sap honey is a by-product of coconut inflorescence sap with pH 6.0 to 6.5. The preparation of honey is same as jaggery preparation and care must be taken to avoid prolonged heating which leads to charring and change in colour.

Economic analysis

The economic analysis accounted for the cost of fixed assets, variable assets, returns by selling ready to serve neera as health drink or as a value added product sugar per 100 coconut trees for month is estimated (Table 5). The additional benefit of nut production by following the sequential tapping method is not taken into account.

Cost: Some of the costs variables involved for the economic analysis include:

Cost of tapping devices like sharp edged knife, mallet, collection device including the ice box, transportation cost, refrigerated shelves for the sale of fresh neera are considered. For the preparation of sugar fuel and utensil cost is taken into account. A person can tap 20 medium height tree per one day. An additional labour is required for the preparation of sugar. A temporary shed is also required for the preparation of sugar.

Fig. 7 Coconut honey

Revenue for this analysis was based upon a return to the entrepreneur, Rs 15/200 ml neera or Rs 500/kg of sugar produced. The recovery of sugar from fresh neera is 15%. From the Table it is clear that even after paying rupees one lakh to coconut growers per 100 tree per month the entrepreneur can earn rupees 1.75 lakh and rupees 1.6 lakh by selling neera and sugar respectively per month at the present market rate. The net profit ratio is 39 and 36% for neera and sugar sales respectively.

Expected initial income of coconut sap products (per 100 trees/month) (Table. 5)

Particulars	Fresh sap	Coconut sugar
Estimated sap harvest from 100 trees/ day (@2litre/tree)	200 lit	200 lit
% recovery	100%	15%
Production/100 trees/month	6000 litre	900 kg
Suggested selling price	@Rs. 15/200 ml	@Rs. 500/Kg
Gross income	4,50,000/-	Rs. 4,50,000/-
Labour cost Sap collection (5 labour @ Rs. 500/- per day)	75,000/-	90,000/- (1 additional labour for processing)
Orchard hiring cost	1,00,000	1,00,000
Other contingencies (including fuel, electricity, transportation, incidental charges etc)	1,00,000/-	1,00,000/-
Total production cost	2,75,000	2,90,000/-
Net income	1,75,000	1,60,000

Financial Capital

Land & Building : 5 lakhs

Machinery & Equipment : 5 lakhs

(Tapping and collection devices, Ice making machine, refrigerated showcase, climbing device, sugar processing utensils, ice boxes)

FINANCIAL ASPECTS

Particulars	Fresh sap	Coconut sugar
Cost of Production(1)	2,75,000/-	2,90,000/-
Expected Sales(2)	4,50,000	4,50,000/-
Net profit (2) – (1)	1,75,000/-	1,60,000/-
Capital Investment	10,00,000	10,00,000
Net Profit Ratio (excluding capital investment)	39%	36%

Contd. from page 23

database on coconut cultivation by the member farmers. The geographical area under each CPS is mapped through GPS to avoid overlapping of area and duplication of members.

Future plans :

i. Production of branded coconut oil :

The copra produced at the copra dryer installed at Muthalamada is of very good quality . This has made the Producer Company think of going one step further for the leasing out an expeller for the production of good quality coconut oil. The Company is planning to establish an expeller unit of its own and market the oil produced under its own brand name.

ii. Production of Neera and its value added products:

With the Government of Kerala taking a positive decision regarding production of Neera under the auspices of Federations of CPS and Palakkad being a district with good palms ideal for tapping, Palakkad Coconut Producer Company is actively into activities for equipping itself for undertaking production of Neera once the Government gives the green signal. Representatives of the Company have visited the pilot plant established by Department of Horticulture, Karnataka at Thumbe so as to familiarize themselves with the production process, the layout of a plant etc. The Company has also identified existing toddy tappers interested in Neera tapping and is in the process of doing a trial production based at Thumbe.

iii. Solar copra dryers, godowns and defibring units at Federation level:

In order to facilitate better procurement of coconut and processing of copra, the Producer Company has asked the federations to take measures for installing Federation level collections centres and solar dryers of 5000 nuts/batch capacity. Establishment of defibring units is also planned attached to the collection centres. This will enable proper utilization of the bye products too thereby realising additional income to the farmers.

iv. Tender coconut processing and packing units :

Palakkad is an area where coconuts have very good water content. Establishment of a tender coconut packing unit under the auspices of the Company is also on the agenda of the developmental activities of the Company.

"Agriculture not only gives riches to a nation, but the only riches she can call her own". This was told by Samuel Johnson. Yes, there is no going away from agriculture if any country wants to sustain.