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Effect of hypoenergetic diet combined with consumption of coconut flour in overweight women

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Abstract

Introduction: **the prevalence of obesity has increased, especially among women.**

Aim: **the aim of this study was to assess the effect of a hypoenergetic diet combined with coconut flour on anthropometric and biochemical data and the quality of the diet.**

Methods: **we carried out a crossover clinical trial involving a step with hypoenergetic diet only and another with the diet associated with coconut flour consumption (26 g) over the course of nine months. The volunteers were recruited from the São Gonçalo city of Rio de Janeiro. Anthropometric, biochemical and dietary data were collected monthly. The diet quality index revised for the Brazilian population (DQI-R) and the consumption of ultra-processed foods and additives were assessed. The Wilcoxon and Mann-Whitney tests were performed, with $p < 0.05$ considered statistically significant.**

Results: **forty-two women of an average 47.5 ± 9.5 years of age participated. The hypoenergetic diet promoted a decrease in body fat, body mass index, waist circumference, waist-to-height ratio, visceral adiposity index, diastolic blood pressure, triglycerides and VLDL. The consumption of coconut flour promoted a drop in glucose and total cholesterol levels when supplementing the hypoenergetic diet. The improvement to diet quality can be noted in the decrease in consumption of ultra-processed foods like vegetable oil, chocolate and soft drinks.**

Conclusion: **the hypoenergetic diet promoted a decrease in the anthropometric parameters, blood pressure and triglycerides. The consumption of coconut flour promo-**

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EFECTO DE LA DIETA HIPOENERGÉTICA COMBINADA CON EL CONSUMO DE HARINA DE COCO EN LAS MUJERES CON SOBREPESO

Resumen

Introducción: **la prevalencia de la obesidad ha aumentado, sobre todo entre las mujeres.**

Objetivo: **el objetivo de este estudio fue evaluar el efecto de una dieta hipoenergética combinada con harina de coco en los datos antropométricos y bioquímicos y, así como la calidad de la dieta.**

Métodos: **se realizó un ensayo clínico cruzado que incluyó un paso solo con dieta hipoenergética y otro con la dieta asociada con el consumo de harina de coco (26 g) a lo largo de nueve meses. Los voluntarios fueron reclutados de la ciudad de São Gonçalo de Río de Janeiro. Antropométrica, datos bioquímicos y dietéticos fueron recolectados mensualmente. Fueron evaluados el índice de calidad de la dieta revisado para la población brasileña (ICD-R) y el consumo de alimentos y aditivos ultraprocesados. Se realizaron las pruebas de Wilcoxon y Mann-Whitney, con $p < 0{,}05$, considerado estadísticamente significativo.**

Resultados: **participaron cuarenta y dos mujeres con un promedio de 47,5 ± 9,5 años de edad. La dieta hipoenergética promovió una disminución de la grasa corporal, el índice de masa corporal, la circunferencia de la cintura, la relación cintura-talla, el índice de adiposidad visceral, la presión arterial diastólica, los triglicéridos y VLDL. El consumo de harina de coco promovió una caída en los niveles de colesterol y glucosa totales al complementar la dieta hipoenergética. La mejora de la calidad de la dieta puede observarse en la disminución del consumo de alimentos ultraprocesados como el aceite vegetal, el chocolate y los refrescos.**

Conclusión: **la dieta hipoenergética promovió una disminución en los parámetros antropométricos, la presión arterial y los triglicéridos. El consumo de harina de coco favoreció una disminución de los niveles de colesterol y**

ted a decrease in glucose and total cholesterol levels when supplementing the hypoenergetic diet. The improved diet quality can be seen in the decrease in consumption of ultra-processed foods.

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Key words: *Hypoenergetic diet. Obesity. Coconut flour.*

de glucosa totales cuando se complementa la dieta hipoenergética. La calidad de la dieta mejorada se puede ver en la disminución del consumo de alimentos ultraprocesados.

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Palabras clave: *Dieta hipoenergética. Obesidad. Harina de coco.*

Introduction

The prevalence of obesity has risen sharply in recent decades, including in developing nations, and is considered to be a major public health problem[1]. It is estimated that in 2010, there was an obese population of around 500 million, which represents about 10-14% of the world population[2]. In Brazil, according to recent data, 17% of the population over the age of 20 is obese[3].

The etiology of obesity is multifactorial; however, the most common cause is an upset to the energy balance as a consequence of a sedentary lifestyle and/or high energy intake[4,5]. Studies show that hypoenergetic, nutritionally balanced diets contribute to the decrease in body fat, total cholesterol levels, LDL cholesterol, triglycerides and blood pressure[6,7].

Furthermore, controlled intervention studies suggest that high fiber intake may prevent weight gain by curbing the appetite and hence energy intake[8]. Coconut flour stands out for its high total fiber content of approximately 30%, which may help in treating obesity[9]. No human studies exist assessing the effect coconut flour may have on body fat in overweight women.

The aim of this study was to assess the effect a hypoenergetic diet combined with the consumption of coconut flour, has on anthropometric and biochemical data and on diet quality in overweight women.

Methods

This is a crossover study involving women in the Rio de Janeiro State municipality of São Gonçalo. Included were women who were >20 years of age, overweight or obese, not pregnant or nursing, and not on diets or taking weight-loss medication or supplements of any nature.

This study was approved by the HUCFF/UFRJ Research Ethics Committee and filed under the number 115.224. The volunteers signed free-and-informed-consent forms (FICFs), in accordance with Ministry of Health Resolution no. 196/96.

The volunteers were contacted by telephone to evaluate their eligibility and inform them of study procedures. The appointments were held over a nine-month period divided into three three-month stages. During each stage blood samples were taken after a 12-hour fast, anthropometric measurements were noted, 24h recall was reported, and blood pressure was measured. During the first stage the volunteers were given a hypoenergetic diet and four subsequent appointments were held. A personalized diet and a food-substitution list were delivered at the first meeting, when the FICFs were signed.

During the second, washout stage no appointments were held. During the third stage four appointments were held and new personalized diets were delivered with orientation as to how to consume the remove, coconut flour, and at the monthly remove appointments the containers were returned and weighed.

The sample calculation was performed using the PS Power and Sample Size Calculation version 3.0.43, with a confidence interval of 95% (α) and the power of 80% (β). The parameter for the sample calculation was a presumed body mass loss of 2kg per month and a predicted 3kg variance for the standard deviation. The calculation suggested 20 as the minimum number of volunteers. Provision was made following a loss of 30% based on the pilot study.

For the anthropometric evaluation we measured body mass (BM) in kilograms (kg) and height in meters (m) using a digital platform stadiometer (Welmy®) placed on a flat surface[10]. Body mass index (BMI) was calculated by dividing body mass (kg) by height (m) squared[11]. Waist circumference (WC) was measured from the midway point between the iliac crest and the last rib, using a measuring tape[11]. Neck circumference (NC) was measured with the head positioned in the Frankfurt horizontal plane, the upper edge of the tape placed under the cricoid cartilage and perpendicularly around the neck[12]. Waist-height ratio (WHtR) was determined by dividing the waist circumference (cm) by height (cm)[13]. Body adiposity index (BAI) was calculated according to the following formula: %F(BAI)=hip circumference/[height^{1,5})-18][14].

Blood pressure was ascertained using a sphygmomanometer (Missouri/aneroid), arm clamp specifically for the obese, and stethoscope (Missouri/duoscopic) by auscultation, according to the protocol proposed in the Brazilian Guidelines on Hypertension IV[15].

The blood samples were taken after 12 hours of nighttime fasting, and kept in tubes containing coagulant. The blood samples were centrifuged at 4,000 rpm for 15 minutes to obtain the serum. Concentrations of total cholesterol (TC), triglycerides, high-density lipoproteins (HDL-c) and glucose were analyzed using the enzymatic colorimetric method: cholesterol oxidase/peroxidase[16], glycerol phosphate oxidase/peroxidase[17],direct detergent[18] and glucose oxidase/peroxidase[19] and expressed in mg/mL. Commercial kits (Abbott Laboratories Brasil LTDA) were used and the reading was taken using an automated LabMax 240 (Labtest Diagn[ostica SA, Brasil) analyzer. LDL-c and VLDL-c concentrations were calculated using the Friedewald formula[20].

A diet balanced in micro- and macronutrients spread over six meals was prescribed. Estimated energy expenditure was based on Dietary Reference Intake[21] according to current BF. Afterward, 513kcal per day, in accordance with the average-energy-value-of-adipose-tissue method (AEVATM), was subtracted from the total energy value (TEV), for estimated BF loss of approximately 2kg per month. We performed the distribution of energetic macronutrients according to the recommendations of the DRI. According to the Brazilian Obesity Guidelines[22] and the Brazilian Guidelines for Dyslipidemia and Prevention of Atherosclerosis V[23], saturated fat was offered at a quantity less than or equal to 7% of the TEV, monounsaturated fats less than or equal to 20% of TEV, and polyunsaturated fats less than or equal to 10% of TEV. During the HDCP stage, too, 130 kcal of energy relating to 26g of CP was subtracted.

The CP was delivered in an opaque standup container with a standard measuring spoon. Each container contained 420g of CP, with two containers allotted for each 32-day month. Any remaining CP was weighed at the follow-up appointments to determine overall daily consumption. The volunteers were instructed to consume two measuring spoons' worth daily, consuming 26g in small meals (adding it to fruit or juice or blended with fruit and milk or yogurt).

To obtain the dietary-intake data, we processed 24-hour recalls using the Food Processor version 7.2 software (Esha Research, Salem, USA, 1998). Diet quality was evaluated according to the diet quality index revised for the Brazilian population (DQI-R)[24]. The DQI-R was assessed for total score and components (dietary groups and nutrients). The total DQI-R score was dichotomized to above and below the 75th percentile (75P). The DQI-R greater than or equal to 75P was considered to be an adequate diet, and less than was inadequate, with the cutoff point a score of 77.8.

Ultra-processed foods and additives were assessed via 24-hour recall, which at the start and end of the study quantified consumption of such foods as chocolates, margarine, cookies, biscuits with filling, soft drinks, bonbons, instant noodles, processed juices, and additives (sugar, sodium and vegetable oil)[25].

All statistical analysis was performed using the SPSS version 21 (SPSS Inc, Chicago, IL). Kolmogorov-Sminorv and Chi-Squared normality tests were employed for categorical variables, and Wilcoxon and Mann Whitney tests for analyzing the groups. A p-value<0.05 was considered statistically significant.

Results

We evaluated 42 volunteers of an average 47.5±9.5 years of age, of whom 73.8% were obese, 9.5% hypertensive and 14.2% diabetic, with a significant difference only noted in regard to menopause between the groups that dropped out and completed the study (Table I).

Table I

Baseline characteristics of volunteers who did or did not complete the study. São Gonçalo (RJ), 2014

Variables	*Dropped out (n= 17)*	*Completed (n=42)*
Age (years)	43.2±7.6	47.5±9.5
Per capita income (R$)	1354.8±713.2	1798.3±1296.9
Skin color – non-white (%/n)	58.8/10	71.4(30)
Marital status – has partner (%/n)	58.2/10	80.9(34)
Education -12 years of study (%/n)	52.9/9	57.1(24)
Hypertensive (%/n)	47.0/8	38.0(16)
Hypothyroidism (%/n)	11.7/2	9.5(4)
Diabetes (%/n)	-	14.2(6)
Physical activity – yes (%/n)	35.2/6	21.4(9)
Menopause – yes (%/n)	**29.4/5**	**59.5(25)***
Smokers (%/n)	5.8/1	47.2(2)
Alcoholics (%/n)	11.7/2	10.6(5)
SBP (mmHg)	120.6±15.6	124.2±19.2
DBP (mmHg)	81.1±7.8	80.4±11.6
BF (Kg)	86.8±13.1	84.8±18.1
BMI (Kg/m^2)	34.3±5.7	32.6±6.2
NC (cm)	37.0±1.9	36.2±3.0
WC (cm)	99.9±20.3	104.6±16.6
WHtR	0.6±0.1	0.6±0.0
BAI (%)	39.3±5.2	40.3±5.3
Glycemia (mg/dL)	98.4±12.7	100.0±24.1
Uric acid (mg/dL)	3.8±1.0	3.9±1.1
TC (mg/dL)	190.5±57.3	211.3±40.3
TG(mg/dL)	143.8±57.3	151.0±100.8
LDL-c(mg/dL)	130.6±31.6	133.5±44.6
HDL-c(mg/dL)	43.8±5.9	45.8±8.9
VLDL-c(mg/dL)	27.5±12.6	30.3±20.0

Values expressed in Mean±Standard Deviation, frequency (n). Mann Whitney test for independent variables. Chi-Squared test of categorical variables.*Level of statistical significance p<0.05. SBP: systolic blood pressure; DBP: diastolic blood pressure; BF: body fat; NC: neck circumference; WC: waist circumference; WHtR: waist-to-height ratio; BAI: body adiposity index; TC: total cholesterol; TG: triglycerides, LDL: low-density lipoprotein; HDL: high-density lipoprotein, VLDL: very low-density lipoprotein.

We noted that the dietary treatment involving the hypoenergetic diet led to significant decreases in BF, BMI, NC, WC, WHtR, BAI, DBP, triglycerides and VLDL in the overweight women. During stage 2 (washout) there was a return to the initial concentrations. In stage 3, the hypoenergetic diet combined with coconut flour (HDCP), we noted a significant decrease in serum glucose and TC levels (Table II).

The volunteers were instructed to ingest 26g/day of CP; however, average consumption was 20.3g/day, and only 2.4% of the volunteers ingested the recommended amount.

By comparing the dietary data against the DQI-R classification during the HDCP stage, we noted a significant increase in the total fiber the volunteers consumed, and a significant decrease in the consumption of proteins and carbohydrates in the group of volunteers with the inadequate diet (Table III). Upon analyzing the anthropometric, biochemical and clinical data against the DQI-R classification, we noted a decrease only in the SBP of the volunteers with the inadequate diet in the HD stage.

Table IV presents the consumption of ultra-processed foods and additives, with a reduction in consumption of cookies noted in the HD stage, reduction of consumption of vegetable oil in the HDCP stage, and reduction in soft drink consumption in both stages.

Discussion

This study is the first of its kind to assess the effect a hypoenergetic diet combined with coconut flour has in lowering the body fat of overweight women. A recent study described the anti-inflammatory, anti-microbial and antioxidant properties of coconut; however, most studies we found involved adding coconut flour to supplement the fiber content of food[27].

We found that the hypoenergetic diet decreased the BF, BMI, WC, WhtR, BAI, DBP, TG and VLDL of overweight women. Similar data were found by Di Daniele *et al.*[27] in a case-control study involving 59 obese individuals undergoing a Mediterranean diet reduced by 500 kcal/day. They also noted a decrease in BF, BMI, SBP, glycemia and LDL-c.

The coconut flour produced an additive effect on the hypoenergetic diet, by decreasing glycemia and TC levels. This same finding coincides with a 14-week randomized, double-blind crossover study assessing the effect consuming coconut flour combined with baked

Table II

Anthropometric data: body composition, blood pressure and biochemical markers over the course of the study. São Gonçalo (RJ), 2014

Variables	*T0(Baseline)*	*Δ T90-T0days (DH)*	*P[1]*	*ΔT180-90days* Washout	*P[1]*	*T180days*	*ΔT270-T180days (DHFC)*	*P[1]*	*P[2]*
BF (Kg)	84.8±18.1	-2.01±2.1	**<0.01**	0.3±2.2	0.9	83.0±19.0	-2.4±3.7	0.33	**<0.01**
BMI (Kg/m^2)	33.7±6.2	-0.8±0.8	**<0.01**	0.1±0.8	0.84	33.0±6.5	-0.26±1.0	0.33	**<0.01**
NC (cm)	36.2±3.0	-0.6±0.5	**<0.01**	0.2±0.7	0.09	35.8±2.9	0.2±0.7	0.77	**<0.01**
WC (cm)	104.6±16.6	-2.7±3.1	**<0.01**	0.8±2.9	0.54	102.7±16.8	-0.5±2.5	0.34	**<0.01**
WHtR	0.66±0.0	-0.0±0.0	**<0.01**	0.0±0.0	0.04	0.64±0.0	-0.0±00	0.38	**<0.01**
BAI (%)	40.3±5.6	-0.8±1.5	**<0.01**	0.4±1.6	0.06	39.8±5.7	-0.2±1.1	0.29	**0.03**
SBP (mmHg)	124.2±19.2	-4.0±17.6	0.05	-9.7±37.1	0.23	110.4±35.4	5.1±37.8	0.61	0.96
DBP (mmHg)	80.4±11.6	-3.0±10.1	**0.03**	-4.7±22.6	0.34	72.6±23.1	1.7±26.7	0.91	**0.01**
Glucose(mg/dL)	100.0±24.1	2.8±9.8	0.07	4.0±13.6	**<0.01**	106.8±20.6	-8.7±20.7	**<0.01**	**<0.01**
UA(mg/dL)	3.9±1.1	-0.1±0.6	0.27	0.3±0.7	**<0.01**	4.1±1.3	-0.2±1.1	0.23	0.56
TC(mg/dL)	210.1±45.8	-11.0±26.9	0.16	12.2±23.2	**<0.01**	211.3±40.3	-11.3±34.6	**0.04**	0.47
TG(mg/dL)	151.0±100.8	-25.8±68.9	**0.04**	0.7±59.1	0.83	125.9±79.1	-9.3±	0.14	0.35
HDL(mg/dL)	45.8±8.9	0.21±9.1	0.91	-1.1±8.5	**0.03**	44.8±7.7	-0.5±9.9	0.98	0.72
LDL(mg/dL)	133.5±44.6	-6.1±29.4	0.18	13.9±24.9	**<0.01**	141.2±35.8	-10.9±33.9	0.15	0.68
VLDL(mg/dL)	30.3±20.0	-5.4±13.7	**0.02**	0.2±11.8	0.88	25.1±16.1	-2.5±10.3	0.11	0.27

Note: Values expressed in Mean±Standard Deviation; HD: hypoenergetic diet; HDCP: hypoenergetic diet plus coconut powder; BF: body fat; BMI: body mass index; NC: neck circumference; WC: waist circumference; WHtR: waist-to-height ratio; BAI: body adiposity index; SBP: systolic blood pressure; DBP: diastolic blood pressure; UA: uric acid; TC: total cholesterol; TG: triglycerides; HDL: high-density lipoprotein; LDL: low-density lipoprotein; VLDL: very-low-density lipoprotein. [1]Wilcoxon test.[2]Mann Whitiney test between the Δ of stages HD and HDCP. Statistically significant p<0.05.

Table III
Dietary data according to DQI-R classification. São Gonçalo (RJ) 2014

Variables	*DQI-R<P75(HDCP) inadequate diet*			*DQI-R ≥P75(HDCP) adequate diet*			*Comparison between stages (T90-T0)*		
	T0(Baseline)	*T90days*	*P1*	*T0(Baseline)*	*T90days*	*P1*	*DQI-R<75*	*DQI≥P75*	*P2*
Energy(kcal)	2102.6±373.7	2297.8±373.5	0.12	2100.6±521.7	2366.9±498.0	0.15	138.8±487.9	-80.6±279.1	0.45
PTN(g/kg/peso)	0.7±0.5	0.6±0.1	0.17	0.9±0.3	0.5±0.1	**<0.01**	0.1±0.4	-0.3±0.8	0.05
CHO(%)	37.2±16.5	30.1±10.8	0.07	35.2±10.4	28.0±13.5	**0.04**	-12.6±27.4	-6.3±27.8	0.88
LIP(%)	23.2±15.3	22.3±18.2	0.63	18.9±10.9	16.5±9.9	0.23	-3.3±19.4	-6.3±18.7	0.31
SFA(%)	8.3±6.1	10.4±10.4	0.51	6.3±3.9	8.1±5.1	0.06	-2.1±11.3	-1.6±7.6	0.35
MUFA(%)	7.9±6.4	7.4±6.4	0.42	5.6±3.0	4.8±3.2	0.15	-0.1±6.9	-1.8±3.6	0.5
PUFA(%)	3.4±2.1	2.7±2.4	0.2	2.1±1.0	1.8±1.0	0.23	-0.6±1.8	-0.4±1.5	0.88
Chol(mg)	250.4±252.7	215.4±186.3	0.63	173.9±95.2	164.8±126.9	0.46	2.1±248.8	82.5±94.8	0.05
Total fiber(g)	13.1±6.2	19.8±7.3	**<0.01**	18.8±9.1	24.6±7.5	**<0.01**	1.8±13.7	-2.8±15.5	0.02
Sodium (mg)	1483.8±1132.0	1353.8±909.3	0.36	1120.5±651.2	1007.4±458.1	0.6	-181.4±1299.4	-66.4±601.0	0.55

Note: Values expressed in Mean±Standard Deviation; HD: hypoenergetic diet; HDCP: hypoenergetic diet plus coconut powder; PTN: protein; CHO: carbohydrates, LIP: lipids; SFA: saturated fatty acid; MUFA: monounsaturated fatty acid; PUFA: polyunsaturated fatty acid: Chol: cholesterol.[1]Wilcoxon test. [2]Mann Whitney test. Statistically significant p<0.05.

Table IV
Ultra-processed foods and additives consumed over the course of the study. São Gonçalo (RJ), 2014

Variables	*T0(baseline)*	*Δ T90-T0dias (HD)*	*P[1]*	*ΔT270-T180days (HDPC)*	*P[1]*
Chocolates (g)	1.6±6.8	0.23±7.5	0.83	-14.0±63.4	**0.03**
Cookies (g)	26.8±47.3	-25.8±48.0	**<0.01**	-2.8±31.7	0.95
Foods with filling (g)	1.5±7.0	1.2±10.1	0.46	-5.6±20.4	0.1
Soft drinks (mL)	100.1±200.0	-86.9±215.0	**0.01**	-64.3±147.8	**<0.01**
Bonbons (g)	1.2±5.9	2.5±15.2	0.29	-0.6±5.9	0.41
Sugar (g)	50.6±33.1	16.3±123.3	0.33	-4.8±29.5	0.23
Vegetable oil (mL)	10.0±8.9	0.51±14.3	0.93	-4.0±7.1	**<0.01**
Sodium (mg)	1129.1±931.9	-175.6±1142.4	0.47	-35.8±801.1	0.2
Processed juices (mL)	43.3±91.5	14.7±6	0.53	-41.6±154.5	0.12

Values expressed in Mean±Standard Deviation; HD: hypoenergetic diet; HDCP: hypoenergetic diet plus coconut powder. [1]Wilcoxon test. Statistically significant p<0.05.

goods in 15 and 25% fiber proportions had on the lipid profile of 21 mostly-female individuals of an average 48 years of age. They identified a decrease in total cholesterol, LDL and triglyceride levels[29]. In rats fed coconut fiber, a decrease in serum glucose and insulin levels[30] were noted. We found no studies assessing glucose profile in humans.

Though studies have noted the positive effect of supplementation with dietary fiber, the outcomes of clinical interventions are still inconsistent in demonstrating the effect it has on reducing body fat[30,31]. Foods rich in fiber are capable of increasing the viscosity of a meal and slowing ingestion, stimulating a release of such intestinal hormones as cholecystokinin and glucagon-like peptide 1, which promote saciety[31,32]. Furthermore, in the intestine, dietary fiber hinders the action of digestive enzymes in their substrate, retarding the nutrient-absorption process.

Ultra-processed foods contain excessive levels of fat, sugar and salt and are high in energy and low in fiber, characteristics that increase the risk of obesity, diabetes mellitus and cardiovascular disease[33]. A decrease in the consumption of ultra-processed foods and additives was noted, which the DQI-R does not assess. This suggests a need to test new diet-quality-assessment indexes[35].

The low number of participants and 30% lost-to-follow-up rate, while predicted in the sample calculation, are limitations inherent in clinical trials involving hypoenergetic diets over a prolonged period. Nevertheless, we can raise the hypothesis that the high fiber content in coconut flour when combined with a hypoenergetic diet can lower anthropometric parameters, lipid profile and glycemia in overweight women.

Conclusion

The hypoenergetic diet promoted decreases in BF, BMI, WC, WhtR, BAI, DBP, TG and VLDL. Consumption of coconut flour promoted a decrease in glucose and TC concentrations as an added effect of the hypoenergetic diet. The improvement in diet quality was notable in the decreased consumption of ultra-processed foods.

Conflict of interest

The authors declare that there is no conflict of interest.

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