



Haematological Assessments of *Cocos nucifera* Linn. Water and Oil on Apparently Healthy Wistar Albino Rats

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

In this study, the effects of the consumption of *Cocos nucifera* L. water and oil on the haematological parameters of apparently healthy wistar albino rats were investigated using standard methods. The albino rats (n= 100) were divided into 8 groups (A-H) of 12 rats each while the remaining four rats were put in another group to serve as control. The first four groups(A-D) were daily orogastrically administered different volumes of coconut oil, 0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml respectively for 4 weeks while groups E-H were daily orogastrically administered different volumes of coconut water, 0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml respectively for four weeks. The control rats (Group I) however were not administered either coconut water or coconut oil. All the rats were allowed free access to rat chow and water. The administration of either of the coconut water or oil caused a significant increase ($p \leq 0.05$) in the PCV, WBC and the differential leukocytes counts within the four weeks of this study with coconut water having higher effect. It is conceivable that the consumption of either coconut water or coconut oil could exert both hematinic and immuno-stimulatory effects in the consumers to checkmate low PCV and also boost innate immunity.

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Keywords: Coconut water, coconut oil; immuno-stimulatory potential; haematological parameters; differential leukocytic count; haematinic potential.

1. INTRODUCTION

Coconut (*Cocos nucifera* Linn.) fruit, is egg-shaped or elliptic. It consists of a fibrous outer layer called coconut husk (mesocarp), which covers a hard layer called shell (endocarp). Inside the shell is a kernel (endosperm), which is considered the most important part of the fruit. Coconut water is sterile, does not produce heat, does not destroy red blood cells and is readily accepted by the body. It makes the absorption of drugs easier by its electrolytic effect, urinary antiseptic and eliminates poisons in case of mineral poisoning [1]. Small amounts of amino acids are also present in coconut water. The percentage of arginine, alanine, cystine and serine in the protein of tender coconut water are higher than those in cow's milk. Trace amount of amino acid such as aspartic acid, glutamic acid, histidine, leucine, lysine, proline, phenylalanine and tyrosine are also reported in tender coconut water [2]. Coconut water is readily available, economically reasonable, and traditionally tolerable besides having various general and oral health benefits without any side effects with numerous amino acids needed by the human immune system to boost immunity. Coconut oil is an edible oil extracted from the "meat" of matured coconuts [3]. Coconut oil is a mild flavored, mostly colorless oil produced from mature coconuts. It is a clear liquid above 76°F (24°C) and a white or light brown solid at lower temperatures. It has several applications in the food industry. It is used in processed foods because it is relatively inexpensive and can provide crisp texture to foods. Coconut oil is a safe and effective moisturizer, produces a high-lather soap due to its solubility in hard water, and can be used in cosmetics, toothpaste, lotions, sunscreens, laundry detergents, as well as several other self-care and household items [4]. It has a high smoke point, the temperature where it starts to break down, which makes it shelf stable and ideal for foods that need a longer shelf-life. Coconut oil is considered a saturated fat and contains 9 calories per gram. Therefore it should be consumed only in small amounts because it can raise the LDL (bad) cholesterol alongside HDL (good) cholesterol level. One tablespoon of coconut oil contains 117 calories, 14 grams of fat, 12 grams of saturated fat and therefore must be taken in moderation [5].

In addition to its culinary uses, inclusion in cosmetics and soaps, this oil is also consumed in folklore medicine to treat various ailments. This study therefore is to assess the effects of consumption of coconut water and oil on the haematological parameters of Wistar albino rats as a guide to the possible effects in humans when consumed for a considerable period of time for health promoting purposes.

2. MATERIALS AND METHODS

2.1 Coconut Water

Fresh coconut water was collected from cleaned coconuts bought from the commercial fruit market in Akure, Nigeria.

2.2 Coconut Oil

Coconut oil (AQUILLA 100% Virgin Coconut Oil with NAFDAC Reg No. 08-1725L) used in this study was purchased from a pharmaceutical shop in Akure, Nigeria. Coconut oil fat is a fat consisting of about 90% saturated fat. The oil contains predominantly triglycerides with 86.5% saturated fatty acids, 5.8% monounsaturated fatty acids and 1.8% polyunsaturated fatty acids.

2.3 Experimental Design

Wistar Albino rats were used for this study because of their close genetic structural makeup to humans. A total of hundred Wistar albino rats were used in this study and divided into were divided into 8 groups (A-H) of 12 rats each while the remaining four rats were put in another group to serve as control. The first four groups (A-D) were daily orogastrically administered different volumes of coconut water, 0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml respectively for 4 weeks while groups E-H were daily orogastrically administered different volumes of coconut water, 0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml respectively for four weeks. The control rats (Group I) however were not administered either coconut water or coconut oil. All the rats were allowed free access to rat chow and water. At intervals of 1 week, the blood of 3 rats randomly picked from each group was collected through venepuncture for the haematological assay.

2.4 Haematological Assay

The blood of apparently healthy Wistar albino rats was collected weekly into EDTA bottles after which the Packed Cell Volume (PCV), total White Blood Cell counts and differential leukocytes counts of the collected blood samples were evaluated according to Nwangwa & Chukwuemeka [6].

2.5 Statistical Analysis

Data generated from the study were subjected to two-way Analysis of Variance (ANOVA). Treatment means were compared using Duncan's New Multiple Range Test (DNMRT) at 5% level of significance using SPSS version 26.

3. RESULTS AND DISCUSSION

Main characteristics of the study population

Group	Title	Number of rats	Treatment
A – D	Coconut oil	48	0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml + distilled water and feed
E – H	Coconut water	48	0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml + distilled water and feed
I	Control	4	Distilled water and feed.

Administration of coconut oil to apparently healthy albino rats caused a significant increase ($p < 0.05$) in PCV from an initial value of $48.00 \pm 0.50\%$ to $51.00 \pm 0.00\%$ after 28 days of administering the rats with the oil at a 0.5ml dose. In the same vein, administration of coconut water also caused a significant increase ($p < 0.05$) in the PCV from the initial value of $48.00 \pm 0.50\%$ to $56.50 \pm 0.50\%$ after 28 days of administering the rats with the coconut water at a dose of 0.5 ml. However, the percentage increase in PCV was observed to be higher in the rats administered coconut water than those administered coconut oil at all doses and the higher the dose of the different component of coconut used, the higher the PCV of the rats except in a few cases (Table 1).

Effects of coconut oil or coconut water on the total White Blood Cell counts of apparently healthy Wistar albino rats showed the total white blood cell count of healthy rats fed with coconut

oil increased from an average initial value of 11.00 ± 0.50 to 11.00 ± 0.50 , 11.60 ± 0.90 , 12.60 ± 0.60 and 13.50 ± 0.50 after 7, 14, 21, 28 days of feeding the rats with coconut oil at a dose of 0.5 ml. In the same vein, rats fed with coconut water which had an initial average value of 11.00 ± 0.50 , increased to 11.95 ± 0.95 , 11.15 ± 0.25 , 12.15 ± 0.25 and 11.05 ± 0.10 by day 7, 14, 21 and 28 of the administration of the water the rats at a dose of 0.5 ml. Percentage increase in the total white blood cell counts was higher in rats administered coconut water than those administered coconut oil at all doses and the higher the dose of the different coconut product, the higher the WBC of the animals (Table 2).

The administration of coconut oil to the apparently healthy rats at a dose of 0.5ml had no significant effect on the initial NEUTROPHIL value of 55.50 ± 0.50 to 56.50 ± 0.50 , 55.00 ± 0.50 , 55.00 ± 0.33 and $53.00 \pm 0.20\%$ after 7, 14, 21 and 28 days. However, the administration of the same proportion of coconut water had a significant increase in the neutrophil count of the rats from 55.50 ± 0.50 to 57.00 ± 0.40 , 57.00 ± 0.33 , 58.50 ± 0.50 and 56.00 ± 0.40 after days 7, 14, 21 and 28 (Table 3).

The EOSINOPHIL count of the apparently healthy rats administered coconut oil had no significant increase from the initial value of 2.50 ± 0.00 to 2.00 ± 0.00 , 2.00 ± 0.00 , 2.50 ± 0.50 and 2.50 ± 0.50 at a dose of 0.5 ml at days 7, 14, 21 and 28. At the same proportion of coconut water, the eosinophil count had a slight increase to 3.00 ± 0.00 and 3.00 ± 0.00 at days 21 and 28 respectively. An increase in the doses however, had slight effect on the eosinophil counts (Table 4).

Effects of coconut oil or coconut water on the differential leukocytic counts of apparently healthy Wistar albino rats showed the LYMPHOCYTE counts of healthy wistar rats fed with coconut oil had no significant effect from the initial value of 32.00 ± 0.50 to 32.50 ± 0.50 , 30.00 ± 0.00 , 31.00 ± 0.00 and 30.00 ± 0.00 after 7, 14, 21 and 28 days of administration of the oil to the rats at a dose of 0.5 ml. The administration of coconut water to the rats however, recorded a significant increase in the lymphocyte count from 32.00 ± 0.50 to 34.50 ± 0.50 at day 28 at same proportion (Table 5).

Table 1. Effects of administration of coconut oil and coconut water on PCV of apparently healthy Wistar albino rats (%)

Sample	Days of assay	Doses of sample administered				
		0.0ml	0.5ml	1ml	1.5ml	2.0ml
Coconut oil	Day 0	48.50±0.50 ^a	48.50±0.50 ^a	48.50±0.50 ^b	48.50±0.50 ^b	48.50±0.50 ^a
	Day 7	48.50±0.50	51.50±0.50 ^c	51.00±0.33 ^c	53.50±0.50 ^c	54.00±0.30 ^c
	Day 14	48.50±0.50	49.50±0.50 ^b	49.00±0.00 ^b	62.50±0.50 ^e	56.50±0.50 ^e
	Day 21	48.50±0.50	52.50±0.50 ^d	50.50±0.50 ^c	46.00±0.00 ^a	55.00±0.00 ^d
	Day 28	48.50±0.50	51.00±0.00 ^c	46.50±0.50 ^a	56.00±0.00 ^d	53.00±0.20 ^b
Coconut water	Day 0	48.50±0.50 ^a	48.50±0.50 ^a	48.50±0.50 ^a	48.50±0.50 ^a	48.50±0.50 ^a
	Day 7	48.50±0.50	56.50±0.50 ^c	56.00±0.50 ^{cd}	58.00±0.00 ^d	58.50±0.50 ^d
	Day 14	48.50±0.50	56.50±0.50 ^c	55.50±0.00 ^c	56.50±0.50 ^c	57.50±0.43 ^c
	Day 21	48.50±0.50	54.50±0.50 ^b	54.00±0.50 ^b	55.50±0.50 ^b	56.50±0.50 ^b
	Day 28	48.50±0.50	56.50±0.50 ^c	56.50±0.50 ^d	57.50±0.33 ^d	58.50±0.33 ^d

Data represent the average for 3 replicates \pm S.E.M and those with different alphabet superscripts along columns for each treatment are statistically significant at $p < 0.05$

Table 2. Effects of administration of coconut oil and coconut water on the WBC counts of apparently healthy Wistar albino rats (%)

Sample	Days of assay	Doses of sample administered				
		0.0ml	0.5ml	1ml	1.5ml	2.0ml
Coconut oil	Day 0	11.00±0.00 ^a	11.00±0.00 ^a	11.00±0.00 ^{ab}	11.00±0.00 ^a	11.00±0.00 ^a
	Day 7	11.00±0.00	11.00±0.50 ^a	10.70±0.70 ^a	14.50±1.50 ^c	16.55±0.50 ^c
	Day 14	11.00±0.00	11.60±0.40 ^a	12.50±1.50 ^{bc}	12.00±1.00 ^{ab}	15.95±0.65 ^{bc}
	Day 21	11.00±0.00	12.60±0.60 ^b	11.50±0.50 ^{abc}	12.35±0.95 ^{ab}	13.70±0.70 ^b
	Day 28	11.00±0.00	13.50±0.50 ^c	12.65±0.65 ^c	13.00±1.00 ^{bc}	16.05±0.95 ^c
Coconut water	Day 0	11.00±0.00 ^a	11.00±0.00 ^a	11.00±0.00 ^a	11.00±0.00 ^a	11.00±0.00 ^a
	Day 7	11.00±0.00	11.95±0.95 ^c	11.20±0.20 ^a	11.05±0.15 ^a	15.60±0.40 ^b
	Day 14	11.00±0.00	11.15±0.25 ^{ab}	11.00±1.00 ^a	14.00±1.00 ^c	19.15±0.25 ^d
	Day 21	11.00±0.00	12.15±0.25 ^c	13.10±0.20 ^b	13.15±0.25 ^{bc}	17.50±0.40 ^c
	Day 28	11.00±0.00	11.05±0.15 ^a	13.00±0.20 ^b	12.80±0.70 ^b	17.00±0.20 ^c

Data represent the average for 3 replicates \pm S.E.M and those with different alphabet superscripts along columns for each treatment are statistically significant at $p < 0.05$

Table 3. Effects of administration of coconut oil and coconut water on the neutrophil counts of apparently healthy Wistar albino rats (%)

Sample	Days of assay	Doses of sample administered				
		0.0ml	0.5ml	1ml	1.5ml	2.0ml
Coconut oil	Day 0	55.50±0.50 ^a	55.50±0.50 ^b	55.50±0.50 ^b	55.50±0.50 ^a	55.50±0.50 ^a
	Day 7	55.50±0.50	56.50±0.50 ^c	60.00±0.20 ^d	55.50±0.50 ^a	57.50±0.50 ^a
	Day 14	55.50±0.50	55.00±0.50 ^b	56.50±0.50 ^c	55.50±0.50 ^a	56.00±0.50 ^a
	Day 21	55.50±0.50	55.00±0.33 ^b	54.00±0.20 ^a	55.00±0.20 ^a	55.00±0.40 ^a
	Day 28	55.50±0.50	53.00±0.20 ^a	59.50±0.50 ^d	57.00±0.20 ^b	60.00±0.33 ^b
Coconut water	Day 0	55.50±0.50 ^a	55.50±0.50 ^a	55.50±0.50 ^{ab}	55.50±0.50 ^b	55.50±0.50 ^a
	Day 7	55.50±0.50	57.00±0.40 ^b	57.00±0.33 ^c	56.50±0.25 ^c	60.00±0.33 ^c
	Day 14	55.50±0.50	57.00±0.33 ^b	55.00±0.33 ^a	55.50±0.50 ^b	58.00±0.33 ^b
	Day 21	55.50±0.50	58.50±0.50 ^c	56.00±0.40 ^b	59.00±0.33 ^d	59.50±0.50 ^c
	Day 28	55.50±0.50	56.00±0.40 ^a	55.00±0.40 ^a	54.00±0.33 ^a	61.50±0.50 ^d

Data represent the average for 3 replicates \pm S.E.M and those with different alphabet superscripts along columns for each treatment are statistically significant at $p < 0.05$

3.1 Discussion

In this study, the effect of Coconut oil and coconut water on the haematological profile of

apparently healthy albino rats was investigated. The administration of either coconut oil or coconut water caused a significant increase ($p < 0.05$) on the haematological parameters such

as PCV, total WBC, lymphocytes and neutrophil counts at a dose which ranged from 0.5ml-2.0ml administered to the rats but no effects on the eosinophil counts. These findings are in agreement with the reports of Zakaria et al. [7] who claimed that this improvement is due to the presence of medium-chain fatty acids in coconut oil and majorly the presence of electrolytes, vitamins, amino acids in coconut water. Kalman et al. [8] postulates that "coconut water can be used intravenously in humans and as a rehydrating drink for athletes".

Packed Cell Volume also known as Hematocrit is a measurement of the percentage of red blood cells present in the blood. PCV levels that are too high or too low can indicate a blood disorder,

dehydration or other medical condition. A normal level of PCV indicates the capability of the red blood cells to deliver oxygen. The values of PCV obtained from this study showed that apparently healthy rats administered coconut water and coconut oil had an increase in the PCV which indicates an increase in the viable red blood cell that are capable of delivering oxygen for use in the body. The superior increase in PCV of rats administered coconut water suggests that coconut water has the ability to stimulate viable red blood cells. The significant increase in the packed cell volume of the rats may indicate that coconut water and coconut oil contain several compounds, such as proteins, peptides lipopolysaccharides and glycoproteins [6].

Table 4. Effects of administration of coconut oil and coconut water on the Eosinophil counts of apparently healthy wistar albino rats (%)

Sample	Days of assay	Doses of sample administered				
		0.0ml	0.5ml	1ml	1.5ml	2.0ml
Coconut oil	Day 0	2.50±0.50 ^a	2.50±0.50 ^a	2.50±0.50 ^a	2.50±0.50 ^a	2.50±0.50 ^b
	Day 7	2.50±0.50	2.00±0.00 ^a	2.00±0.00 ^b	2.00±0.00 ^b	1.00±0.00 ^a
	Day 14	2.50±0.50	2.00±0.00 ^a	2.00±0.00 ^b	3.00±0.00 ^c	2.00±0.00 ^a
	Day 21	2.50±0.50	2.50±0.50 ^a	1.00±0.00 ^a	2.00±0.00 ^b	3.00±0.00 ^c
	Day 28	2.50±0.50	2.50±0.50 ^a	3.00±0.00 ^c	1.00±0.00 ^a	3.00±0.00 ^c
Coconut water	Day 0	2.50±0.50 ^a	2.50±0.50 ^a	2.50±0.50 ^a	2.50±0.50 ^b	2.50±0.50 ^a
	Day 7	2.50±0.50	1.00±0.00 ^a	2.00±0.00 ^b	1.00±0.00 ^a	1.00±0.00 ^a
	Day 14	2.50±0.50	2.00±0.00 ^a	2.00±0.00 ^b	1.00±0.00 ^a	2.00±0.00 ^b
	Day 21	2.50±0.50	3.00±0.00 ^a	1.00±0.00 ^a	0.00±0.00 ^a	1.00±0.00 ^a
	Day 28	2.50±0.50	3.00±0.00 ^b	3.50±0.50 ^c	3.50±0.50 ^c	2.00±0.00 ^{ab}

Data represent the average for 3 replicates \pm S.E.M and those with different alphabet superscripts along columns for each treatment are statistically significant at $p < 0.05$

Table 5. Effects of administration of coconut oil and coconut water on the Lymphocyte counts of apparently healthy wistar albino rats (%)

Sample	Days of assay	Doses of sample administered				
		0.0ml	0.5ml	1ml	1.5ml	2.0ml
Coconut oil	Day 0	32.00±0.00 ^a	32.00±0.00 ^c	32.00±0.00 ^c	32.00±0.00 ^b	32.00±0.00 ^a
	Day 7	32.00±0.00	32.50±0.50 ^d	31.50±0.50 ^c	32.00±0.00 ^b	33.00±0.00 ^b
	Day 14	32.00±0.00	30.00±0.00 ^a	29.50±0.50 ^b	32.00±0.00 ^b	36.50±0.50 ^d
	Day 21	32.00±0.00	31.00±0.00 ^b	27.50±0.50 ^a	29.50±0.00 ^a	35.00±0.00 ^c
	Day 28	32.00±0.00	30.00±0.00 ^a	29.00±0.00 ^b	29.50±0.50 ^a	37.00±0.00 ^e
Coconut water	Day 0	32.00±0.00 ^a	32.00±0.00 ^a	32.00±0.00 ^a	32.00±0.00 ^{ab}	32.00±0.00 ^a
	Day 7	32.00±0.00	31.50±0.50 ^a	33.00±0.00 ^b	32.50±0.50 ^b	35.50±0.50 ^c
	Day 14	32.00±0.00	32.00±0.00 ^a	34.00±0.00 ^c	36.50±0.50 ^c	37.50±0.50 ^d
	Day 21	32.00±0.00	31.50±0.50 ^a	30.00±0.00 ^a	31.50±0.50 ^a	34.50±0.50 ^b
	Day 28	32.00±0.00	34.50±0.50 ^b	35.00±0.00 ^c	36.00±0.00 ^c	38.00±0.00 ^d

Data represent the average for 3 replicates \pm S.E.M and those with different alphabet superscripts along columns for each treatment are statistically significant at $p < 0.05$

White blood cells (WBC) are known to be key actors in immune responses, as they are the first line of defense against invading microorganisms. An increase in WBC values usually indicates a boost/ increase in immune strength and a decrease indicates fall in immune strength [5]. The values of WBC obtained from this study showed that apparently healthy rats administered coconut water and coconut oil had an increase in WBC count which indicates an increase in immune strength. The greater increase observed with the administration of coconut water suggests that coconut water has the ability to stimulate the production of more immune cells than coconut oil. The significant increase in total white blood cell count of the rats indicate that coconut water and coconut oil contain several compounds, such as proteins, peptides lipopolysaccharides and glycoproteins that have immunostimulatory potential on the immune system [6].

Lymphocytes are non-phagocytic mononuclear leucocytes that have the ability to recognize foreign cells and initiate a chain of responses to get rid of foreign cells. However, the observed increase in lymphocyte counts in this study following exposure to coconut water and coconut oil may be one of the mechanisms used to defend the body against the toxic effect of saturated fatty acids [9].

Neutrophils usually makes up about 65% of total white blood cell count. They make the first line of action against infections and are non-specific in their activity. The percentage neutrophils counts obtained in this study was significantly higher when compared with the control group. This increase may provide better level of immunity in the rats [10].

Eosinophils are responsible for protection against parasitic infections. The eosinophils values of the rats fed with both coconut water and coconut oil were not significantly affected when compared to the control group. This suggests that the administration of either may not confer protection against parasitic infections [9].

This research work has broadened the fact that further work has to be carried out on discovering the mode of action of coconut oil and coconut water and the active components in them. This could possibly be used to determine the proportion of the coconut products, especially coconut oil to be consumed so as to avoid the reduction of beneficial bacterial flora in the gut which can lead to the upset in the microbial balance in the gut

4. CONCLUSION

In conclusion, the consumption of coconut water and coconut oil has haematinic potential and immunostimulatory potential with coconut water having a higher effect. The consumption of both especially coconut water is therefore advocated because it increased PCV which is a function of viable red cells in the blood and WBC, lymphocytes and neutrophils which play key roles in immunity.

CONSENT

It is not applicable.

ETHICAL APPROVAL

As per international standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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