

**ON-FARM PRODUCTION AND PROCESSING OF SELECTED
COCONUT SAP-BASED NATURAL AND NUTRITIOUS
FOOD PRODUCTS FROM SCTNP SCHEME**

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Abstract

The processing of coconut sap produced from the sequential coconut toddy and nut production (SCTNP) scheme was conducted at the Philippine Coconut Authority - Zamboanga Research Center, San Ramon, Zamboanga City from 1997 and 1999-2001 to determine their acceptability to local community members and evaluate their economic profitability.

The processing of coconut sap into food products such as fresh sap beverage, coconut syrup, sugar and vinegar involves simple procedures at the farmer's level. These sap-based food products proved to be highly acceptable in terms of their nutritional and economic values. They are rich in total solids, sugar (sucrose), protein, carbohydrates, phosphorus and amino acids. Coconut-sap sugar contains high amounts of essential elements such as N, P, K, Mg, Cl and S and micronutrients (B, Zn, Fe, Cu) compared to brown cane sugar and refined white sugar(almost without micronutrient). The production of sap beverage, syrup and vinegar showed higher farmer's net income (PhP14,800 - 9,100/month) and return on investment-ROI (465%-380%) compared to sugar making (PhP 5,900/month, 278% ROI).

On-farm production and processing of coconut sap-based food products have both social and economic advantages. This technology offers bigger opportunity for farmers to increase their income and generate employment especially to family members. Likewise, this product diversification scheme can promote multi-uses and competitiveness of the coconut palm.

Keywords: Coconut sap, processing, sap-based food products, diversification

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1. INTRODUCTION

The coconut tree popularly known as the 'tree of life' is characteristically a food supplier from its fruit, inflorescence and other edible parts throughout the year. The inflorescence of this palm is a source of many food products, its unopened spathe can be tapped to produce sap for coconut beverage, vinegar, syrup or 'honey', sugar and even wine while its fertilized flowers or fruit can produce coconut meat, milk, cream oil, water, flour, desiccated coconut, chips and nata de coco.

The coconut sap, tapped from unopened inflorescence or spathe can be produced from coconut full toddy scheme or from a production technology known 'Sequential coconut toddy and nut production (SCTNP) scheme (Maravilla and Magat, 1991). The technology provides early income (from coconut sap) to coconut farmers before the copra can be obtained, while the inflorescence is still close and female flowers are still developing. This scheme has been successfully done in 'Laguna' tall and Malayan yellow dwarf x West African tall ('MAWA') hybrid coconuts and proved feasible and profitable (Maravilla and Magat, 1993). Likewise, its application has been proven more profitable in local hybrids such as Catigan dwarf x Laguna tall (CATD x LAGT), Malayan red dwarf x Baybay tall (MRD x BAYT) and MRD x Tagnanan tall (Secretaria et al., 2001; 2002).

The conversion of coconut into copra is the most popular on-farm processing activity in local coconut-growing communities in the country. While it is possible to produce diverse products from coconut, our coconut farmers, in general have not adopted the other known processing technologies at the farmer's level. The coconut sap as an important coconut product could be processed into diverse natural food products using simple and easy procedures. In countries (e.g. Thailand, Indonesia and India) where coconut sugar production is already developed, production and marketing are well organized in the cooperative sector (Thampan, 1996). Thus, it is feasible for small coconut farmers to undertake the required processing right at their fields. Diversification of coconut products is very beneficial to local coconut farmers as it will increase farm productivity and income of coconut farmers and workers.

This paper presents the simple processing procedures of coconut sap-based food products such as coconut sap drink (beverage), syrup ('honey' or nectar), sugar and vinegar and its acceptability to consumers in the local community. This was a component of the completed project entitled 'Varietal response of various coconut hybrids and cultivars to sequential coconut toddy and nut production (SCTNP) scheme' conducted at the PCA-Zamboanga Research Center, Zamboanga City from April-December 1997 (phase 1) and April, 1999 to September 2001 (phase 2). It also aims to determine the economic profitability of the produced sap-based food-products.

2. MATERIAL AND METHODS

2.1 *Tapping and harvesting of coconut sap*

Coconut sap was tapped from coconut trees from three local dwarf x tall hybrids Catigan dwarf x Laguna tall – CATD x LAGT, Malayan red dwarf x Tagnanan tall – MRD x TAGT, Malayan red dwarf x Baybay tall –MRD x BAYT) and one tall cultivar (LAGT) using the sequential coconut toddy and nut production (SCTNP) scheme (Fig. 1) as described in Maravilla and Magat (1993) in contrast to the traditional full toddy tapping scheme (Fig 2). In both schemes, harvesting of coconut sap/toddy could be done twice a day:

- a) Morning (before 8 A.M.) for the production of 'tuba' or vinegar;
- b) b) Afternoon (not later than 3 P.M.) - toddy produced is sweeter than that of the morning, thus is used for fresh sap drink and syrup/sugar making.

2.2 *Processing of coconut sap food products*

As coconut sap is highly perishable due to the yeast microflora, the harvested sap (filtered thru netted cloth) and intended for beverage, syrup and sugar should be processed by boiling for ½ hour in a large cast iron pan (Levang, 1988). This process prevents the sap from fermentation.

All tools and containers should be clean at all times. A little amount of lime (CaO) was added to the receptacle to prevent the sap from

fermentation. The materials and equipment needed for processing of coconut sap by-products were :

- Materials: large or medium size iron cast pan, wide large plastic container, netted cloth, 350 ml plastic cups or bottles, glass bottles with cover or seal, plastic packaging material, plastic sealing material, wooden utensil (spatula), wood or charcoal fuel.
- Equipment: Cooking furnace, refrigerator, plastic sealer machine (optional)

The procedures for processing coco sap by-products were as follows:

1. Fresh sap drink (Fig. 3)

- Boil fresh harvested sap for 1/2 hour in a large iron pan.
- Allow the boiled sap to cool, then pour separately in desired container (usually 350 ml. plastic cups or bottles), seal tightly and place in a refrigerator (freezer). If hygienically prepared, the sap drink could be stored until three (3) days without deterioration .

2. Coconut sap vinegar (Fig. 4)

- Pour freshly harvested sap in a wide large plastic container with netted cloth to allow aeration, prevent entrance of dirt and foreign objects.
- After 10-14 days fermentation in a well ventilated room, the sap is transformed to a new product, natural sap vinegar.
- The vinegar is pasteurized by heating for 5-10 minutes at 60-65⁰C to maintain the desired quality of vinegar (with at least 4% acidity).
- Allow the vinegar to cool before placing in very clean bottles with tight sealed cover.

3. Coconut syrup (nectar or 'honey') - Fig. 5

- Boil freshly harvested sap for ½ hour in a large iron pan.
- Continue boiling of sap until it reaches 110⁰C temperature or sticky under a moderate to very low heat (color of sap changes to yellow orange).

- Allow the coconut syrup (honey-like and sticky liquid) to cool, then pour into a desired container.

4.a Coconut sugar (small volume of coconut sap - 4 l) - Fig. 6

- Boil freshly harvested sap for ½ hour in a large iron pan.
- Continue boiling of coconut sap to evaporate the water under moderate heat with occasional stirring until the liquid thickens at 115⁰C.
- Remove the pan with boiling sap from the flame when it becomes sticky.
- Continue mixing the sap until it becomes granular.
- Air-dry the coconut sugar (pale brown, sweet with distinct coconut aroma) before placing them in plastic packaging material. Seal tightly using a plastic sealer machine (if available) or with a cellophane tape.

4.b Coconut sugar (big volume of coco sap [30 liters] -Fig. 7) based on Naka (1996)

- Pour the afternoon collected sap into a dry-clean large iron pan and immediately boil.
- During evaporation, stirring has to be done occasionally. Discard the foam formed in the surface as it would impart a burnt smell on the liquid.
- When excessive foam is formed, place an open-end bamboo basket in the pan so the sap will not spill out from it. Continue cooking at medium fire until a thick liquid is formed. When foaming subsides, remove the open-end basket from the pan.
- When the temperature of the liquid reaches 115⁰C, maintain the temperature of the liquid at medium fire for about 30 minutes to 1 hour until it became very sticky. Then, remove the pan from the fire. A iron plunger is used to introduce more air to the liquid so that granulation would take place.
- When mixture assumes a solid form, continue stirring of the mixture using a wooden spatula. Stirring should be more

vigorous until mixture will break into small granules. Cool the mixture.

- Transfer the granulated sugar into a flat surface pan to break the granules into smaller size using a wooden spatula. Air dry sugar at room temperature. When dry, it is now ready for packing using plastic packaging material, sealed with cellophane tape or by plastic sealer machine (if available).

An acceptability test of the sap-based food products was conducted with ZRC employees (male & female) and some members of the ZRC Housing Compound San Ramon, Zamboanga City as respondents (12 persons per food product).

3. RESULTS AND DISCUSSION

3.1 Acceptability test of sap-based food products

Some significant results of the acceptability or organoleptic test of the coconut sap-based food products revealed that:

- Coconut sap vinegar produced was highly acceptable, comparable or even better in acid taste than the other commercial brands of vinegar.
- Fresh sap drink was acceptable to male respondents as well as to female ones but should be taken in smaller amounts only. Like buko juice, fresh sap drink has a high potential in the market especially with the present trend of utilizing natural drinks.
- Coconut syrup ('honey') initially produced (with sour taste) for the production of sugar

during the first phase of the project was further tested in the 2nd phase following the procedure indicated in the Techno Guide Sheet No. 8. To date, a better quality and acceptable coconut syrup and sugar have been produced from the SCTNP-produced coconut sap.

Based on the results of the acceptability test, it showed that coconut sap can be an alternative source of sugar/syrup and beverage and vinegar. The production of these cocosap-based food products shows their high potential for multi-uses as natural healthy and exotic drinks, use in jam

jellies, marmalades and confectionaries (Masa, 2001).

Among these food products, coconut sugar shows higher potential for economic gains. Although labor intensive and time consuming, the coconut sugar industry (from cocosap) is highly profitable compared to nut/copra production (115% in terms of farmer's gross income based on Thailand experience (Naka, 1996). Unlike in our country where coconut sugar industry is not yet developed, coconut sugar is already an export commodity in Thailand, (Naka, 1996) and commonly produced in coconut-growing communities in Indonesia and India (Thampan, 1996).

3.2 Nutritional value of the sap-based food products

As people are now becoming health conscious and are inclined towards consuming natural products instead of synthetic ones, the processing of cocosap-based food products provides for nutritious natural food products as freshly gathered coconut sap has high total sugar, calories, carbohydrates, ascorbic acid, phosphorus, (Naka, 1996 - Table 1) rich in amino acids (Kosaki and Sanchez, 1974 -Table 2) Coconut sap contains 17.5% total solids, 0.40% ash and 16% sucrose (Gibbs, 1911).

In fresh coconut sap, sugar is a major component after water, ranging from 16.1-18.99 g/100 ml (Naka, 1996). It is composed only of sucrose. Gibbs (1911) reported that the sucrose content of coconut sap is comparable with that of sugar cane, sugar beet, nipa (*Nipa fructicans*, Wurmb), buri (*Croypha slate*, Roxb) and kaong (*Arenga saccharifers*, Labill).

3.3 Chemical and physical analyses of sap-based food products

The chemical and physical analysis conducted by the Department of Science and Technology-Region XI, Zamboanga City on the coconut sap and sap-based food products revealed that the fresh coco sap contains more sucrose than the cocosap-based products (Table 3). However, cocosap-based food products contain more % total solids, reducing sugars, crude protein and ash indicating that these food products are nutritious and healthy, thus are good for our body. The coconut-sap sugar as compared to brown cane

sugar and refined sugar contains higher amounts of nitrogen (N), phosphorus (P) potassium (K), chlorine (Cl), magnesium (Mg), sulfur (S) and micronutrients (boron-B, zinc-Zn, iron-Fe, copper-Cu) than either brown cane sugar or refined white sugar (almost without micronutrient) as reflected in the chemical analysis done by the PCA Plant Tissue Analysis Laboratory (Magat, 2002-Table 4).

3.4 Cost and return analysis of sap-based food products

A simple cost and return analysis on a monthly basis of cocosap and its food by-products shows higher net income (PhP 9,100 - 14,800/month) and return on investment (ROI) on the production of vinegar, syrup and sap beverage with 388%, 380% and 465%, respectively, compared sugar (Table. 5). Although the return on investment of selling fresh sap product without processing is just the same as that of vinegar and syrup, it is still advisable to process sap-based food products since these food products could be used for cooking, desserts and curries and some as raw material (syrup and sugar) for food industries e.g. confectionery. Hence, high value food products should be produced for the promotion of multi-uses and competitive-ness of the coconut palm. The technology offers bigger opportunity for coconut farmers for increased farm income and generation of employment to family members (processors) and farm workers (tappers).

4. SUMMARY AND CONCLUSION

The processing of coconut sap for the production of natural and nutritious sap-based food products involves very simple procedures. Since the procedures for processing can be done at farmers' level, the technology could provide employment opportunities to family members especially to women members.

The food products produced were highly acceptable to the local community members in terms of its nutritional value. These products are rich in nutrients needed by our body such as sugar, protein, carbohydrates, amino acids. Coconut sugar has higher amounts essential elements i.e. N, P, K, Cl, Mg, S than brown cane sugar and refined white sugar. Furthermore, processing of sap-based food products could provide for additional income to the farmers as more coconut

products are produced and marketed. Higher farmer's net income (PhP14,800 – 9,100/month) and return on investment-ROI (465-380%) can be obtained from the processing of sap beverage, syrup and vinegar than sugar (PhP 5,900/month and 278% ROI).

5. IMPLICATION AND RECOMMENDATION

Realizing the significant social and economic benefits that can be derived from this sap-based food processing technology, it is therefore recommended that farmers should be encouraged to diversify their production to natural, high value and nutritious food products (beverage, syrup, sugar and vinegar) from coconut sap/toddy in additional to nut/copra based, fresh nut-based, shell-based, coir –based high value products. However, there should be available market for toddy and its by-products for this product diversification scheme to prosper. In this way, the promotion of multi-uses and competitiveness of coconut palm as the 'tree of life' will be achieved.

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Fig 1. Sequential coconut toddy and nut production (SCTNP) scheme



Fig. 4. Coconut vinegar



Fig. 3. Fresh sap drink (beverage)



Fig. 2. Full coconut toddy tapping scheme



Fig. 5. Coconut syrup



Fig. 6 Coconut sugar (small volume 4 li)

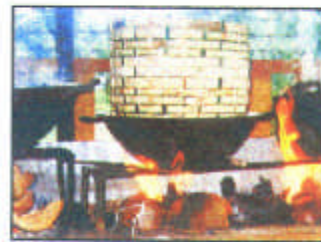
Fig. 7. Processing of coconut sap (big volume - 30 li) into sugar



Boil sap immediately



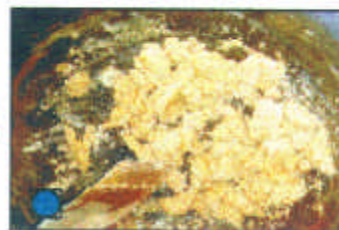
Discard formed foam



Place an open-end basket when excessive foam is produced



Break granules into smaller size



Vigorous stirring until mixture breaks into smaller granules



Use an iron plunger to introduce more air

Table 1. Average chemical composition and nutritional value of coconut sap (Naka, 1996)

Property	Value (per 100 g or ml)
pH	5.75
Total sugar (%) mainly sucrose	18.09 gm
Water	87.5 ml
Calories	48.0 joule
Carbohydrate	11.4 g
Protein	0.22 g
Fat	0.40 g
Ca	0.40 mg
Phosphorus	20.0 mg
Iron	0.18 mg
Thiamine	0.016 mg
Riboflavin	0.006 mg
Niacin	0.48 mg
Ascorbic Acid	20.6 mg

Table 2. Amino acid content of freshly-gathered coconut sap (Kozaki & Sanchez (1974))

Amino acid	Value (g/100g)
Tryptophan	1.27
Lysine	0.32
Histidine	1.19
Arginine	0.35
Aspartic acid	11.22
Threonine	15.36
Serine	8.24
Glutamic acid	34.20
Proline	3.52
Glycine	0.47
Alanine	2.56
Isoleucine	0.38
Leucine	0.48
Tyrosine	0.31
Phenylalanine	0.78

Table 3. Chemical and physical analysis¹(%) of coconut sap and sap-based food products at PCA-ZRC, Zamboanga City, January 2000

Product	Total solids	Sucrose	Red. sugar	Protein	Ash	pH	Acidity
Fresh sap	12.1	0.66	2.00	0.30	0.52	3.61	0.94
Vinegar	5.4	-	-	0.12	0.46	3.11	2.31
Syrup	79.5	-	7.88	1.28	1.97	5.43	-
Sugar	98.3		13.50	1.78	2.37	5.40	-

¹ *Conducted by the Department of Science & Technology, Region IX, Zamboanga City*

Table 4. Elemental content (ppm/mg/li) of three sources of edible sugar¹

Element/nutrient	Coco-sap sugar (Produced at ZRC)	Brown cane sugar	Refined white sugar
N	2,020	100	0
P	790	30	0.7
K	10,300	650	25
Ca	60	240	60
Mg	290	70	10
Na	450	20	10
Cl	4,700	180	100
S	260	130	20
B	6.3	0	0
Zn	21.2	2	1.2
Mn	1.3	2	0
Fe	21.9	12.6	1.2
Cu	2.3	0.6	0.6

¹ *Analyzed by the PCA-Plant Tissue Analysis Laboratory, 11 September 2000, compiled by S.S. Magat (2002)*

**Table 5. SIMPLE COST AND RETURN ANALYSIS OF COCOSAP PRODUCTS, 2001
(from 30 trees per month production)**

	Fresh Sap	Vinegar	Sap Drink	Syrup	Sugar
Estimated harvest (30 trees) - @ 2.0 l/tree ²	60 l ¹	60 l ¹	60 l ¹	60 l ¹	60 l ¹
Recovery (%)	100	80	70	17	15
Production - 30 trees/mo (l)	1,800	1,440	1,260	306	270 kg
Suggested selling price (PhP)	5/l	8 /l	5 /350 ml	10 /200 ml	30/kg
Gross Income (PhP)	9,000	11,520	18,000	15,500	8,100
Material Cost	2,100	2,020	2,410	1,830	455
Processing Cost	-	337.5	775	1,350	1,687.5
Total Cost ³ (PhP)	2,100	2,357.5	3,185	3,180	2,142.5
Net Income (PhP)	6,900	9,162.5	14,815	12,120	5,957.5
Return on investment ⁴ (%)	328	388	465	380	278

¹ Assuming all total sap harvest from 30 trees is used for each food product

² From SCTNP-tapped trees

³ Details of total cost indicated in Annex table 1

⁴ Farmer/tapper uses his harvested coconut sap for processing of food products

Annex Table 1. Details of total cost on processing of coconut sap-based food products

Food Product/Item	No. of unit	Cost/unit (PhP)	Total Cost (PhP)
<i>1. Coconut Vinegar</i>			
Plastic bottles (1 Lt capacity)	1,440 pcs	1.00	1,440
Large plastic container	2 pcs	150	300
Iron pan	1 pc	200	200
Cloth/kitchen utensil	1 pc	50	50
Wooden fuel	3 bundles	30	30
Sub-total			2,020
Labor * (processing –1hr/day)			337.5
Grand Total			2,357.5
<i>2. Coconut fresh sap drink</i>			
Plastic cups with cover	3,600 pcs	30/50pcs	2,160
Wooden fuel	5 bundles	10	50
Iron cast pan	1 pc	200	200
Sub-total			2,410
Electric consumption/mo		100	100
Labor (processing- 2 hrs/day)			675
Grand Total			3,180
<i>3. Coconut syrup</i>			
Glass bottles	1,530	1.00	1,530
Wooden fuel	10 bundles	100	100
Iron cast pan	1 pc	200	200
Sub-total			1,830
Labor (processing – 4 hrs/day)			1,350
Grand Total			3,180
<i>4. Coconut sugar</i>			
Plastic container (6 “x 9”)	300 pcs	15/100pcs	45
Scotch tape	1 pc	20	20
Wooden fuel	15 bundles	10	150
Iron cast pan	1 pc	200	200
Bamboo basket	1 pc	40	40
Sub-total			455
Labor (processing – 5 hrs/day)			1,687.5
Grand Total			2,142.5
<i>5. Fresh sap</i>			
Plastic container (20 Lt capacity)	21 pcs	100	2,100

*at PhP90/m-day