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EFFECT OF PREPRANDIAL CONSUMPTION OF CACAO NIBS  
VS. PECANS ON APPETITE

By

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James Carter III

**PURPOSE.** The purpose of this graduate student research study is to compare the differential effects of cacao nibs and pecans on calorie intake.

**METHODS.** Participants (n=34) were asked to log food intake for three days (Tuesday through Thursday) for three weeks. They were instructed to consume an intervention (cacao nibs or pecans) 15-30 minutes prior to mealtime with one 8 oz cup of water. During week one, participants were asked to complete questionnaires. During week two they were asked to log their usual intake. During week three, they consumed cacao nibs as intervention. During week four, they consumed pecans as intervention. At week five, post-questionnaires were administered and data was collected. After organizing data for all participants, 15 of them were selected for data analysis (others were eliminated due to non-compliance).

**RESULTS.** Both cacao nibs and pecans decrease appetite; however, only pecans showed a statistically significant difference ( $p = .02$ ) based on Visual Analogue Scales. Calorie percentages for dinner were calculated and cacao nibs showed statistically significant mean difference of 9% between the two days analyzed ( $p = .02$ ).

**CONCLUSIONS.** The results from this study indicate that consumption of either cacao nibs or pecans decrease appetite. Pecan consumption prior to mealtime showed a statistically significant decrease in appetite, whereas cacao nibs did not. A larger sample size is needed to confirm findings

Increased appetite often leads to energy over-consumption, thus contributing to obesity. The Center for Disease Control and Prevention states that one-third of Americans were obese in 2015.<sup>1</sup> People have tried numerous diets and weight-loss programs with hopes of reaching a healthy weight and optimal health. It is known that most weight-loss programs and special diets have failed to maintain their claims and people tend to revert back to their previous habits of over-consumption.<sup>2</sup> In light of these studies and the plethora of diet fads, appetite suppression may play a key role in the successful long-term management of healthy weight.

Existing studies have demonstrated that dark chocolate and cocoa have medicinal properties providing numerous health benefits. These benefits are associated with reduction of blood pressure, risk of cardiovascular disease and type 2 diabetes, as well as lower mortality rates.<sup>3,4</sup> In this graduate student research study, we concentrated on raw cacao alone, without other components such as fat and sugar that are typically found as ingredients of commercially purchased chocolate products. Dark chocolate contains cocoa (which is made of powder from the separation of cocoa butter and chocolate liquor), cocoa butter, and sugar. Cacao nibs are the raw form of cocoa/chocolate that has not been refined, heated, or processed. They are considered a potent health food because of the surpassing medicinal properties.<sup>5</sup>

Cacao has been claimed by numerous sources to promote weight loss and suppress appetite, however, the purported mechanisms differ. In an article titled, "Cacao's Wow Factor," a natural foods expert David Wolfe states that cacao can be an aide in weight-loss because of its numerous vitamins and minerals.<sup>5</sup> All of these minerals are essential nutrients that sometimes fall short in daily intake. Research also has shown that dark chocolate consumption leads to increased satiety, lower consumption of food, and lessened desire for sweet, savory, or fatty foods when compared to white chocolate consumption.<sup>6</sup> These findings may be attributed to the higher content of cacao in dark chocolate compared

to white chocolate. Dark chocolate also contains less fat and sugar when compared to white chocolate.

Since there is limited evidence from recent research and peer-reviewed journal articles that have focused on raw cacao and demonstrated a relationship to appetite suppression, further research studies are needed to evaluate the effect of cacao nibs on appetite suppression. This graduate student research study compared the differential effects of cacao nibs and pecans on caloric intake.

## **Methods**

### *Participants*

Participants were recruited with flyer distribution on campus and via email from Loma Linda University (LLU) campus and Loma Linda University Adventist Health Sciences Center (LLUAHSC). Participants responded to the flyers with a text message or email response to express their interest. Inclusion criteria for participants were: must consume three meals per day, enjoy the taste of cacao nibs and pecans, and be between the ages of 18-80 years. Potential participants were excluded if they were pregnant or breastfeeding, had a history of a respiratory problem (such as asthma or bronchitis), or had allergies to cacao or pecans.

### *Questionnaires*

Questionnaires used in the study were the Pittsburgh Sleep Quality Index (PSQI), Perceived Stress Scale (PSS), and screening questionnaires.

The PSQI allows participants to answer questions regarding their sleeping habits and quality of sleep. The PSQI contains 24 questions and the scoring is based on 19 self-rated questions which fall under seven components, each receiving a score of 0 to 3. The scores of the seven components are added together to obtain the global PSQI score, ranging from 0 to 21 points (0 = no difficulty, 21 = severe difficulty in all areas).<sup>7</sup>

The PSS was designed in a simple and understandable way to measure stressful events. The questions from this scale are aimed to reflect on recent feelings and thoughts. According to scoring instructions, PSS scores are obtained by reversing responses to the four positively stated items and then summing across all scale items. An example of a question would be: "In the last month, how often have you felt nervous and 'stressed'?" Participants chose a score from 0 to 4 (0 = never, 4 = very often). The PSS is the most widely used questionnaire for assessing human stress level.<sup>8</sup>

Pre- and post-screening questionnaires were designed by the student investigators. The purpose of the pre-screening questionnaire was to determine eligibility of participants based on predetermined inclusion and exclusion criteria. It collects the following information: gender, age, height, weight, allergies to nuts, allergies to cacao or chocolate, respiratory issues, breastfeeding/nursing, birth control pill use, and regular consumption of three meals per day. The post-screening questionnaire was identical to the pre-screening questionnaire with the purpose of determining any changes that might have occurred during the course of the study.

### *Microsoft PowerPoint*

A Microsoft PowerPoint document was used for instructions on logging food intake as well as visualizations of portion sizes. The PowerPoint was emailed to participants upon eligibility to use as a reference for logging food.

### *Visual Analogue Scales*

Visual Analogue Scales (VAS) were used to objectively measure degree of hunger of each participant that ranges across a continuum of values that cannot be precisely measured or categorized.<sup>9</sup> Each VAS is a horizontal line measuring 100 mm in length with word descriptors at each end. A micrometer was used to measure the scales in millimeters from the left end of the line to the point that the participant marks.

The scales for weeks three and four answered the question, “Before dinner and before cacao nibs, *how hungry do you feel?*” and “Now, 15-30 minutes after you ate the cacao nibs and before you eat your dinner, *how hungry do you feel?*” The scales allowed investigators to determine if there were any appetite changes after the cacao nibs and pecans were taken.

### *Food Logs*

Food logs were created for each participant by the student investigators. Participants completed one log per meal for three weeks, which included breakfast, lunch, dinner, snacks and fluid intake. Each log also contained visual analogue scales (VAS). As an example of VAS, participants were asked “Please rate how hungry you feel before meal consumption below on the line.” The food logs also contained other questions relating to the start and finish times of the meal, the setting in which the meal took place, the mood at the time of the meal, and if the meal was purchased or homemade.

### *Food Processor Software*

Food logs were input into the computer program “Food Processor,” created by Elizabeth Stewart Hands and Associates (ESHA), for nutritional analysis of food consumed by subjects.<sup>10</sup> Caloric intake was calculated for total intake and dinner intake alone.

### *Cacao Nibs*

The cacao nibs used in this study were provided by Parliament Chocolate located in Redlands, California. The cacao nibs used in the study were dried and fermented from beans that were sourced from the Dominican Republic. The cacao nibs have no additional ingredients added. The amount of cacao nibs provided to each participant was 10 grams per day, which provided approximately 60 calories and 4.8 grams of fat.<sup>10</sup> The amount administered was measured using an electronic weighing scale. The cacao nibs were then packaged into individually sealed bags. Cacao nibs were distributed to participants in week three. The participants were instructed to consume the amount in one bag 15 to 30

minutes prior to eating dinner for the three days (Tuesday, Wednesday, and Thursday) in that week.

### *Pecans*

Pecans used in this study were provided by Loma Linda University School of Allied Health Professions Department of Nutrition and Dietetics. Pecans were weighed and packaged in the same manner as the cacao nibs. They were delivered as pre-weighed aliquots that were calorically equivalent to the cacao nibs and were administered during week four. Each package contained nine grams of pecans that provided approximately 63 calories and 6.3 grams fat.<sup>10</sup>

### *Procedures*

Appointments were made with participants who had expressed interest in the study (see Table 1 for the general framework of the study). The instructional PowerPoint was emailed to all potential participants prior to meeting with them during week one. This allowed participants to familiarize themselves with the instructions for the food logs and portion size estimates prior to the first meeting. The participants were also encouraged to bring any questions they had to our first meeting during week one. All questionnaires were administered during weeks one and five.

### *Week One*

At the first appointment during week one, potential participants were introduced to the student investigators. They were asked to complete informed consent documents (ICD), Health Insurance Portability and Accountability Act (HIPPA), and the following questionnaires: PSQI, PSS, and pre-screening.

Student investigators administered the pre-screening questionnaires first to help determine the eligibility of the participants based on the predetermined inclusion and exclusion criteria. Once participants were confirmed, they were asked to complete the remainder of the documents. These participants were then given more information on the procedures for the subsequent four weeks. They were encouraged to sample the cacao nibs to ensure that they enjoyed the taste.

In the ICD, participants were asked if they either agreed or disagreed to participate in a video interview upon conclusion of the study to obtain subjective information about their feelings throughout the study.

The first meeting with participants lasted about 15 minutes per person. A few participants were allowed to take home the PSQI and PSS to complete and return at the meeting scheduled for the following week. Questions were answered about the PowerPoint regarding food logging.

### *Week Two*

Participants met with student investigators at either the LLU campus or LLUAHSC. They were given their food log folders and were asked to begin keeping a food and beverage log

for three days (Tuesday, Wednesday, and Thursday). No changes in diet were asked of the subjects at this time. Subjects were asked to continue their usual diets. The purpose of logging their normal intake without any intervention was to obtain baseline data. The elimination of Monday and Friday, as well as weekends, was due to these days likely not being as consistent in food intake as mid-week days.

Thirty minutes prior to dinner, participants were asked to consume one 8 oz cup of water and no other food or beverage until the start time of their meal. This step was also implemented throughout the duration of the study in weeks three and four. Water was given to reduce the possible confounding variable of different feelings of fullness.

### *Week Three*

Student investigators met with the participants at either the LLU campus or LLUAHSC to deliver the cacao nibs. This week, participants were asked to consume the cacao nibs 15 to 30 minutes prior to dinner, along with the eight ounce cup of water previously mentioned. The participants were asked to keep food logs as done previously, as well as record the time of cacao nibs consumption and start time of dinner. This allowed the investigators to ensure participants were following the predetermined criteria that cacao nibs were to be consumed 15 to 30 minutes prior to the start of dinner.

### *Week Four*

Student investigators met with the subjects at either the LLU campus or LLUAHSC to deliver the pecans. Participants were asked to consume pecans in the identical manner as week three. Food logs were kept again for the same days, Tuesday through Thursday.

### *Week Five*

The final week of the study was a follow-up session with the participants. This session was held at either the LLU campus or LLUAHSC. For participants who specified their consent in the ICD, recorded video interviews were conducted allowing them to subjectively share their feelings related to the study. All food log folders were collected at this time and participants were asked to complete the post-questionnaires (PSQI, PSS, and post-screening). Participants were given a gift card of \$20 for Parliament Chocolate as a token of appreciation for their participation and commitment to the study.

### *Data Analysis*

Data were analyzed with SPSS version 24. Frequencies were used to summarize qualitative variables such as mood, setting, age, gender, and method of meal preparation. Means and standard deviations were calculated for BMI. A two-tailed paired t-test was used to compare the following: pre- and post-PSQI, pre- and post-PSS, VAS of appetite before and after the consumption of cacao nibs and pecans, and the differences in percent of dinner calories between day one and day two for weeks two (baseline), three (cacao nibs) and four (pecans). Repeated measures ANOVA was used to analyze shift in percent of dinner calories for baseline, week three and week four.

Food logs that were kept for three consecutive days (Tuesday, Wednesday, Thursday) were not consistently recorded for all participants. Therefore, only two out of the three days were analyzed for this study. Wednesday and Thursday were specifically used during week two because Tuesday of this week was a holiday, thus participants did not follow their typical dietary intake. For the subsequent weeks, the two days used for each participant were different depending on which set of data was most complete.

## **Results**

### *Participants*

Out of 47 individuals that contacted student investigators, 36 individuals were selected based on the inclusion and exclusion criteria. Fifteen participants were included in data analysis at the completion of the study (see Figure 1 for a flow sheet of participants from week one through week five). Thirteen of the participants were female and two were male. Participant Body Mass Index (BMI) varied from 18.9 kg/m<sup>2</sup> to 34.2 kg/m<sup>2</sup> with a mean of 23.9 kg/m<sup>2</sup> (SD = 4.7). The majority of the participants (73%) were between the ages of 18 and 29.

### *Caloric Intake of Dinner*

When analyzing caloric intake, results were calculated as a percentage of dinner calories for the entire day. The purpose was to determine if the amount of food eaten at dinner varied from week to week and if the type of intervention was a factor in amount of calories consumed.

Using repeated measures ANOVA, there was no difference found between the three weeks or within the weeks ( $p = .76$ ). There was also no difference found between the days ( $p = .38$ ). However, results from the paired t-test showed that between the two days during week three (cacao nibs), the difference between caloric intake was found to be significantly lower ( $p = .02$ ), with a mean difference of 9%. For week four (pecans), a slight difference was noted but it was not found to be significant ( $p = .46$ ) (Table 2).

### *Visual Analogue Scales*

Data for VAS were analyzed and results show that there was a reduction in appetite for both cacao nibs and pecans (Table 3). The reduction in pecans was greater than cacao nibs with mean difference values of 8.0 mm and 6.1 mm, respectively. When comparing both cacao nibs and pecans, only the reduction in appetite for pecans was found to be statistically significant ( $p = .02$ ).

### *Pittsburgh Sleep Quality Index and Perceived Stress Scale*

There was no significant change between the PSQI and PSS (Table 4) from week one to week five ( $p = .31$ ,  $p = .50$ , respectively).

### *Mood*

For each dinner, participants were required to indicate their current mood. Categories include the following: content/good, relaxed/calm, cheerful/happy, okay/normal, stressed/rushed, angry/depressed, tired, and hungry. Table 5 shows frequencies of mood for each domain. The most frequent moods of participants throughout weeks two through four were cheerful/happy at dinnertime (approximately 47%, 37%, and 27%, respectively). The percentage of cheerful/happy decreased over the course of the three weeks, indicating that moods changed from positive to negative. Over the course of the study, moods remained relatively consistent. For pecans, 11 of 14 participants were in the same mood for both meals. For cacao nibs, 9 of 14 participants were in the same mood for both meals.

### *Setting*

The setting of the meal varied from eating with company (i.e. with mother, sister, boyfriend, etc.), watching TV, at a restaurant, home/dorm, and alone. Table 6 shows frequencies of settings for 14 participants. Results show that >40% of participants ate with company, followed by either watching TV (~18%) or eating out at a restaurant (~13%), while eating alone was the least reported setting for dinner at 10%.

### *Method of Meal Preparation*

Meal preparation method options were either purchased, homemade, or a combination of both. For example, in week two, two out of the 15 participants purchased dinner for both of the days that were analyzed. Nine of these 15 participants made their dinners at home both of the two days that were analyzed. Of the 15 participants, three of them had a combination of purchased dinner and homemade dinner, for the two days that were analyzed. See Table 8 for results on frequency of meal preparation method for weeks two, three, and four.

## **Discussion**

To our knowledge, this is the first study that provides insight into appetite suppression and energy intake using cacao nibs as an appetite suppressant. The purpose of this study was to determine the difference in caloric intake as a measure of appetite when consuming 10 grams of cacao nibs (60 calories) versus 9 grams of pecans (63 calories). Each was consumed in an identical manner, 15-30 minutes prior to meal consumption. The findings from this study suggest that cacao nib consumption prior to mealtime produced an overall decrease in appetite, however, the results were not statistically significant. Results showed a slightly larger effect for pecans on appetite suppression than for cacao nibs.

Based on this study, various factors surfaced that may have had an overall influence on appetite. Some of these factors are timing of the intervention in relation to dinner, sleep, stress, control of water consumption, mood, and setting of dinner.

### *Strengths*

The study design included pre-determined instructions that participants were asked to follow. All participants were provided with specific instructions that were given within an appropriate time frame. Communication with participants was consistent and investigators were readily available to answer questions. Participants reported the study was well organized and the food logs were well designed for easy interpretation and logging. Participants also reported that PowerPoint instructions for logging their food intake were very clear and helpful. In addition, water was used as part of the intervention in this study to control the amount of fluid consumed with the interventions (cacao nibs and pecans).

### *Limitations*

Thirteen of the 28 original participants were eliminated because of non-compliance. The number of instructions and responsibilities for participants may have been overwhelming, leading to non-compliance, which resulted in missing data. Participants were not asked to specify the brands of food items consumed, which made it impossible to analyze the exact caloric/nutrient content of meals using the Food Processor program. Variability between exact timing of intervention and start time of meal may have altered the effectiveness of cacao nibs and pecans for decreasing overall appetite. Stress and sleep were two potential factors that could indirectly influence appetite and overall energy consumption, however, they were not assessed throughout the study. The setting of dinner was not controlled in this study, which could have influenced total caloric intake.

### *Recommendations for Further Studies*

In further studies, it would be useful to determine the optimal time of intervention prior to meal consumption to maximize satiety or decreased caloric intake. To reduce the percentage of non-compliant participants, food logging and food analysis could be done with smart phone applications. To determine the influence of water on appetite suppression, we recommend having three interventions (water, cacao nibs, pecans) for the same group of participants. Another recommendation would be to monitor levels of hunger between the timing of intervention and the start time of dinner. It would be optimal to conduct these studies in a free-living environment, however, some of these suggestions may only be able to be carried out in a controlled environment.

### **Conclusion**

The results from this study indicate that consumption of either cacao nibs or pecans decrease appetite. This indicates that there does not appear to be a unique component in cacao nibs that contributes to appetite suppression, however, other factors such as timing of intervention and meal, amount of consumption, nutrient compositions of intervention, sleep, stress, sample size, water, mood, and setting could influence the effects of cacao nibs and pecans on appetite.

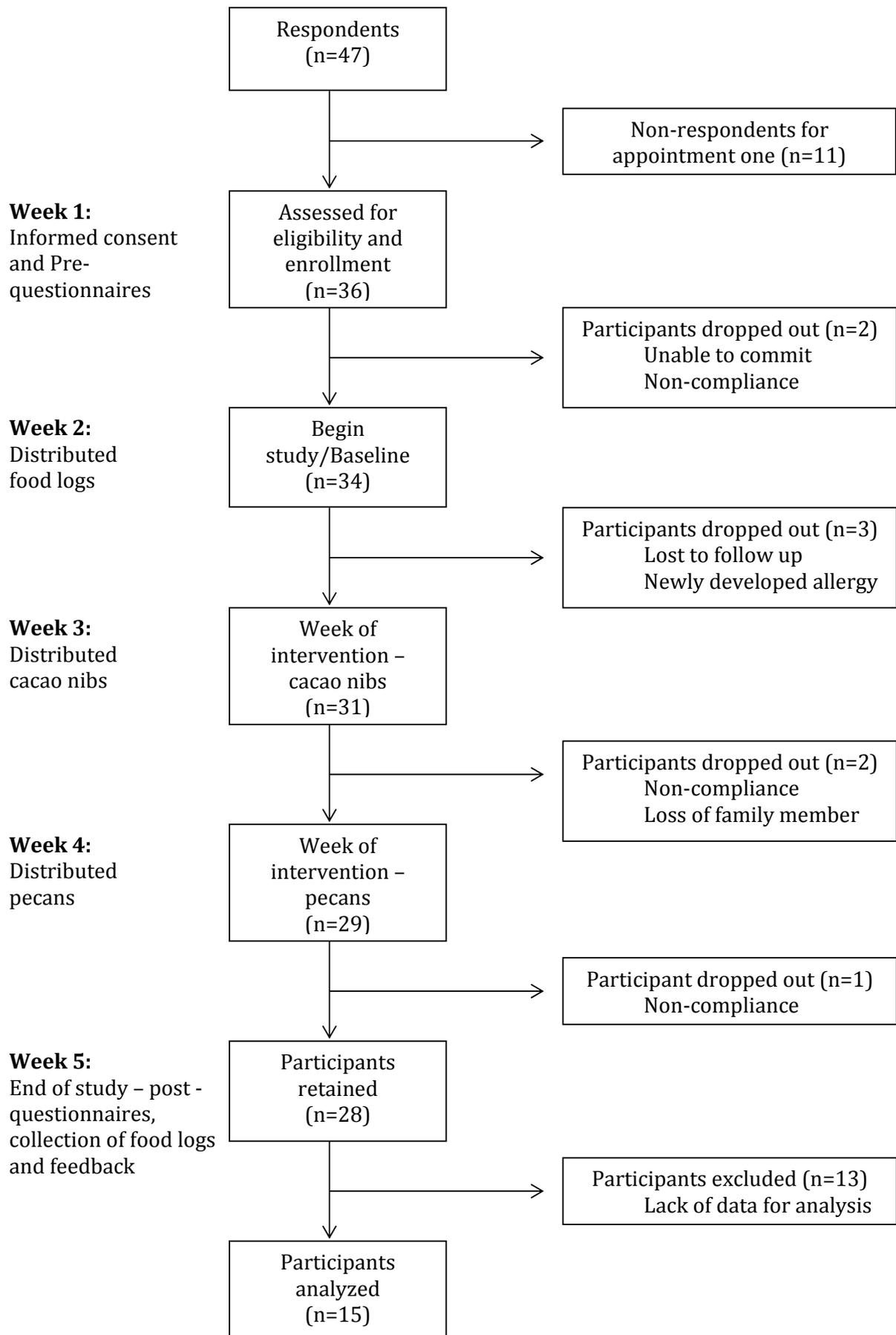
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**Figure 1. Participant Flowchart.**

Table 1. General Framework of the Study

	Week One	Week Two	Week Three	Week Four	Week Five
Procedures	Sampling of cacao nibs Questionnaires ICD & HIPPA Training and protocol	Control week No supplement administered	Cacao nibs	Pecans	Final meeting Video interview Questionnaires Collection of food logs
Logging	No food log	Food log	Food log	Food log	No food log

Table 2. Summary of Age, Gender and BMI for Study Participants (n=15)

Variable	Frequency
Age	
18-29	11
30-39	2
40-49	1
50-59	1
Gender	
Male	2
Female	13
BMI (kg/m <sup>2</sup> )	23.9* (4.7)

\*BMI data given as mean

Table 2. Means and (SD) for Percent Calories of Dinner between Weeks and Days

	Baseline Mean* (SD)	Cacao Nibs Mean* (SD)	Pecans Mean* (SD)	p-value**
Day 1	35.7 (18.3)	39.0 (13.8)	35.0 (14.8)	.76
Day 2	35.7 (18.3)	29.9 (10.8)	38.7 (13.7)	
Difference	0	9.1 (12.7)***	3.6 (18.3)	
p-value**		.38		

\*Mean values measured in %

\*\*Repeated measures ANOVA

\*\*\*Significant difference using paired t-test (p = .015)

Table 3. Means (SD) of Appetite for Cacao Nibs and Pecans Based on Visual Analogue Scales

	Cacao Nibs Mean* (SD)	Pecans Mean* (SD)	p-value**
Before	51.5 (23.7)	55.8 (23.7)	
After	45.4 (20.44)	47.8 (19.9)	
Difference	6.1 (29.3)	8.0 (11.5)	.75
p-value**	.44	.02	

\*Mean value units measured in millimeters (mm)

\*\*Paired t-test

Table 4. Mean (SD) of Perceived Stress Scale and Pittsburgh Sleep Quality Index

	Mean (SD)
PSS	
Pre	15.1 (5.2)
Post	14.3 (5.3)
Differences	0.8 (4.5)
p-value*	.50
PSQI	
Pre	5.2 (2.6)
Post	3.9 (3.1)
Differences	1.3 (4.0)
p-value*	.31

\*Paired t-test

Table 5. Comparison of Mood Frequencies at Dinner for Baseline (Week 2), Cacao Nibs (Week 3), and Pecans (Week 4) (n=14)\*

Mood	Week 2 Day 1	Week 2 Day 2	Week 3 Day 1	Week 3 Day 2	Week 4 Day 1	Week 4 Day 2
Content/Good	2	1	3	3	1	1
Relaxed/Calm	2	3	3	1	3	2
Cheerful/Happy	8	6	7	4	4	4
Okay/Normal				2	1	1
Stressed/Rushed		1	1	2	2	3
Angry/Depressed	1				1	
Tired	1	2		2	2	1
Hungry		1				2
Total	14	14	14	14	14	14

\*One participant with missing data

Table 6. Frequencies of Setting at Dinner (n=14)\*

Setting	Week 2	Week 2	Week 3	Week 3	Week 4	Week 4
	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2
With Company	8	8	7	7	6	6
Watching TV	2	2	3	3	3	3
Restaurant	2	2	4	4		4
Home/Dorm	2	2			3	
Alone					2	1
Total	14	14	14	14	14	14

\*One participant with missing data

Table 7. Summary of Meal Preparation Methods

Method of Preparation	Week 2 Baseline	Week 3 Cacao Nibs	Week 4 Pecans
Purchased	2	1	2
Homemade	9	5	10
Mixed*	3	8	2
Total**	14	14	14

\*Day 1 purchased & day 2 homemade, or vice versa

\*\*One participant with missing data