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Impact Of Magnetised Water on Nigeria Broiler Chicken Performance and Growth Rate

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Abstract— Poultry farming is vital to Nigeria's economy and provides a key protein source, yet many farms struggle with slow growth and high mortality in broiler chickens. This study aimed to assess the impact of magnetised water on broiler growth. Forty (40) broiler chickens were housed in four groups (T_0-T_3) at the National Integrated Farm Project in Ilorin, Nigeria. The water treatment involved a setup with neodymium magnets and varied exposure times: T_0 (control, no magnetisation), T_1 (55 s), T_2 (110 s), and T_3 (165 s). Each group had ten (10) birds, and weekly weight was recorded over seven weeks. A paired t-test was used to analyze growth differences between treatments. Average weekly weight gains for T_0, T_1, T_2, and T_3 increased progressively, with T_3 showing the highest gain. Paired t-test results indicated significant differences in growth between magnetised and non-magnetised groups, with calculated values above the threshold (ttab = 2.969). This study established that magnetised water increased broiler chicken performance and growth rate. Therefore, magnetized water is recommended to produce broiler chicken for high income from poultry farming.

Keywords— *magnetised water, broiler chicken, mean body weight, growth rate*

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1.0 Introduction

Water quality is important for animal production because it is vital to life; it keeps cells healthy, carries nutrients and fluids through the blood, and controls body temperature [1]. Being made up of two positively charged hydrogen atoms joined to an oxygen atom; water is a relatively basic molecule. According to Ref [2], opposite electrical charges attract each other, thereby attracting water molecules. However, when a permanent magnet is placed in contact with water for a long time, the water acquires magnetic properties and becomes magnetically charged [3]. When consumed internally and consistently over an extended period, such magnetically treated water impacts the human body [4]. When water is let to pass through a magnetic field in a pipe or hose, magnetized water—also known as magnetic water or magnetically treated water—is created [5]. Moreover, the purpose of the technique used to provide broiler chicks magnetized water is to increase their development rate (as a growth stimulant), increase their feed conversion ratio, strengthen their immunity, and lessen the unpleasant smell of their droppings [6]. Reducing the bonding angle of the magnetic field from 1040 to 1030 alters the characteristics of magnetized water by decreasing the rate of carbonate deposition in the pipe, increasing its solubility, and decreasing surface tension [5]. One of the methods used to enhance water quality is using magnetic forces to make the water more magnetic. Improvements in crop yields, germination rates, soil and water quality, and the removal of scale formation in pipes are some of the primary advantages of magnetic water in agricultural activities [7]. According to Ref [8], magnetised water improves chicken's biochemical functions and eggs' quality. Also, the research by Ref [9] confirms that using magnetised water accelerates broiler chicken development rate, improves feed conversion ratio, strengthens chicken immunity, and lessens the unpleasant odor of the chicken droppings. Consequently, Nigerian farmers' incomes and the country's economy may both benefit from the profitable industry of raising broiler chickens. In Nigeria, galactosidase and related enzymes have been and continue to be utilized as feed additives to boost broiler chicken productivity. These feed additions, however, are chemical-based, inefficient, and hard for nearby farmers to obtain. Thus, this study employed magnetized water, a (non-chemical) method, and a basic technology that may be used to increase the growth of broiler chickens [10]. Poultry production with magnetized water improves the hens' immunity and lowers the odor in the poultry buildings. In order to increase the growth rate of broiler chickens and lower the degree of objectionable odor in the poultry houses—the primary emphasis of this study—an alternate approach that is cheap for farmers is required.

In addition, digitalization enhances magnetized water usage's effectiveness, monitoring, and scalability in Nigerian broiler production. By combining technology with innovative water treatments, farmers can achieve higher productivity, sustainability, and profitability in poultry farming. In real-time, the Internet of Things (IoT) device was installed to monitor the magnetic field strength, water quality, pH levels, and mineral content. This ensures that the magnetized water remains effective for improving broiler performance. This work has contributed to the study of magnetised water in poultry performance in Nigeria using digitalization to enhance magnetized water's effectiveness, which made it different from previous studies.

Furthermore, the motivation for working on magnetised water for broiler chicken performance in Nigeria stems from various challenges and opportunities within the poultry sector. These include improving productivity, addressing resource constraints, enhancing sustainability, and boosting economic returns. Magnetised water has potential benefits such as reducing stress, improving immunity, and minimizing disease outbreaks, which are critical for maintaining high productivity.

Also, working on magnetised water for broiler chicken performance in Nigeria has several implications that span agricultural productivity, economic development, environmental sustainability, and scientific advancement. Magnetised water can improve broilers' health and nutritional profile, leading to better-quality poultry meat that can fetch higher market prices.

The study observed, among other factors, a lack of Farmer Awareness: Many Nigerian farmers are unfamiliar with the concept and potential benefits of magnetized water and the Cost of Equipment: Magnetising devices may be expensive for smallholder farmers, who dominate the poultry industry in Nigeria. Also, the factor of Smart Farming Solutions: Combining magnetized water with IoT devices, sensors, and AI systems for real-time monitoring and control as the current limitations and future opportunities for the impact of magnetised water on the broiler chicken performance in Nigeria.

1.1 Statement of the Problem

Many poultry farms in Nigeria are associated with the problems of poor growth rate, low production to meet the demand in Nigeria, high mortality rate, environmental pollution (offensive odour) from the poultry droppings and high cost of poultry feeds resulting in high cost of production costs and low marginal profits. According to

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Ref [11], the patented methods used by authors in [12] and [13] for enhancing broiler chicken quality and serving as a growth promoter were organic acids and chemicals by nature, and when taken by people, these chemicals had a negative impact on human health. Therefore, this study used magnetised water, a nonchemical-based method that is non-harmful to humans, to promote the growth rate of broiler chickens.

1.2 Objectives

This study investigated the impact of magnetised water on Nigeria broiler chicken performance and growth rate.

1.3 Materials and Equipment

A total number of 40 broiler chickens were collected from the Aromokeye Veterinary Farm, Ilorin and, weighed on arrival, and stocked on the 15th of September 2023. The materials and equipment used in this study are listed below.
10 x 25 x 50 mm neodymium magnet
Magnetic treatment unit of 250 mm by 200 mm plastic container,
4 units water trough
1 saw blade
4 units feeding trough
50 L water tank
Gum
1-unit 12.7 mm diameter flow control valve
4-unit 12.7 mm (1/2 inch) diameter PVC pipe
6 number elbows
2 number union PVC pipe
150 kg bags of starter feed and 250 kg bags of finisher feeds.

2.0 Materials and Methods

This study was conducted at the National Integrated Farm Project (NIFAP) unit of the National Centre for Agricultural Mechanization (NCAM), Ilorin, Nigeria on longitude 4.61220 East and Latitude 8.41610 north. A total number of 40 broiler chickens were dispersed randomly into four treatment groups of 10 birds each. The system of rearing for the first 4 weeks was a deep litter system in which the treatment houses were constructed using planks and iron sheets and the floor was covered with some wood shavings as the litters, and the remaining 3 weeks, the birds were transferred to the battery cage house. (See Plates 1.4a and 1.4b).
In this housing system, the birds were kept in a litter floor arrangement of 1.90 m by 1.14m dimension. Feed and water were made inside the house and as a general rule of thumb, broiler chicken require 1 kg of starter crumbs of grower pellets and 1.5 kgs of finisher pellets. The total quantity of feed fed to the birds at the end of the 7th week of the study was 150 kg bags of starter feed and 250 kg bags of finisher feed.
Ref [14] calculated the daily water consumption of broilers by multiplying the bird's age in days by 0.00591 liters of water and found that chickens need 0.91 to 1.36 liters of water for every 0.45 kilogram of feed ingested. In this study, broiler chickens in each treatment house were given 10 litres of water per day, and in the 7th week, the total quantity of water provided to the birds was estimated to be 490 litres.

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Plate 1.4a: Deep litter house arrangement for the Broiler chicken Plate **1.4b**: Broiler chicken with magnetised water under the Battery cage arrangement.

2.1 Magnetic Treatment Unit

A 10 mm x 25 mm x 50 mm neodymium magnet was used in the development of the magnetic treatment unit. The strongest magnet in the world, the NdFeB magnet, is created by combining neodymium (Nd), iron (Fe), and boron (B). It is a permanent magnet with a magnetic flux density of 1.0 to 1.5 T (1T = 10,000 G) or higher. Neodymium is an effective rare earth magnet that can withstand temperatures as high as 80 °C without demagnetizing, according to [15]. In this study, the magnetic treatment unit utilized the setup of [16], which comprised a pipe (a rectangular clear pipe with a diameter of 20 x 60 mm and a length of 960 mm but built with a plastic container) encircled by 12 neodymium magnet pieces. A 50 L bucket was attached to the magnetic treatment device, and the water flow was controlled by a 25.4 mm pipe control. In order to distribute water to treatment houses two and three, a non-returning valve was attached to a second 20 L bucket along the main line. The magnetic treatment equipment for creating magnetized water was depicted in isometric, orthographic, and pictorial views in Figure 1.4a, 1.4b, and Plate 1.2, respectively.

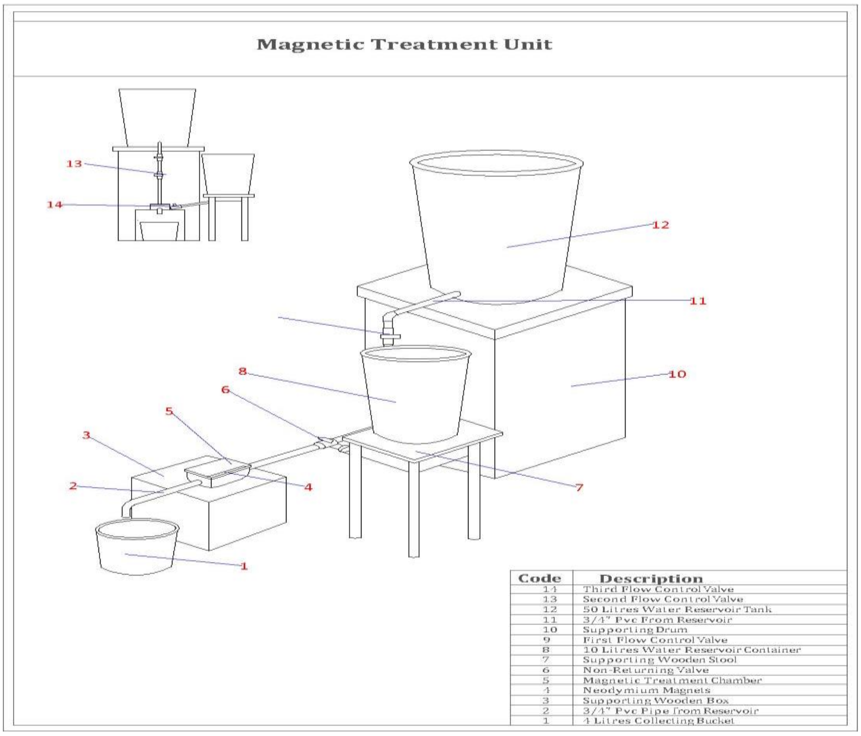

Fig. 1.4a: Isometric image of the magnetised water production equipment

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Plate 1.4: An image of the magnetized water production unit's magnetic treatment setup

2.2 Production of Magnetised Water

Various methods for obtaining magnetised water are known and different researchers have used different methods to produce magnetised water according to the aims of their studies. Ref [17] stated that one of these techniques is placing two bottles, jugs, or any other flat-bottomed container in the middle of a magnet with the north pole exposed and the other in the middle of a magnet with the south pole exposed. After a certain amount of time, the magnetism in water or any other liquid pierces it, changing the liquid's characteristics and, consequently, its magnetic. A flowing technique was employed to create the magnetized water used in this study, whereby water was permitted to pass through the magnetic treatment chamber's magnetic field. Broiler chicken was produced using water from the poultry farm's running tap, which was allowed to pass through the magnetic treatment unit once for 55 s. The broiler chicken in treatment house T1 received this water, while the broiler chickens in treatment house T2 received magnetized water that passed through the unit for 110 s, and the broiler chickens in treatment house T3 received magnetized water that passed through the unit for 165 s. Broiler chickens in the control house denoted by T0 were given non-magnetised water. The magnetised water was poured into a drinking trough from which the broiler chickens drank the water.

2.3 Methods

The study used 40 broiler chickens in total, with 10 broiler birds in each of the four treatment homes (see Plates 3.3a and 3.3b). Each treatment house's broiler chickens (designated T0, T1, T2, and T3) were fed the same kind of feed (Starter and Finisher feeds) in the same amount for seven weeks. Water was collected in a graduated cylinder for distribution after being moved through the magnetic chamber at a comparatively slow pace to avoid overflow. The water flow velocity in this configuration was determined to be 0.0058 m/s. As advised by the manufacturers of magnetic funnels (Magnetic Technologies LLC), the water was replaced every 12 hours to guarantee high-quality magnetized water and to make sure it was used within that time frame. Water that has passed through the magnetic field at the funnel can maintain its magnetic characteristics for up to 12 hours, according to [18]. A pH meter was used to measure the water's pH after it had been magnetically treated.

An N52 Neodymium magnet was a type of magnet used in this study where water was magnetically treated by passing it through a magnetic treatment unit made of plastic material following Fleming's right-hand rule with neodymium magnets placed beside the pipe inside the treatment chamber. The treatment summaries are as follows:

NMW (T0) non-magnetised water group (Control group)
MW 1 (T1) flowed through the magnetic field for 55 s

MW 2 (T2) flowed through the magnetic field for 110 s
MW 3 (T3) flowed through the magnetic field for 165 s

Plate 1.4a: Day-old broiler chicken **Plate 1.4b**: 3 weeks old broiler chicken

2.4 Determination of growth rate and weight gain of broiler chickens

The average growth rate (body weight gain) was determined by measuring the weights of the chickens in each treatment group weekly using an electric weighing device for 7 weeks and recorded as indicated in Plate 1.5. Average weight gain was calculated by dividing the total weight taken by the number of birds in each treatment group. Appendix A shows the % increase in weight gain as well as the growth rate of broiler chickens.

Plate 1.5: Weekly weighing to determine the body weight gain

2.5 The statistical analysis of the paired T-test

The study used a paired t-test statistical analysis to ascertain whether or not the weight and feed conversion ratio of broiler chickens were significantly impacted by magnetically treated water. The average difference between the magnetized and non-magnetized water results was calculated and is shown in Appendices B1–B3 and C. In accordance with [19] description, equations (1), (2), (3), and (4) were used to determine the mean, standard deviation, standard error, and t-test values.

$$\overline{d} = \frac{\sum d}{n} \quad (1)$$

$$\delta = \sqrt{\frac{\sum d^2 - n\left(\overline{d}\right)^2}{n-1}} \quad (2)$$

$$\delta_{Er} = \frac{\delta}{\sqrt{n}} \quad (3)$$

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$$t_{cal} = \frac{\bar{d}}{\delta_{Er}} \quad (4)$$

where;
$\bar{d}$ = mean of the difference from x1 and x2,

Σd = summation of d

n = number of the observations,

δ = standard deviation

σEr = standard error

tcal = calculated value of t-test.

3.0 Result and Discussion

3.1 Effects of magnetised water on the growth rate of broiler chicken

The broiler chickens that received magnetized water for 165 seconds (T3) gained the most body weight between the first and seventh weeks, increasing by 6.29 percent, and their growth rate increased by 899 g (89.9 g/broiler) overall. In contrast, the control group (non-magnetized water) had the least body weight gain. The trends in the mean body weight of the broiler chickens from week 1 to week 7 are shown in Figures 1.5a. The results of T2 and T3 were very close to each other, and they overlapped, and similarly, T1 and T0 were very close and overlapped as well. The average body weight of the broiler chickens is displayed in Figure 1.5b. By the end of week 7, when the broiler chicks were ready to be sold, the body weight gain was higher due to the magnetized water (Figure 1.5c). Appendix A provides comprehensive findings on how magnetized water affects broiler chicks' body weight gain. This outcome is consistent with Yusuf et al.'s study from 2022, which indicated that magnetized water improved broiler chicken growth rates.

All broiler chickens that were given magnetised water had a higher body weight than broiler chickens given non-magnetised water (control). The percentage increments in body weight gain in the 7th week for T1, T2, and T3 were 5.51 (%), 6.21 (%), 6.29 (%) respectively compared to T0, which showed that magnetised water is economically good and advisable to use to increase the growth performance of broiler chicken. According to this study, the chickens that drank magnetized water gained more body weight, which is consistent with the findings of [6].

The effect of magnetized water on the body weight gain of broiler chickens was statistically significant at $\alpha \leq 0.025$, according to the paired t-test statistical analysis shown in Appendices B1–B3 and C, respectively. This was because the calculated values of the paired t-test were greater than the table value at $\alpha \leq 0.025$ (the table value of the t-test = 2.969 at $\alpha \leq 0.025$, while the calculated values of the t-test for T1, T2, and T3 compared with T0 were 4.599, 5.562, and 5.560, respectively).

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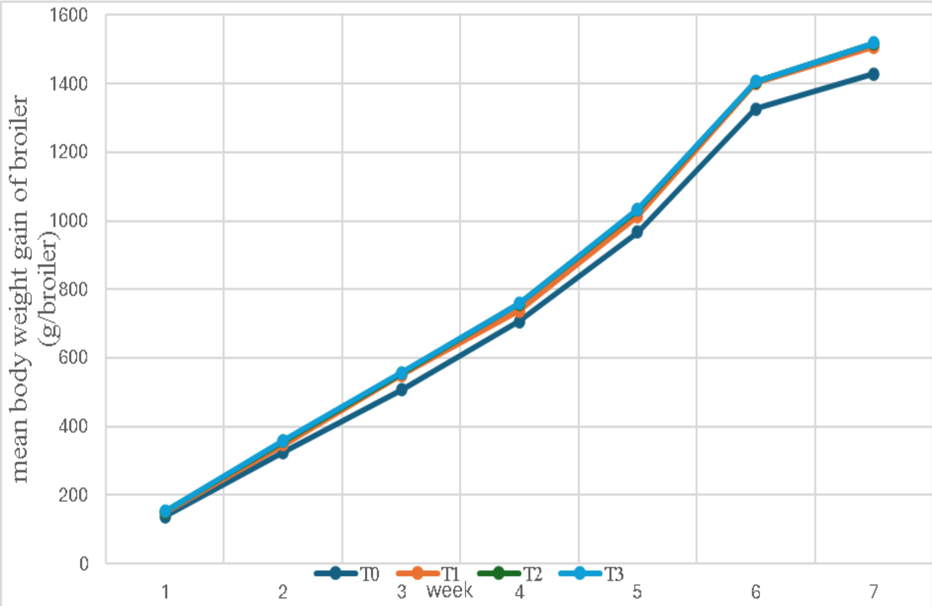

Fig. 1.5a Mean body weight gain of broiler chicken (g/broiler)

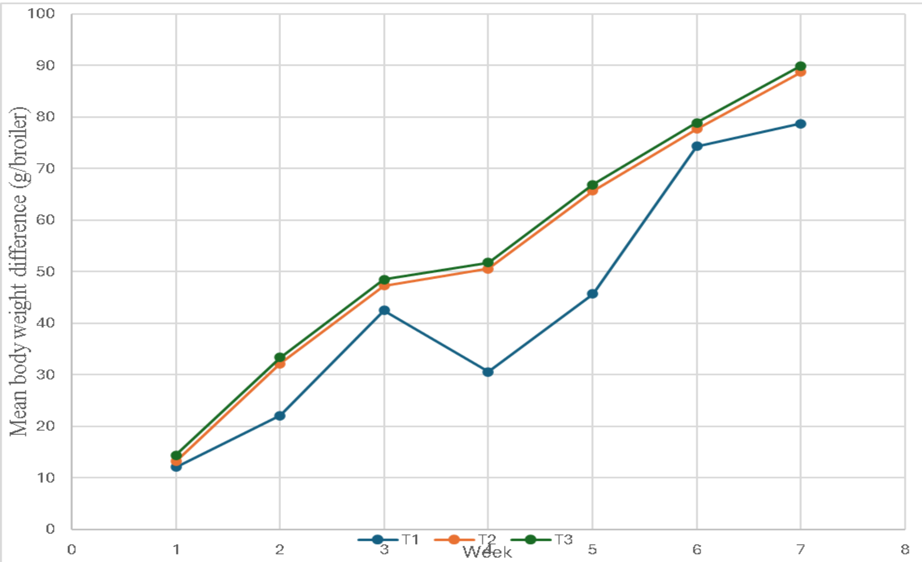

Fig. 1.5b Mean body weight difference (g/broiler)

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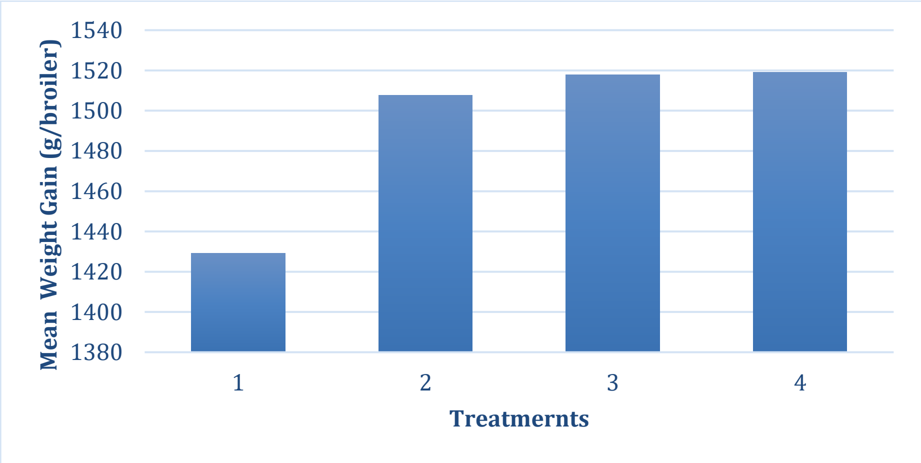

Fig. 1.5c Average weight growth of broiler chickens T_0, T_1, T_2, T_3 at week 7

4.0 Conclusion

Water magnetised for 165 s increased the growth rate of the broiler chicken by 89.9 g/broiler with a percentage increment of 6.29%. The findings of this study highlight the potential impact of magnetised water on broiler chickens' performance and growth rate in the Nigerian production environment. Magnetised water, as a novel technique, appears to offer tangible benefits by enhancing broiler performance metrics, including body weight, feed conversion ratio (FCR), and average daily gain (ADG). The results indicate that broilers given magnetised water exhibited significantly improved growth rates compared to those provided with non-magnetized water, suggesting its positive influence on nutrient absorption and metabolic efficiency.

Moreover, the improvement in growth performance may be attributed to the enhanced physicochemical properties of magnetized water, which are hypothesized to improve cellular hydration, nutrient solubility, and overall feed utilization. This could be particularly relevant in regions like Nigeria, where water quality and feed costs pose significant challenges to poultry production. By improving feed conversion efficiency, the use of magnetized water has the potential to reduce feed costs and enhance profitability for farmers, contributing to more sustainable poultry farming practices.

Furthermore, the study also demonstrates that magnetised water may mitigate stress-related growth depressions, especially in tropical climates characterized by high temperatures, which often impede poultry productivity. This is a particularly valuable observation for Nigerian poultry farmers striving to optimize production under challenging environmental and economic conditions.

However, while the results are promising, certain study limitations need to be addressed. The long-term effects of magnetised water on broiler health, meat quality, and carcass traits were not within the scope of this research and warrant further investigation. Additionally, the economic feasibility of adopting magnetized water on a large scale in commercial poultry operations should be explored to determine its practicality for Nigerian farmers.

In conclusion, magnetised water presents a promising innovation for improving the growth performance and efficiency of broiler chickens in Nigeria. While further research is needed to establish its long-term efficacy and economic viability, its potential as a cost-effective, non-invasive strategy for enhancing poultry productivity makes it an attractive option for addressing the challenges of broiler production in Nigeria and other similar regions.

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APPENDIX B - 1

APPENDIX B-1: Determination of Paired t-test

Table 1. T_1 Compared with T_0

Body Weight MW (T_3)	Body weight NMW (To)	d = T_3 – To	d^2
149.6	137.5	12.1	146.41
346.5	324.4	22.1	488.41
549.8	507.3	42.5	1806.25
737.0	706.4	30.6	936.36
1012.2	966.5	45.7	2088.49
1401.2	1326.9	74.3	5520.49
1507.8	1429.1	78.7	6193.69
		∑d =306.0	**$\sum d^2$ = 17180.1**

APPENDIX B- 2

APPENDIX B-2: Determination of Paired t-test

Table 2. T_2 Compared with T_0

Body Weight MW (T_3)	Body weight NM W (T_0)	d = T_3 – To	d^2
150.7	137.5	13.2	174.24
356.6	324.4	32.2	1036.84
554.6	507.3	47.3	2237.29
757.0	706.4	50.6	2560.36
1032.2	966.5	65.7	4316.49
1404.6	1326.9	77.7	6037.29
1517.8	1429.1	88.7	7867.69
		∑d =375.4	**$\sum d^2$ = 24230.20**

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APPENDIX B - 3

APPENDIX B-3: Determination of Paired t-test

Table 3. T_3 Compared with T_0

Body Weight MW (T_3)	Body Weight NMW (T_0)	d = T_3 – To	d^2
151.9	137.5	14.4	207.36
357.8	324.4	33.4	1115.56
555.8	507.3	48.5	2352.25
758.2	706.4	51.8	2683.24
1033.4	966.5	66.9	4475.61
1405.8	1326.9	78.9	6225.21
1519.0	1429.1	89.9	8082.01
		∑d =383.8	**$\sum d^2$ = 25141.24**

APPENDIX C

Determination of Statistical Parameters using Paired -test Statistical Analysis

The formular given by Nahm (2005) was used to determine the paired t-test

$$\overline{d} = \frac{\sum d}{n}$$

$$\overline{d} = \frac{383.8}{7} = 54.83$$

$$\delta = \sqrt{\frac{\sum d^2 - n(\overline{d})^2}{n-1}}$$

$$\delta = \sqrt{\frac{25141.24 - 7(54.83)^2}{7-1}} = 26.131$$

$$\delta_{Er} = \frac{\delta}{\sqrt{n}}$$

$$\delta_{Er} = \frac{26.131}{\sqrt{7}} = 9.861$$

$$t_{cal} = \frac{\overline{d}}{\delta_{Er}}$$

$$t_{cal} = \frac{54.83}{9.861} = 5.560$$

at the 5% significant level t_{cal} and t_{tab} values were compared, however, for the paired t-test, the difference was 2.5% (α = 0.05/2 = 0.025)

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Ethical Compliance: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with 1964 Helsinki Declaration and its later amendments.

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Conflict of Interest declaration: The authors declared that they have no affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in the manuscript.

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