

An Unblinded Study of the Physiological Effects of *Moringa* Tea and Coffee on Pulse in Young Adult Nigerians.

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ABSTRACT

Pulse is a prognostic factor for cardiovascular disease (CVD) and tells how heart rate can be affected by substances consumed. This work examined the physiological effect of coffee and *moringa* tea on the pulse rate of 48 subjects (24 males and 24 females) aged 17 – 24 years old using an optical BIOPAC Photoplethysmography (PPG). Results obtained showed that coffee lowered the pulse rate in the observed subjects irrespective of gender while *moringa* did not have any significant effect on the subjects' pulse rate. Data collected also shows all heart rates are still within the normal range of 60 – 100 beats per minute. This research work concludes that at tested conditions (equal weight of coffee and *moringa* dissolved in water at the same temperature), coffee impacts heart rate with differing effects in genders at various times while *moringa* does not have a significant effect in a young adult population. This could inform the design of public health policies for the target group especially in university communities.

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1.0 Introduction

Heart rate (HR) is the rate of recurrence of the cardiac cycle, consisting of periods of myocardial contraction and relaxation. Also known as pulse rate, it has been used historically and in modern times to indicate the presence and absence of life, and as a vital sign in contemporary medicine [1], [2]. Pulse is a prognostic factor for cardiovascular disease (CVD), as an elevated heart rate is associated with increased risk of CVD-related deaths [3]–[5].

HR is considered to control the metabolic activity of the body, since adjusting the rate enables the heart to regulate the temperature as well as the energy requirements of the whole body [6], [7]. Many factors can influence and affect HR, including but not restricted to physical fitness, psychological status, diet, drugs, and the genetics interaction and the environment. Historically, humans utilized existence or lack of a pulse, which equals HR under appropriate conditions, as an indicator to differentiate between life and death [1]. Heart rate can be modified by a number of factors, such as physical activity, psychological stress, ingestion, smoking and medications [8]–[13].

Consumption of some beverages such as coffee have been associated with risk of CVD and their effects have been extensively studied in recent years; a growing body of evidence suggesting a change in the perception of the health effects of this beverage may be needed [14], [15]. Coffee is a widely consumed stimulant, whose regular consumption is associated with elevated blood pressure, contributing to the onset of CVD [16], [17].

Conversely, *Moringa* is a herb reported to reduce blood pressure [18], [19], leading to its indiscriminate consumption by hypertensive patients due to this perceived benefit [20]–[22]. Sundararajan [23] reported that *M. Oleifera* leaf has the potential to prevent CVDs because of its antioxidant, hypo-lipidemic and atherosclerotic properties.

There appears to be a dearth of study on the effects of *Moringa* on pulse rates while that on blood pressure abounds. As heart rate is an independent risk factor in CVD and mortality, understanding the effect of widely consumed stimulant, Coffee, and *Moringa* on the Cardiovascular system (CVS) is important. Therefore, this study seeks to examine the effect of Coffee and *Moringa* tea on the heart rate of a young adult population in Nigeria.

2.0 Methods

2.1 Subjects

This study was performed on participants drawn from the Faculty of Engineering and Technology, University of Ilorin. The subjects comprised of twenty-four (24) males and twenty-four (24) females, totalling forty-eight (48) individuals. Each gender group were divided into three equal sub-groups to be administered water, moringa and coffee. All participants consented to participate in the study and filled a consent form. The form was also used to capture their demographic data and information about if they are habitual, non-habitual or non-users of caffeinated drinks, nicotine, cocaine,

marijuana and herbal medicine for research purposes. The subjects were briefed about the experimental procedures and assumed a sitting upright position, facing away from the computer monitor after substance consumption. Their ECG and pulse rate were recorded for thirty (30) minutes. The experiment was conducted in accordance with International Compilation of Human Research Standards and was approved by the Faculty of Engineering Ethics Committee, University of Ilorin. Each subject's anthropometric measurements, calculated BMI and substances consumed are presented in Table 1. In the Table, 1 = Gender, 2 = Age (years), 3 = Height (m), 4 = Weight (kg), 5 = BMI (kg/m²) and 6 = Substance.

Table 1: Anthropometric Measurements

1	2	3	4	5	6	1	2	3	4	5	6
M	23	1.68	58	20	Coffee	F	20	1.51	45	19	Coffee
M	17	1.72	52	17	Coffee	F	20	1.65	58	21	Coffee
M	17	1.7	62	21	Coffee	F	18	1.74	76	25	Coffee
M	21	1.77	63	20	Coffee	F	19	1.6	59	23	Coffee
M	24	1.84	64	18	Coffee	F	17	1.73	78	26	Coffee
M	20	1.76	67	21	Coffee	F	18	1.65	57	20	Coffee
M	20	1.82	73	22	Coffee	F	18	1.57	53	21	Coffee
M	19	1.75	73	23	Coffee	F	21	1.7	60	20	Coffee
M	23	1.74	69	22	Water	F	20	1.63	56	21	Water
M	24	1.72	55	18	Water	F	18	1.76	58	18	Water
M	17	1.67	66	23	Water	F	17	1.66	69	25	Water
M	21	1.71	63	21	Water	F	17	1.6	49	19	Water
M	23	1.78	62	19	Water	F	18	1.56	61	25	Water
M	20	1.75	66	21	Water	F	23	1.67	51	18	Water
M	17	1.73	61	20	Water	F	17	1.62	59	22	Water
M	19	1.71	59	20	Water	F	21	1.57	60	24	Water
M	21	1.76	75	24	Moringa	F	23	1.7	50	17	Moringa
M	18	1.71	55	18	Moringa	F	18	1.5	36	16	Moringa
M	18	1.64	61	22	Moringa	F	19	1.57	47	19	Moringa
M	18	1.77	66	21	Moringa	F	19	1.56	50	20	Moringa
M	23	1.82	79	23	Moringa	F	18	1.67	60	21	Moringa
M	22	1.77	71	22	Moringa	F	19	1.6	50	19	Moringa
M	23	1.75	56	18	Moringa	F	22	1.6	58	22	Moringa
M	19	1.72	55	18	Moringa	F	22	1.59	66	26	Moringa

2.2 Electrocardiogram Measurement

To measure Electrocardiogram (ECG) parameters, and heart rate (HR), a Biopac electrode lead set was attached to a subject at 3 different points: wrist, just above the left ankle, and the right ankle to take the ECG parameter and a Pulse transducer (SS4LA) attached to the tip of the right index finger of the subject to record the pulse rate. The ECG and pulse rate values were measured after each subject had taken one of the three drinks (water, moringa or coffee) provided. The subjects were distributed in three groups for each gender. One gender group of six subjects, served as the control group (water), drank ordinary water, another gender group of 6 subjects drank moringa prepared with 2 g of moringa in a tea-bag dissolved in 25 cl of water at 30 °C and 6 subjects in each of the gender group drank coffee (2 g in 25 cl of water prepared at 30 °C). The experiment protocol entailed giving the participants a cup of coffee, moringa or water to drink and the cardiac function observed immediately after substance consumption. Cardiac function analysis was conducted by electrocardiogram observation and pulse rate recording after the consumption of the substance. At the end of the experimental protocol, no subject reported any adverse effect of the consumed substances or illness.

2.3 Statistical Analysis

For each subject, continuously registered data were recorded between the baseline (T_0) and 28 minutes at an interval of four minutes. The mean and standard deviation of the anthropometric variables (height, weight, and BMI) of each subject was obtained. A one-way analysis of variance with subsequent Turkey *post hoc* test was performed to compare the means of the substances consumed. A Duncan paired T-Test was used for the comparison of two means; the gender by the substance consumed at all intervals. A similar comparison was performed on the BMI by substance variables. Furthermore, a chi-square test was done on the effect of BMI on the pulse rate of the subjects with respect to the substance consumed. The BMI data was arranged in a classified grouped distribution based on the standard BMI range. The expected result was estimated using equation (1).

$$E_{ij} = \frac{\text{Row Total} \times \text{Column Total}}{\text{Column Total}} \quad (1)$$

The calculated value was achieved using $\sum(O_i - E_i)^2/E_i$ and the critical value was obtained using $\chi^2(r-1)(c-1)$, α where r = row, c = column, and α = level of significance. The decision rule rejects the null hypothesis H_0 if the statistics calculated is greater than the table value. All the statistical analyses were performed with the SPSS software (IBM SPSS Statistics version 20.0.0.0).

3.0 Results and Discussion

3.1 The Effect of coffee/moringa tea on HR

ECG and pulse transducer's records show that the consumption of *moringa* did not have any abrupt change in the HR of the subjects in both genders. In contrast, the consumption of coffee induced abrupt changes in the HR of the subjects. The effect of coffee started to be significant after 10 minutes of consumption as seen in Figure 1 below:

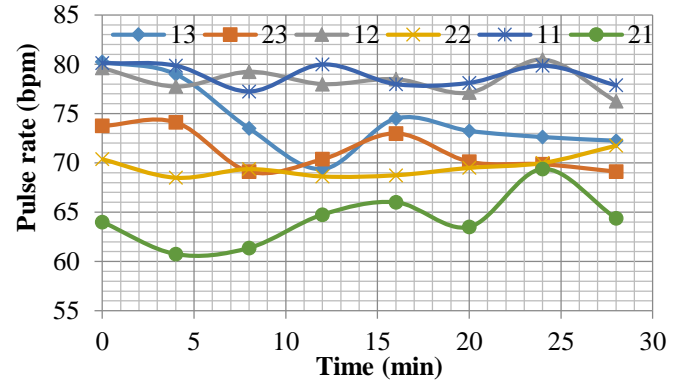


Figure 1. Pulse rate change against Time for Gender by Substance (GenderCode 1 = Female, GenderCode 2 = Male; ProductCode 1 = Water, ProductCode 2 = Moringa, ProductCode 3 = Coffee).

The summation of difference in heart rate for male and female assigned to water are 0.05 and 0.32 respectively and are the lowest in each of their respective group. This shows that water was indeed a good control as it did not have significant effect on the heart rate of subjects within the duration of the study. The effect of Moringa appeared to be minimal just like water when their sinusoidal graphs are observed and compared in both male and female subjects, since their variations from the baseline did not indicate any significant increment or decrement, but a repeated sinusoidal progression.

While the graph for Moringa and Water followed a sinusoidal progression, the Coffee graph displayed a sharp decrease in heart rate until about 10 – 12 min before there was an increment in heart rate as shown in Figure 1. The initial decrease in heart rate from the baseline for Coffee graph could be attributed to system bias since the products were expected to be administered blindly. However, as the subjects had prior knowledge of the substances they were to consume, it could have probably led to the initial excitation of their cardiovascular activities at the baseline. Subsequent observation of the heart rate graph showed a decline until about 12 min, similar to results obtained by Boolani [24] and opined that the arousal of caffeine effects in the body can be obtained 10 min post-

consumption. Therefore, this explains the increase in the heart rate witness after 10 minutes for the male subject and after 12 minutes for the female subjects. This increment in heart rate continued for about 5 - 7 minutes in the female and male subjects respectively before a gradual decline is maintained as shown in Figure 2. Therefore, it is safe to say that the mean effect of coffee consumption is pronounced in both subjects group, most especially in the female subjects' group and it cumulatively lowers the pulse rate. The Coffee graph for male subjects had similar pattern as the female graph except that the arousal effect of caffeine occurred earlier between 9 to 10 minutes.

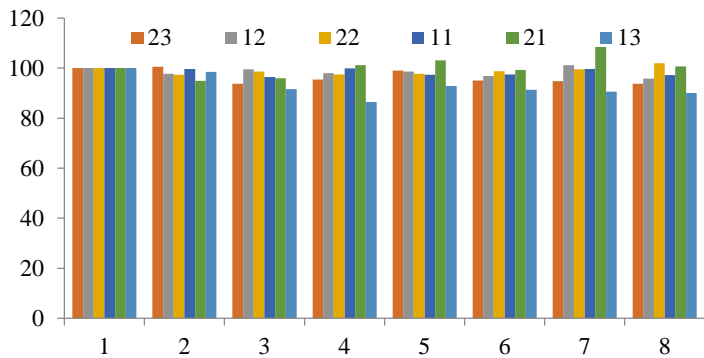


Figure 2. Heart Rate Percentage Change for Gender by Substance (GenderCode 1 = Female, GenderCode 2 = Male; ProductCode 1 = Water, ProductCode 2 = Moringa, ProductCode 3 = Coffee).

Table 2. Distribution of Product consumed against BMI.

Products	BMI											Totals
	16	17	18	19	20	21	22	23	24	25	26	
Coffee	0	1	1	1	4	4	1	2	0	1	1	16
Moringa	1	1	3	2	1	2	3	1	1	0	1	16
Water	0	0	3	2	2	3	2	1	1	2	0	16
Totals	1	2	7	5	7	9	6	4	2	3	2	48

The calculated value yielded 4.2534, a value that was less than the table value of 12.952. Hence, the null hypothesis H_0 cannot be rejected and concludes that there is no significant effect of the products on BMI at 5% level of significance. From Figure 1, at baseline (pre-administration of product, T_0), pulse rate was significantly higher in female individuals assigned to the coffee, moringa and water groups than all comparative male product group. Also, the average pulse rate of males assigned to coffee was comparatively higher than the heart rate of other male product group and it was also observed that the baseline average pulse rate of male

2.4 The effect of BMI on subjects' response

To detect if the BMI as an anthropometrical variable impacts the detected HR difference because of the consumed substance by a subject, a chi-square test done on BMI against Product. Table 2 shows the distribution of BMI across the Products. The result yielded a marginal difference in change in heart rate for the sample size observed. Hence, there is no significant effect of the BMI on the pulse rate based on the consumption of the products as demonstrated by the chi-square test.

The 2 by 3 one-way ANOVA Post-Hoc tests on gender by product yielded marginal significance in the heart rate interactions. The test on BMI by product yielded small differences, although more samples would be needed if a significant and more accurate result is to be obtained. For the paired T-Test ANOVA, the Coffee effect was significant in male subjects compared to other products with an increase in the average heart rate for both users and non-users. The one-way ANOVA multiple comparisons of rate increase and rate percentage change on product by gender produced a result in which the products all nearly started from the baseline for female subjects while the starting baseline for male subjects varied significantly. A few factors could have contributed to this variation in male subjects, with the major contributor being the effect of system bias.

individuals assigned to the water group was significantly lower than all other subject and product group. This could be attributed to bias of the system. It is pertinent to point out that the baseline observed heart rates were not because of substance consumption but the initial physiological state of the subject pre-consumption.

At four minutes following administration of substances (T_4), pulse rate was significantly ($p < 0.05$) higher in the female water group than in the male *moringa* group and male water group. The female and male coffee groups as well as the female *moringa* group were not significantly different from the female water group and the

male *moringa* group. The male water group has significantly ($p < 0.05$) lower pulse rate than all but the male *moringa* group. The two products had a significant effect on heart rate in female subjects. However male test subjects that consumed coffee had a significantly higher pulse rate than those that consumed water. Though the pulse rate of male subjects consuming *moringa* is slightly higher than that of the water group, this difference did not achieve statistical significance ($p > 0.05$)

Gender had no significant effect on pulse rate at T4 in coffee and *moringa* drinkers with a higher pulse rate. Product had no significant effect on pulse rate in females at T4. In males however, males consuming water had significantly lower T4 pulse rate than those consuming coffee. The pulse rate of males among *moringa* has between the two groups not significantly different from either. Also, irrespective of product substance consumed, females had higher T8 pulse rate than males administered water. Gender had no effect on T8 pulse rate in groups administered coffee and *moringa*. However, females administered water had a significantly higher pulse rate than males administered the same substances. No product effect on T8 pulse rate was observed in males and females.

The pulse rate of males and females administered coffee fell between the two. Gender had no effect on T12 pulse rate in the coffee and *moringa* groups. However, females consuming water had a higher ($p < 0.05$) pulse rate than males consuming the same product. Substances had no effect on T12 pulse rate within gender and gender had no effect on T12 pulse rate within substances. The lower heart rate in males consuming coffee is consistent with published literature indicating that coffee (essentially caffeine) lowers pulse rate at low doses [25], which in turn is meteorically explained by its effect in elevating blood pressure. The current data suggest that this observation is limited to males at least at the point of consumption in the subjects examined.

The higher baseline pulse rate in females than male individuals point to sexual dimorphism of basal pulse rate in the studied demographic group. This rate is consistent with published literature showing that females generally have a higher pulse rate than males [26], [27]. It has been shown that the dimorphism is because of oestrogen and its effect on the hypothalamus pituitary areas. The trend towards significantly higher pulse rate in male individuals assigned to Coffee than those assigned to the water may indicate a psychological stress response to visual suggestion stimuli i.e., acquisition of prior knowledge of the product which the tested individuals would shortly consume. Unlike in Western societies, “*coffee consumption in Nigeria is still in its infancy*” [28] and not much is reported about the patterns of behaviour and consumptions amongst the demographic group examined by this study.

Conclusion

The variation in heart rate arising from coffee consumption across different genders indicated a cumulative decrease in pulse rate with arousal effect observed around 10-12 minutes after consumption while *moringa* tends to have no significant effect on the measured pulse rate of the male and female subjects with their mean observed pulse rate almost equal to the pre-consumption measured heart rate of the subjects. The experiment suggests that consumption of coffee erodes the gender dimorphism of pulse rate observed at baseline, and evident and preserved in individuals consuming water, which contains potentially pulse-rate-modulatory components. The effects of BMI on the heart rate of a subject when consuming coffee or Moringa were found to be minute. Future research can be geared towards understanding to what extent, habitual/familiarity with *Moringa* and Coffee might affect anticipated changes in heart rate prior to consumption in test subjects. Also, examination of the placebo effect (psychological responses) that underline the results of the present study through compacting double-blinded studies may be researched.

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