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ORIGINAL ARTICLE

Impact of Fresh Coconut on Dietary Intake: A Randomized Comparative Trial

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ABSTRACT

Context: Controversies exist about health effects of coconut. Fresh coconut consumption on human health has not been studied substantially. Indians enjoy fresh coconut consumption and thus there is a need to understand the effects of fresh coconut.

Objective: To compare the effects of increased saturated fatty acid (SFA) intake (provided by fresh coconut) *vs* monounsaturated fatty acid (MUFA) intake (provided by a combination of groundnut oil + groundnuts) on dietary intake in healthy adults.

Materials and methods: Eighty healthy volunteers were randomized into two groups and provided with 100 gm of fresh coconut/day (diet C) or a combination of 45 gm groundnuts and 22 gm groundnut oil/day (diet G) for 90 days. 24-hour recall was collected. One-day fatty acid analysis of the diets were measured.

Results: Significant decrease was seen in intake of calories, protein, fat, SFA, MUFA, poly unsaturated fatty acid (PUFA), cholesterol, sodium, calcium, and phosphorus in diet C and calories, fat, SFA, PUFA, phosphorous, and sodium in diet G. On comparing both the diets, we found a significant increase in iron and no significant change was seen in carbohydrate intake. No change was observed in MUFA levels on diet G but significant decrease on diet C compared with subject's usual diets.

Conclusion: Daily consumption of 100 gm of coconut, rich in SFA, for 3 months had numerous positive effects on dietary intake, similar to that of MUFA fats, which are deliberated as good fats. The results of this work have particular relevance in suggesting that individuals wishing to use fresh coconut everyday can do so safely.

Keywords: Coconut, Diet, Groundnut, Monounsaturated fatty acid, Saturated fats.

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INTRODUCTION

Indian diets are relatively rich in inclusion of coconut in the daily diet. India is the 3rd largest producer of coconuts in the world, and more than half of this (52%) is consumed in raw form as either fresh or dry coconut.[1] Recent survey shows that regular consumers are advised by clinicians and nutritionists to either reduce or completely eliminate consumption of coconut as they are rich in fat and particularly saturated fatty acid (SFA) (92%).[2] Increased consumption of fat is known to increase total calorie intake and thus might increase the risk of developing obesity. Obesity in turn is a cause for host of diseases, namely type II diabetes,[3] cardiovascular diseases (CVD), hypertension,[4] and cancer.[5] Such studies are the basis for dietary recommendations that advise reduced consumption of fat, specifically SFA,[6] as SFA can increase plasma total cholesterol and can lead to higher risk of CVD.[7] However, fresh coconuts are a bundle of nutrition and are known as functional foods.[8] Even though they are rich in SFA, they are also rich in fiber, protein, and a number of vitamins, minerals, electrolytes, and are made of 40 to 50% moisture.[9] Furthermore, the coconut SFA composition is unique in that it consists of over 50% of medium-chain SFA (MCSFA), whose properties and metabolism appear to differ from longer chain SFA commonly found in animal products.[10,11] Medium-chain SFA are rapidly oxidized in the liver to acetyl CoA, and do not enter or alter the lipid pool in the liver, thus remaining neutral with respect to regulation of plasma cholesterol or low-density lipoprotein levels.[12] There are no studies conducted on the impact of SFA-rich fresh coconut consumption on diet. The current study was therefore undertaken to study the effects of daily consumption of fresh coconut on dietary intake in comparison to monounsaturated fatty acid (MUFA), in the form of groundnuts and groundnut oil, in healthy adults.

MATERIALS AND METHODS

Study Design and Subjects

The study was carried out from October 2015 to January 2016 among 80 healthy adults who were recruited following the advertisement of the study within SVYASA University. Of these, 58 completed the study (27 from coconut group and 31 from groundnut group). Subjects were aged 23.8 ± 4.8 years and had no known metabolic,

endocrine, or hematological diseases, were not on any medications, and had high physical activity level. Subjects were nonsmokers and were teetotallers, residing on a residential campus of a Yoga University. The study protocol was approved by the Institutional Ethics Committee, SVYASA, Bengaluru. This study has been registered with Clinical Trial Registry of India (CTRI/2016/07/007071). Signed informed consent was obtained from the volunteers. 24 hour recall was collected on day 1 and day 90. Fatty acid analysis of both the meals were measured using Gas chromatography (GC-FID). Body weight was measured using a digital scale. Hemoglobin was measured using HemoCueHb 201+ system and the results were documented immediately.

Dietary Information

The subjects were randomized into two groups: Coconut group (diet C) and groundnut group (diet G). The randomization was done using a computer-generated random number table. Both the groups received a balanced diet based on Yogic principles of food (Satvic, Rajasic, and Tamasic) blended with modern medical nutrition (calorie requirements, composition of balanced meal). The meal consisted of higher percentage of Sattvic foods with lesser Rajasic and least Tamasic foods.[13,14] The percentage energy, amount of fat, carbohydrates, and proteins and the fatty acid composition were based on recommended dietary allowance (RDA) and both the diets were identical in the standard diet. Subjects consumed this standard diet and intervention for a period of 90 days. Group C consumed 100 gm of fresh coconut per day and group G consumed 45 gm of groundnuts and 22 gm of groundnut oil per day. A combination of groundnut and oil was used, to make the two study interventions isocaloric and ensure macronutrient composition was identical, as close as possible. Coconut group subjects consumed around 2689 kcal, 392 gm of carbohydrates (58.3% E), 77 gm of proteins (11.4% E), and 91 gm (30.3% E) of fat, while groundnut group subjects consumed 2699 kcal, 384 gm of carbohydrates (57% E), 88 gm proteins (13% E), and 90 gm fats per day (30% E). Fresh coconut was generally added in snacks to garnish boiled or sprouted grams or/and in chutney (a sauce in the cuisines of the Indian subcontinent, a side dish made with coconut, coriander, roasted bengal gram, green chillies, and salt). Groundnuts were added to snacks or powdered and added to a dish in meals. Groundnut oil was used during cooking of G meals. The dietary intake of SFA was 2.6 times higher in the coconut group as compared with the groundnut group (58 *vs* 22%) as indicated in Table 1. Subjects were trained and requested to abstain from consuming anything other than the food and snacks provided by the coconut project kitchen, setup exclusively for the study.

Table 1: Fatty acid composition of the one-day meal through GC-FID

FA %	*Diet C*	*Diet G*
12:0	27.3	
14:0	11.7	
16:0	14.3	14.4
18:0	4.4	4.7
18:1	17.9	40.6
18:2 n–6	23.1	36.7
18:3 n–3	1.2	0.8
Total SFA	58.9	21.5

C: Coconut; G: Groundnut; FA: Fatty acid; SFA: Saturated fatty acid; GC-FID: Gas chromatography-flame ionization detector

Statistical Analysis

The statistical analysis was done using Statistical Package for the Social Sciences version 10. Each variable was first assessed for normality distribution using Kolmogorov-Smirnov test. When the data were normally distributed with equal variance, parametric statistical tests were selected for analysis. Within group analysis was done using a paired sample t test comparing the data collected on day 90 with the respective day 1 values for each variable separately. Chi-square test was performed when the data were nonparametric in nature. The between group comparisons were done to understand the significant differences between the group C and group G at baseline as well as at day 90 using an independent sample t test.

RESULTS

Fatty acid composition per 100 gm of the one-day meals (breakfast, lunch, snack, and dinner) of both coconut diet and groundnut diet was obtained through gas chromatography-flame ionization detector and is presented in Table 1.

The mean nutrient intakes obtained through 24-hour recall for all subjects at baseline and on the 90th day of dietary intervention phase are presented in Table 2. The diets were isocaloric and identical in macronutrients composition.

Based on RDA intakes and tables of food composition (Nutritive value of Indian foods, National Institute of Nutrition, Indian Council of Medical Research, India, 2012), there was a significant decrease in intake of calories, protein, fat, SFA, MUFA, poly unsaturated fatty acid (PUFA), cholesterol, sodium, calcium, phosphorus, and stress levels on diet C and calories, fat, SFA, PUFA, phosphorous, sodium, and stress levels on diet G, compared with the subject's usual diets. Similarly, there was a significant increase in iron on both the diets, compared with the subject's usual diets. There was no significant change seen in intake of carbohydrates on both the diets and no change observed in MUFA levels on diet G but significant

Table 2: Twenty four hours recall data

	Coconut group			Groundnut group				
	Mean (SD)	Mean (SD)	Paired t-test	Mean (SD)	Mean (SD)	Paired t-test	Independent t-test	
Variable	Pre test	Post test	p-value	Pre test	Post test	p-value	t-value	p-value
Energy (Kcal)	2701.0 (875.9)	2121.91 (712.6)	0.003*	2670.8 (897.02)	2306.9 (562.6)	0.030*	–0.124	0.283
Protein (mg)	76.50 (25.6)	61.8 (22)	0.010*	75.13 (24.1)	72.66 (19.89)	0.590	–1.928	0.059
Fat (mg)	91.93 (35.7)	50.32 (29.2)	0.001*	87.64 (38.32)	65.71 (19.19)	0.004*	–2.860	0.006*
Carbohydrate (mg)	392.99 (123.7)	350.1 (113.1)	0.098	397.0 (124.9)	352.18 (83.8)	0.047	–0.076	0.940
Calcium (mg)	846.01 (312.28)	700.12 (327.5)	0.019*	813.0 (334.04)	820.0 (330.2)	0.921	–1.356	0.181
Phosphorus (mg)	1745 (591.5)	1410.5 (481.01)	0.005*	1759.5 (560.5)	1562.3 (400.77)	0.045*	–1.288	0.203
Iron (mg)	25.03 (9)	34.34 (19.3)	0.027*	25.22 (8)	36.27 (15)	0.001*	–392.000	0.696
Sodium (mg)	4777.8 (1.7)	3120.2 (1.46)	0.001*	5037.6 (2.15)	3642.3 (1.44)	0.004*	–1.326	0.191
Sat Fat (mg)	25.89 (11.6)	16.9 (5.11)	0.001*	22.19 (12.22)	15.73 (6.39)	0.010*	0.756	0.453
MUFA (mg)	19.59 (8.40)	9.59 (5.33)	0.001*	19.86 (9.9)	19.64 (6.8)	0.920	–6.067	0.001*
PUFA (mg)	39.41 (16.65)	20.767 (11.3)	0.001*	39.412 (16.65)	20.76 (11.38)	0.001*	–2.489	0.016*
Cholesterol (mg)	83.78 (44)	18.49 (10.3)	0.001*	56.37 (41.8)	14.41 (12.27)	0.001*	0.954	0.348

Data is represented as Mean & Standard deviation. *p < 0.05 comparing the Day 90 values with the Day 1 respectively

decrease on diet C, compared with subject's usual diets. Body weight decreased significantly in coconut group subjects (p = 0.04) and not in groundnut group subjects (p = 0.06). Hemoglobin levels in both groups increased similarly (p = 0.001).

DISCUSSION

In this carefully controlled diet study, we seek to shed light on the impact of SFA from fresh coconut (diet C) in comparison with MUFA from groundnuts and groundnut oil combination (diet G) on some key nutrients in the diet before and after intervention. A significant decrease in calorie consumption was seen in group G and a highly significant decrease in group C, after the intervention. This was reflected in reduction in body weight. This is in agreement with previous findings (St-Onge & Jones). The reason of this decrease in calories might be both dietary fiber and MCFA present in coconut, which seems to induce satiety and satiation.[15-17] Mechanisms underlying the effect of fiber are reduction of energy density of a meal and prolonging the intestinal phase of nutrient processing and absorption. Also, coconut fiber shows highest water retention and swelling capacity when compared with other dietary fibres.[18] Although exact mechanisms by which MCFA may induce satiety have not been established, hormones like cholecystokinin, peptide YY, gastric inhibitory peptide, neurotensin, and pancreatic polypeptide have been proposed.[19]

The interesting observation is that the carbohydrate intake did not change in either of the groups. This is a valuable finding as lower calorie intake and weight loss were achieved without decreasing the carbohydrate quantity. The addition of dietary fiber and MUFA can achieve this desired result. So it is the quality of carbohydrate which matters and not the quantity as demonstrated by many studies earlier.[20]

Consumption of protein decreased in both groups but significantly in group C, after intervention. This could be due to subjects adhering to vegetarian diet prescription for the period of intervention, who otherwise would eat nonvegetarian food on weekends (54% of subjects ate nonvegetarian food) before intervention. Significant decrease of protein in coconut group could be also for the fact that they consumed almost 8 gm of protein less in their standard diet/day. Consumption of fat decreased significantly in both groups and more so in group C. Both the diets were designed to give 30% calories from fats but due to decreased consumption of food gradually, the consumption of fats could have decreased. A satvic diet by design is low on visible fats. Deep fried foods were not prepared nor served during the intervention period. For the same reason that they switched to vegetarian satvic diet during intervention, SFA could have decreased significantly in both the groups and more so in group C in spite of coconut (SFA-rich) intervention. It was obvious that MUFA decreased in group C after intervention as group G got groundnuts rich in MUFA as intervention. Poly unsaturated fatty acid decreased significantly on both groups and the oil used in standard diet cooking was sunflower oil for both groups. It was around 50 ml/person/day. Fall in PUFA could be due to food consumption in commercial canteens before intervention, junk, and deep fried food consumption (higher levels of fat). Cholesterol was significantly low in both the groups as they were on plant-based diets. There are concerns in increasing dietary fiber due to its negative effect on the bioavailability of minerals like calcium, iron, zinc, and magnesium. This is due to the property of dietary fiber to bind nonspecifically and reduce their absorption.[21,22]

However, reports from MCFA-rich diets showed increased absorption of calcium and magnesium.[23] This was also observed in another study with increasing concentrations of dietary fiber from coconut flour which did not affect mineral availability from all test foods.[24] This is in agreement with our findings on iron which increased significantly, which is well reflected in significant increase in hemoglobin levels in both groups. Conversely, we saw significant decrease in calcium levels in group C, after intervention. Few studies report a negative balance of calcium due to increased fiber and increased fecal excretion.[25]

A positive effect was observed in significant decrease in sodium levels in both the groups and more so on group C. Phosphorous levels significantly decreased in both the groups, and more so in C group. The theoretically planned major nutrients of the diet has been reflected in the post intervention 24-hour recall data, accurately. The only concern is the decrease of calcium in diet after intervention.

LIMITATIONS

The main limitation of the study was that there was no way to be certain that the participants did not eat anything other than the food and snacks provided from the study kitchen on Sundays, except for their self-reported data.

CONCLUSION

Fresh coconut, even though rich in saturated fatty acids in comparison to a combination of groundnut and groundnut oil when consumed over a period of 90 days, had positive effect on the dietary intake - major nutrients and energy consumption, after intervention. The results of this work have particular relevance in suggesting that individuals wishing to use fresh coconut in their diets can do so safely but more studies need to be conducted with larger sample sizes and longer duration.

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