

Research

Evaluation of dietary intake in the Caribbean region of Costa Rica where coconut products have been an essential component of the diet

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ABSTRACT

Unsubstantiated health claims indicating that coconut oil prevents cognitive dysfunction and cardiovascular disease highlight the need for epidemiological research in populations where coconut products are part of the diet. Coconut products have been traditionally consumed in the Caribbean Coast of Costa Rica, but data on its intake is needed to justify whether this region is suitable to evaluate the relationship between coconut products and chronic diseases. We conducted a cross-sectional study to assess dietary intake in 131 randomly selected adults 50 years old and above, living in the county of Limón, Costa Rica. Fieldworkers visited participants in their homes to assess diet and general characteristics using a cultured-specific food frequency questionnaire (Afro-Caribbean FFQ). Prevalence of overweight and obesity was 75% in women and 73% in men and over 70% of participants reported having diabetes, hypertension and/or high cholesterol levels. Overall, the Afro-Caribbean diet included a relatively high proportion of dairy products, fruits, vegetables, and red meat, and a relatively low proportion of legumes, green leafy vegetables, chicken, fish, and whole grains. Thirteen percent of the population reported daily intake of traditional dishes containing coconut products whereas 26% reported their intake 2-6 times per week. The frequency of intake of rice & beans and stew beans was the highest, with 46% and 24% reporting intake of once per week, and 8% and 15% reporting intake of 2-4 times per week, respectively. On average, a portion of these dishes contained about ~ 1.7 g of 8:0+10:0 fatty acids, for a total of ~12 g per week among those reporting intakes of once per day. Thus, exposure to coconut products in the studied population may be appropriate for epidemiological studies to assess the role of coconut and its derived products on cognitive dysfunction. Further studies are needed to validate the dietary assessment tools.

Keywords: coconut oil, coconut milk, coconut products, Afro-Caribbean FFQ, dietary intake in the Afro-Caribbean, Costa Rica, Hispanic

INTRODUCTION

Intake of coconut products such as coconut water and coconut oil has increased dramatically in the United States and Europe in the past few years.⁽¹⁾ Health claims in popular media channels promote intake of coconut oil to prevent and control almost any health problem.⁽²⁾ Coconut oil, composed approximately of 90% saturated fatty acids is relatively high in caprylic 8:0 and capric 10:0 fatty acids.⁽³⁾ It is suggested that these medium chain fatty acids have unique metabolic effects that may improve cognitive function.⁽⁴⁻⁷⁾ However, the evidence to support these claims is scarce and based on small intervention studies in patients at various stages of Alzheimer's disease and animal models.⁽⁸⁾ There are no large intervention trials or epidemiological studies on the role that medium chain fatty acids could play in cognitive dysfunction. Coconut oil has also been recommended to prevent cardiovascular disease (CVD) because it contains a large proportion of lauric acid, 12:0, a fatty acid that decreases the total to HDL cholesterol ratio.⁽⁹⁾ Also, lower rates of heart disease are apparent in populations where

intake of coconut oil is high.^(10,11) Nevertheless, evidence on its potential role in CVD prevention is scarce.⁽¹²⁾ Thus, the role of coconut oil in cognitive dysfunction and cardiovascular disease remains uncertain.

Data on the intake of coconut oil or other coconut products, as well as the use of coconut products in food preparation are scarce. Coconut oil has been traditionally consumed in low and middle-income countries in tropical regions in Asian countries.^(11,13,14) Other studies in populations of Afro-Caribbean descent indicate that coconut products are part of their traditional diet, although data on its intake are unclear.^(15,16) In Costa Rica, the region of Limón is inhabited by an Afro-Caribbean population that arrived from Jamaica at the end of the 19th century for the construction of the Atlantic Railroad and fieldwork at the banana plantations.⁽¹⁷⁾ The essential ingredients of the traditional cuisine of this population have been coconut fruit and its main by-products, coconut milk and coconut oil.⁽¹⁸⁻²⁰⁾ However, whether these foods are commonly used today is unknown.

Given the potential role that coconut products could have in the prevention of cognitive dysfunction and cardiovascular disease, it is important to identify suitable populations for the conduct of epidemiological studies. We examined the diet of the Afro-Caribbean population living in Limón Costa Rica to determine intake of coconut products in the context of the overall diet. If exposure to coconut products is adequate, this population of Costa Rica would be ideal for the conduct of a longitudinal study to examine whether medium chain fatty acids could prevent cognitive dysfunction and/ or cardiovascular disease. Costa Rica is a politically stable country with no army, it has a centralized health care system where all the population has access to health care regardless of income, and the population is highly educated and generally willing to collaborate.^(21,22) Furthermore, the Costa Rica Heart Study (CRHS), a large population-based study on diet and heart disease has already laid the ground for future studies if the desired exposure to the nutrients of interest are obtained.^(23,24)

METHODS

Study participants

Study participants were both women and men 50 years old and above, living in different neighborhoods from the central county of Limón, Costa Rica. Subjects were randomly chosen from areas with high probability of finding eligible subjects according to the 2011 census. A total of 14 neighborhoods were visited for data collection. As shown on Figure 1, the participants represented a diverse set of communities including: Limón city center, Hospital, Trinidad, Bohío, Cieneguita, Jamaica Town, Corales 1, Corales 2, Cerro Mocho, Pueblo Nuevo, Colina, Limoncito, Villas del Mar and Santa Eduvigis.

Data collection

Fieldworkers visited the participants' homes for data collection. Data collected included age, sex, region of residence, marital status, education, occupation, smoking and health and lifestyle characteristics. Dietary intake was assessed using a food frequency questionnaire (FFQ).⁽²⁵⁾ The FFQ was specifically developed for the Afro-Caribbean population by adapting a validated FFQ previously used in CRHS.⁽²⁶⁾ Height and weight were also measured using a Seca 213 stadiometer and a Seca 813 scale respectively. Body mass index (BMI) was calculated as kg/m² where kg corresponded to the subject's weight in kilograms and m² to the subject height in meters squared. In order to estimate the nutrient composition of traditional dishes including medium chain fatty acids,

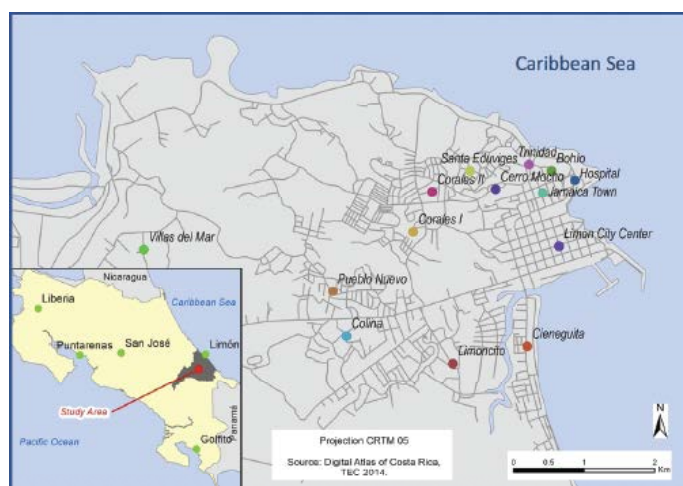


Figure 1. Map of Limón showing the neighborhoods included in the study

the recipes of the four most commonly consumed traditional dishes containing coconut products (rondón, rice & beans, rice with coconut, and stew beans) were collected. The USDA nutrient composition database was used for nutrient analyses.⁽²⁷⁾ The average intake of the medium chain fatty acids 8:0 and 10:0 was estimated according to the reported frequency of intake of traditional dishes.

All fieldworkers were trained and standardized before data collection. Training included basic information on the research project, nutrition survey methodology, and fieldwork theory. Interviewers were instructed on specific procedures for data collection and anthropometric measurements. All fieldworkers performed practice sessions on the measurements of height and weight as well as the application of the questionnaires, including introductory dialogues (before and during the application of the questionnaire) as well, handling and coding of ambiguous responses. All participants were assured anonymity and signed an informed consent as stated in the Declaration of Helsinki.⁽²⁸⁾ The names and contact information from the participants were not collected on the questionnaires.

Data analysis

A total of 131 (48 men and 83 women) out of 198 contacted (66%) accepted to participate in the study. The Afro-Caribbean FFQ was not completed in 2 participants and anthropometric measurements could not be obtained from 25 participants. Data collected were downloaded into the Statistical Analysis Software (SAS) for data cleaning and descriptive analyses. The 81 food items from the Afro-Caribbean FFQ were grouped into the following categories: Dairy (6 items), Fruits (10 items), Vegetables, starchy vegetables and seeds (19 items), Meats (11 items), Cereals (11 items), Beverages (11 items), Sweets (10 items) and Coconut products and dishes (13 items). The nine intake frequencies in the FFQ were merged into five groups (<1/wk, 1/wk, 2-6/wk, 1/day and 2+/day). The average \pm SD and frequencies for variables included in the sociodemographic and health questionnaire as well as anthropometric data were estimated for continuous and categorical variables respectively.

RESULTS

Table 1 shows the socio-demographic characteristics of study participants. The mean age was 70 for women and 66 for men. Most of the participants finished primary school. Most men reported being retired while most women reported being homemakers. Table 2 shows the health characteristics of study participants. The prevalence of overweight and obesity was 23% and 52%, respectively in women and 43% and 30% respectively in men. Nine percent of women and 6% of men reported being current smokers, while 22% of women and 38% of men reported being past smokers. Most of the population manifested the presence of at least one chronic disease. The prevalence of diabetes, hypertension and high cholesterol were 28%, 63%, and 34% respectively in women, and 29%, 56%, and 31% respectively in men.

The frequency of intake by food groups is shown in Table 3. The most frequently consumed foods were high-fat dairy products, tropical fruits, vegetables, red meats, and refined grains and cereals. Daily intake of legumes was reported by 39% of participants. Daily intake of red meat was reported by 44% of participants compared to 17% and 10% for daily intake of chicken and fish, respectively. Water was the most frequently consumed beverage with 77% reporting intake of 2 or more glasses per day. Commercial sugar sweetened beverages were consumed at least once daily by 25% of participants, and 22% reported intake of 2-6 times per week.

Table 1. Socio-demographic characteristics of men and women 50 years old and above living in the county of Limón, Costa Rica.

	Women	Men
Variable n (%)	N= 83	N= 48
Age, yr (mean ± SD)	70 ± 10	66 ± 10
Education level n (%)		
Primary	31 (37%)	22 (46%)
High school	25 (30%)	15 (31%)
University	20 (24%)	7 (15%)
Occupation n (%)		
Retired	26 (31%)	23 (48%)
Homemaker	42 (51%)	0 (0%)
Health professionals, lawyers and teachers	2 (2%)	4 (8%)
Other: artists, artisans, workers, traders, laborers, personal services, drivers.	10 (12%)	20 (42%)

N=131

Table 2. Health characteristics of men and women 50 years old and above living in the county of Limón, Costa Rica.

	Women	Men
Variable n (%)	N= 83	N= 48
Body mass index, kg/m² (mean ± SD)*	31.1 ± 8	30.9 ± 9
Overweight†	16 (23%)	16 (43%)
Obesity‡	32 (52%)	11 (30%)
Smoking (≥ 1/day)		
Current	7 (9%)	3 (6%)
Past	18 (22%)	18 (38%)
Health history n (%)		
Diabetes	23 (28%)	14 (29%)
Hypertension	52 (63%)	27 (56%)
High cholesterol	28 (34%)	15 (31%)

*N=69 women and 37 men

†BMI >24.9 Kg/m² among adults < 65 years old and BMI >27.9 Kg/m² among adults ≥ 65 years old.

‡BMI >29.9 kg/m² among adults < 65 years old and BMI >30 Kg/m² among adults ≥ 65 years old.

Table 4 shows intake of foods and dishes containing coconut products. Almost none of the participants reported intake of individual traditional dishes five or more times per week. The frequency of intake of rice & beans and stew beans was the highest, with 46% and 24% reporting intake of once per week, and 8% and 15% reporting intake of 2-4 times per week, respectively. **Figure 2** shows the frequency intake of the sum of traditional dishes with coconut oil and/or coconut milk. Thirteen percent of the participants reported an overall intake of dishes with coconut products once a day, 26% reported 2-6 times per week, and 47% once per week.

Table 5 shows the nutrient composition of a 250 g portion of the most frequently consumed Caribbean dishes. Coconut milk was the most commonly used ingredient, contributing medium chain saturated fatty acids. The saturated fat content ranged between 10.8 g for rice and beans and 17.0 g for rice with coconut. The content of 8:0 + 10:0 fatty acids per portion ranged between 1.51 g for rice and beans and 2.4 g for rice with coconut. The average content of the 8:0 + 10:0 fatty acids was 1.71 g per portion. The estimated intake of 8:0+10:0 fatty acids was ~12 g per week for those with daily intake and ~7 g per week for those reporting intakes between 2 and 6 times per week.

DISCUSSION

We assessed dietary intake in the Afro-Caribbean population living in Limón Costa Rica using a food frequency questionnaire specifically

developed for the studied population.⁽²⁵⁾ Overall, the Afro-Caribbean diet included a relatively high proportion of dairy products, fruits, vegetables, and red meat, and a relatively low proportion of legumes, green leafy vegetables, chicken, fish, and whole grains. Thirteen percent of the population reported daily intake of traditional dishes containing coconut products whereas 26% reported their intake 2-6 times per week. Rice and beans and stew beans were the most frequently consumed traditional dishes. The estimated intake of medium-chain fatty acids 8:0+10:0 was ~12 g per week among those reporting intakes once per day and ~7 g among those reporting intakes 2-6 times per week. Daily intake of coconut water was reported by 11% of participants compared to 25% and 24% reporting daily intake of sugar-sweetened commercial and homemade beverages, respectively.

Studies suggest that medium chain fatty acids, specifically 8:0 and 10:0 have beneficial effects on improved cognition in patients with mild cognitive impairment, or early onset to mild Alzheimer's disease.^(4,5,29) These studies lasted a few weeks and used doses between 10-40 g of medium chain fatty acids in formulations that could not be achieved through diet alone. Interestingly, intake of 20 g of extra virgin coconut oil containing ~ 2.4 g of 8:0+10:0 fatty acids per day for 6 weeks also resulted in significant improvements in cognitive performance among patients with moderate to severe Alzheimer's disease.⁽³⁰⁾ The latter results raise the question of whether long-term exposure to these relatively low intakes of medium chain fatty acids would result in prevention of cognitive dysfunction. Our study showed that 13% of study participants consumed ~ 1.7 g of 8:0+10:0 fatty acids per day, 26% 2-6 times per week and 47% once per week. This intake level is close to that given in the study showing a potential benefit of coconut oil.

Interest in medium-chain fatty acids is attributed to its role as a precursor of ketones that could provide an alternative source of energy to the glucose depleted neurons found in patients with Alzheimer's disease.⁽³¹⁾ Dose-response studies show a high correlation between medium-chain fatty acids, specifically, 8:0 and plasma ketone concentrations, which in turn are strongly associated with cerebral metabolic rate.⁽³²⁾ Supplements providing 20-70 g of 8:0+10:0 fatty acids increase plasma β-hydrobutyrate to ~ 0.5-1.0 mM and are associated with improved cognitive performance.^(4,5) Interestingly, coconut oil intake *per se* significantly improved cognitive function in patients with Alzheimer's disease despite providing substantially lower medium chain fatty acids.⁽³⁰⁾ The levels of plasma ketone bodies observed with approximately 1.5 tablespoons of coconut oil are comparable to levels induced by exercise or low carbohydrate diets 0.3-0.5 mM.⁽³³⁻³⁵⁾ This suggests that coconut oil could also play a role in cognitive dysfunction via alternative mechanisms. For example, medium chain fatty acids could be involved in weight loss via increased fatty acid oxidation.⁽³⁶⁾ Furthermore, studies

Figure 2. Intake frequency of the sum of traditional dishes containing coconut milk and/or coconut oil*.

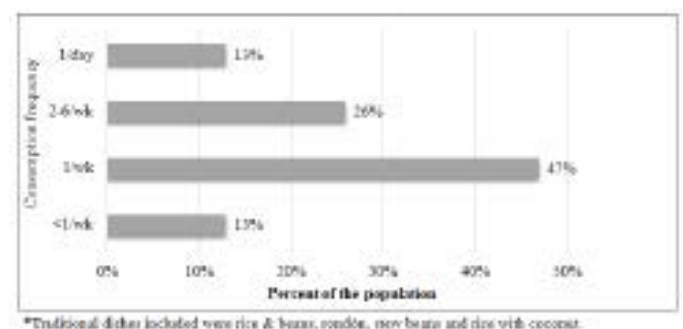


Table 3. Frequency of reported intake of food groups in the county of Limón, Costa Rica.

Food group	Consumption frequency/portions per day				
	<1/wk %	1/wk %	2-6/wk %	1/day %	2+/day %
Dairy					
Low fat dairy (skimmed or semi-skimmed milk, yogurt)	34	19	19	13	14
High fat dairy (whole milk, custard, cheese, butter)	8	11	22	38	22
Fruits					
Tropical fruits (pineapple, banana, papaya, mango, orange)	2	8	23	22	44
Non-tropical fruits (apples, grapes, strawberries).	30	30	15	15	10
Vegetables					
Green leafy vegetables (lettuce, mustard leaves, spinach and other green leafy vegetables).	19	15	35	26	6
Other vegetables (tomato, cucumber, avocado, chayote, squash, carrot, breadfruit).	2	6	8	26	57
Spices (celery, cilantro, sweet pepper)	5	6	5	19	64
Roots, tubers, and starchy fruits and vegetables					
Potato	33	33	29	4	0
Sweet potato, cassava	24	45	22	7	1
Starchy vegetables (pejibaye*, sweet plantain)	9	19	37	30	5
Legumes & nuts					
Legumes (black beans, gungu beans, white beans)	10	24	27	29	10
Nuts	74	6	15	5	0
Meats					
Red meats (beef, pork, processed meats†)	16	20	19	20	24
Chicken	5	19	60	14	3
Eggs	19	15	43	18	5
Fish	12	30	47	10	0
Grains & cereals					
White rice	19	13	26	32	10
White bread	29	10	23	26	12
Pasta	36	38	24	2	0
Whole cereals (fiber or whole grain oat supplements, wholegrain bread)	28	7	28	28	10
Breakfast cereal	67	12	12	6	3
Corn tortillas	48	20	27	4	1
Salty snacks & chips	83	11	5	1	0
Beverages					
Sugared beverages (sugar sweetened carbonated and non-carbonated beverages, commercial fruit drinks and commercial orange juice)	36	17	22	17	8
Homemade fruit beverages “fresco”	17	15	43	15	9
Natural orange juice	46	20	21	10	2
Alcohol (beer, liquor)	82	9	5	2	1
Coffee	37	4	9	22	28
Water	5	0	12	7	77
Sweets and deserts					
Candies and chocolates	66	8	15	8	3
Sweet and salty cookies	80	8	9	1	1
Atol de plátano§	80	8	9	1	1

N=129

*Peach palm fruit.

† Processed meats includes ham, mortadella, salami, chorizo and sausage.

§Atol de plátano is a warm, smooth, and sweet thickened desert with plantain as its main ingredient.

in animal models suggest that the beneficial effects of coconut oil could be mediated through potential anti-inflammatory and antithrombotic properties, inhibition of lipid peroxidation, lowering of blood pressure, and improvements in insulin resistance and plasma lipid profile.⁽⁸⁾ Thus, a better understanding of the role of coconut oil, *per se*, on cognitive performance is warranted.

The consumption of typical dishes containing coconut oil has decreased in the Caribbean coast of Costa Rica.⁽¹⁸⁾ For example, the frequency of intake of *rice and beans*, a dish that was eaten almost daily, was consumed once a week by 46% of the population and 45% reported intakes of less than once a week. Furthermore, only 11% of participants

reported daily intake of coconut water, whereas 25% reported daily intake of sugar-sweetened beverages. Similar results have been observed in other Afro-Caribbean populations.⁽¹⁵⁾ It is possible that these changes in diet are attributed, in part, to the nutrition transition that accompanies economic development and globalization.^(37,38) It has been hypothesized that a decrease in coconut oil intake in India and the South Pacific Islands is responsible, in part, for the increase in type 2 diabetes.⁽³⁹⁾ We hypothesize that a decrease in intake of coconut products in tropical regions could contribute to early cognitive dysfunction. Other factors, such as low intake of green vegetables and whole grains could also play a role.

Table 4. Frequency of reported intake of foods and dishes containing coconut in the county of Limón, Costa Rica.

Food	Consumption frequency/portions per day						
	Never or < 1/month	1-3/ month	1/ wk	2-4/ wk	5-6/ wk	1/ day	2+/day
	%	%	%	%	%	%	%
Coconut (fruit)	67	11	9	7	2	1	1
Coconut water	37	19	10	17	5	6	5
Caribbean dishes containing coconut							
Rice and beans*	17	28	46	8	1	0	0
Rondón†	66	24	4	5	0	1	0
Stew beans‡	38	19	24	15	1	2	0
White rice with coconut oil or coconut milk.	78	7	8	4	1	1	1
Escabeche¥ with coconut oil or coconut milk.	76	10	11	1	1	0	0
Akee¶ with coconut oil or coconut milk.	60	23	8	8	1	0	0
Coconut desserts							
Cookies with coconut or coconut milk.	74	10	8	5	0	1	0
Pudding with coconut or coconut milk	76	18	4	1	0	1	0
Fried cake	53	93	20	8	0	0	0
Coconut flan	86	9	4	1	0	0	0
Cocadas or coconut cajeta	77	16	6	1	0	0	0
Chicheme with coconut milk	61	27	7	3	1	0	0

N=129

* A dish made with rice, beans and coconut milk, or

† A stew made with coconut milk, tubers and fish or meat,

‡ Black beans prepared with beef and coconut milk.

¥ Marinade made with coconut oil, vinegar, bay leaf and other spices.

¶ Fruit grown in the Caribbean region of Costa Rica widely eaten as a vegetable.

 Fried bread made with flour and coconut milk.

 Drink made with whole cooked corn, sugar, milk and spices.

 Traditional sweets made with coconut and sugarcane.

 Desert made with coconut milk and corn.

Table 5. Nutrient composition in Caribbean recipes from Limón Costa Rica.

Nutrients	Caribbean recipes (portion of 250 g)			
	Rice and beans	Rondón	Stew beans	Rice with coconut
Energy (kcal)	373	468	498	399
Carbohydrates (g)	56.2	49.4	39.2	51.6
Proteins (g)	9.7	18.9	24.5	5.8
Total fat (g)	12.6	23.5	28.1	19.4
Saturated fat (g)	10.8	14.7	15.4	17.0
6:0 (g)	0.07	0.07	0.06	0.11
8:0 (g)	0.84	0.89	0.73	1.34
10:0 (g)	0.67	0.71	0.59	1.06
12:0 (g)	5.35	5.64	4.64	8.46
14:0 (g)	2.11	2.55	2.13	3.34
16:0 (g)	1.13	1.84	4.65	1.70
18:0 (g)	0.63	0.14	2.42	0.98
Monounsaturated fats (g)	0.62	4.36	8.36	0.91
Polyunsaturated fats (g)	0.38	2.51	2.12	0.31

Diet and lifestyle-related chronic diseases continue to increase in tropical regions of the world.^(40,41) The prevalence of overweight or obesity was 75% in women and 73% in men in our study, a finding consistent with previous studies in the Caribbean region. Not surprisingly, a large proportion of the population reported the presence of diabetes, hypertension and/or high blood cholesterol. Our study showed relatively high intake of refined cereals, high-fat dairy products, sugar-sweetened beverages and red meat, along a relatively low intake of legumes and whole grains. It is possible that this dietary pattern is responsible for the high prevalence of these chronic diseases.⁽⁴²⁾

In sum, more studies on the role of coconut products in the prevention of cognitive dysfunction are needed.^(8,43) Results from our

study suggest that exposure to coconut products in the population living in the Caribbean Coast of Costa Rica may be appropriate for epidemiological studies. Studies to validate the dietary assessment tools need to be conducted before embarking on long-term studies.

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