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EFFECT OF PARTIAL WATER DEPRIVATION ON THE PERFORMANCE AND CARCASS CHARACTERISTICS OF BROILER CHICKENS EXPOSED TO SELECTED DURATIONS OF WATER DEPRIVATION IN THE HUMID TROPICAL ENVIRONMENT

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ABSTRACT

A study was conducted to assess the effects of partial water deprivation on the biologic performance and carcass qualities of broiler chickens raised in a humid tropical environment. There were 2 experiments involving the use of 280 and 500 broiler chickens of mixed sexes respectively. These birds were raised to 4 weeks of age and then subjected to selected durations of water deprivation treatments which lasted for 2 and 5 weeks respectively. Water deprivation exposure had no significant effect ($P>0.05$) on body weight, weight gain, feed intake, feed conversion ratio and mortality following 2 weeks of treatment in the first experiment. However, in the second experiment, when the birds were exposed to longer period of water deprivation (5 weeks), body weight and water consumption were significantly affected ($P<0.05$) by treatments. But weight gain, feed intake, EFU, water/feed ratio and efficiency of water utilization were not affected. Depriving birds of water for 6 and 8 hours daily did not adversely depress dressing percentages. Weights of some body parts were affected by the partial water deprivation treatments. Organ weights (liver, gizzard, heart and spleen) were generally depressed by water deprivation. Treatments did not seem to affect the chemical composition of the meat. However the dry matter and moisture contents of the meat tended to vary inversely as the intensity of water deprivation increased.

Keywords: Partial water deprivation; broiler chickens; performance; carcass; characteristics.

INTRODUCTION

Water is an important requirement in the nutrition of all farm animals because of the functions it performs in the body. Water is a prime nutrient. Its metabolism and balance in the body are related to the maintenance of a dynamic equilibrium within and between the extra-cellular, intracellular, interstitial and plasma components. The ability of an animal to maintain this equilibrium depends on the balance between water intake and water output. Where this balance is upset, some biological consequences may arise which may include poor feed intake, poor efficiency of feed utilization and poor growth. Ross (1960), observed that chicks deprived of water partially to three ½ hour periods each day grew to only 90% the weight of their control counterparts. The authors associated this weight deficit with the difference between water intake and feed intake, indicating a relationship between the two.

Water intake through drinking on an absolute basis increases with age, although its consumption per unit of body weight decreases with age. In the avian species, the drinking behaviour is intimately associated with the hypothalamic control centres of the brain, type of feed, ambient temperature and the release of anti-diuretic hormones from the pituitary, which decrease the output of water excreted via the kidneys and the possible storage of water in the cells and tissues (Wagner 1964). These factors are under the feed back control mechanisms of the body.

Other sources of water to the bird include metabolic water produced in the body as by products of nutrient catabolism and dietary water, which is present in both

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biologically active and structural forms (Karmas 1978). All these sources of water help to meet the water needs of the birds. Although never deliberate ,water deprivation occurs frequently in broiler flocks through neglect .This is of serious concern because it could adversely affect performance or even meat characteristics to the extent that producers may not fully appreciate. The objective of this study was to examine the effects of partial water deprivation on the performance and carcass characteristics of broiler chickens raised in the humid tropical environment.

MATERIALS AND METHODS:

Two experiments were carried out in this study:

Experiment 1:

Two hundred and eighty (280) 4-week old broiler chickens of mixed sexes were weighed and randomly divided into 10 groups of 28 birds per group. The birds had an average initial body weight of 439.30g per bird. The groups were allocated to 4 water restriction modalities and a control in which water was not restricted, using the completely randomized experimental design. Two replicates were assigned to each water restriction treatment.

There were four periods of partial water restriction:
2 hours daily – 7 am. to 9 am; 4 hours daily – 7 am. to 11 am; 6 hours daily – 7 am. to 1 pm. and 8 hours daily – 7 am. to 3 pm. for 2 weeks. The birds were returned to full drinking for another 2 weeks before the experiment ended. Weighed quantities of proprietary feeds in mash form were allowed *ad libitum* to each treatment group for the duration of the experiment. Analysis was made of the feeds and their proximate composition is shown in Table 1. Records were kept of body weight, weight gain, feed intake and mortality for each treatment group.

Efficiency of feed utilization was computed on a weekly basis:

Experiment 2:

Five hundred (500) 4 – week old broiler chickens, also of mixed sexes, were weighed and divided into 10 groups of 50 birds per group and assigned to 10 pens and randomly allocated to the water restriction treatments and a control in a manner similar to the pattern in experiment 1. In this case, the birds were subjected to 5 weeks of water deprivation treatments.. There were 2 replicates per treatment and the birds had a mean initial average body weight of 307.80g. The birds were fed *ad libitum* using the same proprietary feeds as in experiment 1.Water consumption was determined by volumetric difference.using a measuring cylinder; and in order to determine water consumption in the past 24 hours, unconsumed water was measured back every morning. Data on live weight, weight gain, feed intake and mortality were kept. Water consumption, efficiency of feed utilization, water/feed ratio and efficiency of water utilization were also monitored throughout the duration of the experiment.

At the end of the experiment 4 birds from each replicate (two males and two females) were randomly selected for carcass quality evaluation. They were weighed prior to killing. After plucking, the carcasses were dressed and cut up to determine the characteristics as affected by the treatments, including effect on some organs. Meat from the thigh was used for chemical analysis according to the method of AOAC (1990). Data collected in the two experiments were subjected to analysis of variance procedure according to Snedecor and Cochran (1980). Significant differences between treatment means were examined using Duncans Multiple Range Test Procedure as outlined by Steel and Torrie (1980).

RESULTS AND DISCUSSION:

The effects of partial water deprivation at the selected durations applied and for the periods of observation in experiment 1 are presented in table 2. The results showed that limiting water intake for the four periods examined over a 2 – weeks exposure duration did not adversely affect the performance of broiler chickens There were no statistical differences ($P > 0.05$) among the treatments in respect of body weight dynamics, live weight gains, feed intake, feed conversion ratios and mortality rates. The results also showed that recovery in birds exposed to partial water deprivation was similarly not affected by the treatments as evidenced by the body weights at 8 weeks of age. There

TABLE 1: PROXIMATE COMPOSITION OF DIETS USED IN THE EXPERIMENT

Components %	Broiler Starter	Broiler Finisher
Crude protein	21.50	19.25
Crude fat	6.59	4.40
Crude fibre	4.44	4.00
Ash	5.00	4.00
Dry matter	50.44	45.00
Moisture	49.56	55.00
Nitrogen free extract	10.00	12.95

TABLE 2: EFFECTS OF SELECTED DURATION OF WATER DEPRIVATION ON THE PERFORMANCE OF BROILER CHICKENS (2 WEEKS EXPOSURE AND 2 WEEKS POST-EXPOSURE)

	Duration of Water Restriction Treatments (HRS)				
Performance Characteristics	0	2	4	6	8
Initial body weight at 4 weeks of age(g)	441.50	441.00	438.50	437.70	437.80
Body weight at 6 weeks of age(g)	1028.20	1034.60	1078.80	1110.25	1069.20
Body weight at 8 weeks of age(g)	1872.20 ± 486.9	1853.80 ± 81.6	1886.00 ± 484.7	1986.50 ± 515.8	1732.65 ± 442.8
Weight gain at 6 weeks of age(g)	359.05	319.25	328.85	319.85	369.20
Weight gain at 8 weeks of age(g)	482.70	465.40	480.75	486.55	332.70
Mortality at 6 weeks of age(%)	0	2	2	2	2
Mortality at 8 weeks of age(%)	1	2	2	2	2
Feed consumption/week /bird at 6 weeks (g)	453.33	486.77	489.77	425.00	429.80
Feed consumption/week /bird at 8 weeks (g)	663.46	541.35	661.54	632.69	660.58
Feed conversion ratio at 6 week of age	1.26	1.52	1.49	1.33	1.16
Feed conversion ratio at 8 week of age	2.70	2.90	2.83	2.58	3.04

were no significant differences ($P > 0.05$) among the different groups when they were returned to *ad libitum* water consumption and observed for 2 weeks relative to the body weight changes, live weight gain, feed consumption, feed conversion ratios and mortality rates.

Mean body weight was one of the parameters used to evaluate the effects of partial water deprivation. Body weight was not significantly affected by the differences in the treatments. This could be due to the fact that the duration of water deprivation was not long enough. This result was similar to the observations of Kellerup et al (1965) and Arscott (1969) in which 10% water deprivation or subjecting birds to 24 –72 hours period of water deprivation did not adversely affect mean body weight of the broiler chickens. Feed consumption was not significantly affected by the treatments. When birds are deprived of water, one would have expected a decrease in feed intake. But it seems that the amount of water consumed by the birds in the present experiment was sufficient to support their drinking needs and water requirement, which probably supported normal feed intake and adequate digestion. There were no significant differences in the feed conversion ratios. This could be attributed to the fact that the different water deprivation intensities affected neither the feed consumption pattern nor weight gains adversely.

The performance of broiler chickens subjected to the selected durations of water deprivation in experiment 2 are presented in Table 3. There were statistical differences among treatments in respect of body weight ($P < 0.05$). The control group weighing 1729.17g was significantly heavier than the groups exposed to 4,6 and 8 hours of water deprivation which weighed 1473.77g, 1424.38g and 1520.06g respectively, but not significantly heavier than birds deprived for 2 hours daily. Exposing the broiler chickens for a period of up to 5 weeks (35 days) to partial water deprivation in this experiment depressed body weight dynamics. This observation agrees with the work of King (1983), Bohra and Ghosh (1983), who observed reduction in performance of birds following 20 – 50% water restriction for up to a period of 36 days. These authors attributed the reductions in body weight to reduced feed intake because there is an unavoidable relationship between water consumption, feed intake and growth performance.

The drinking needs and water requirement of chickens are intimately associated with the hypothalamic control centres in the brain (Wagner 1964). Birds deprived of water resort to water present in the feed as well as their body water reserve for normal metabolism. Consequently such birds suffer water deficit and loss of weight as compared to their counterparts provided water *ad libitum* (Wagner 1964; Ewing 1963; Herrick 1971; Zeigler et al 1972 and Bierer et al 1966). There were, however, no significant differences in the treatments relative to weight gain, although the period of water deprivation lasted 5 weeks.

Feed consumption was similarly not significantly affected by treatments, although when compared with the control the later tended to eat insignificantly more. When birds especially broiler chickens are deprived of water one would expect a decrease in feed intake. But it seems that the amount of water consumed by birds in this study was sufficient to support normal feed intake and digestion.

Water intake was significantly higher ($P < 0.05$) in the control compared with the consumption in the groups partially water deprived for 6 and 8 hours respectively daily, the control consuming 1132.0 ml per bird as compared to 935.00 ml and 813.00 ml for the 6 and 8 hours partial water deprived groups respectively. However, there was no significant difference in the amount of water consumed by the control, the 2 hours and the 4 hours water deprived groups. In terms of water/feed ratio and efficiency of feed utilization (EFU) there were striking similarities. Treatments did not seem to affect mortality or EFU. From the results, it appears that the different water deprivation modalities affected neither the feed consumption pattern nor the weight gain and EFU adversely.

EFFECTS ON CARCASS CHARACTERISTICS:

The dressing percentages, dressed weights, wing weights, thigh/drumstick and neck weight values are presented in table 4. The dressing percentages of 77.76, 74.59,

TABLE 3: EFFECTS OF SELECTED DURATION OF WATER DEPRIVATION ON THE PERFORMANCE OF BROILER CHICKENS (5 WEEKS EXPOSURE)

Performance Characteristics	Duration of Water Restriction Treatments (HRS)				
	0	2	4	6	8
Initial weight (g)	305	305	334	291	290
Live weight at 9 weeks (g)	1729.17 ± 85.7^{a}	1567.90 ± 102.0^{ab}	1473.77 ± 102.0^{b}	1424.38 ± 193.5^{b}	1520.06 ± 337.6^{b}
Total weight gain (g)	1424.17 ± 84.3	1262.90 ± 73.8	1138.77 ± 60.5	1133.77 ± 69.4	1230.06 ± 126.0
Feed consumption (g)	3345.00 ± 242.7	3042.00 ± 109.8	3111.00 ± 217.0	3034.00 ± 191.6	2693.00 ± 94.3
Mortality (%)	7.78	5.97	7.03	8.17	5.32
Water consumption (ml/bird)	1132.00 ± 96.0^{a}	1018.00 ± 76.5^{ab}	1009.00 ± 73.6^{ab}	935.00 ± 81.7b^{c}	813.00 ± 66.7^{c}
Water /Feed Ratio	0.34	0.33	0.32	0.31	0.30
Efficiency of feed utilization	2.35	2.40	2.70	2.70	2.20
Efficiency of water utilization	0.8	0.8	0.9	0.8	0.7

^{abc} Means in the same row with different superscripts are significantly different ($P < 0.05$)

TABLE 4: EFFECTS OF SELECTED DURATION OF WATER DEPRIVATION ON THE CARCASS CHARACTERISTIC OF BROILER CHICKENS AT 9 WEEKS OF AGE

Water restriction Treatments (HRS)	Sample Weight (g)	Dressing Percentages (%)	Breast Weight (g)	Wing Weight (g)	Thigh/ Drumstick Weight (g)	Neck Weight (g)
0	1600.00	77.76 ± 7.4	277.23 ± 47.0^{a}	87.68 ± 11.8^{a}	214.83 ± 28.4^{a}	115.68 ± 20.9^{a}
2	1495.00	74.59 ± 3.0	233.05 ± 18.7^{ab}	83.48 ± 9.3^{ab}	198.13 ± 29.3^{ab}	106.80 ± 12.0^{ab}
4	1400.00	74.26 ± 3.0	204.50 ± 51.0^{bc}	74.50 ± 7.5^{b}	181.33 ± 11.6^{b}	81.28 ± 23.0^{bc}
6	1394.00	69.67 ± 4.4	167.18 ± 32.0^{c}	59.03 ± 6.0^{c}	147.18 ± 26.4^{c}	74.25 ± 11.1^{c}
8	1200.00	68.80 ± 2.0	150.83 ± 44.0^{c}	63.88 ± 4.4^{bc}	129.98 ± 12.9^{c}	63.63 ± 17.0^{c}

^{abc} Means in the same column bearing different superscripts are significantly different ($P < 0.05$)

TABLE 5: EFFECTS OF SELECTED DURATION OF WATER DEPRIVATION ON THE ORGAN WEIGHTS (G/100G BODY WEIGHT) OF BROILER CHICKENS AT 9 WEEKS OF AGE

Duration of water Deprivation (HRS)	Liver	Gizzard	Heart	Spleen
0	4.34	3.94^{a}	1.33^{a}	0.25^{a}
2	4.09	4.25^{a}	1.02^{b}	0.18^{ab}
4	3.98	3.61^{al}	0.08^{b}	0.20^{ab}
6	3.51	3.44^{ab}	0.08^{b}	0.14^{b}
8	3.98	3.20^{b}	0.07^{b}	0.15^{b}

^{abc} Means in the same column bearing similar superscripts are not significantly different ($P > 0.05$)

TABLE 6: EFFECTS OF SELECTED DURATION OF WATER DEPRIVATION ON THE CHEMICAL COMPOSITION OF THE MEAT OF BROILER CHICKENS (5 WEEKS EXPOSURE)

	Duration of Water Restriction Treatments (HRS)				
	0	2	4	6	8
Crude Protein (%)	77.85 ± 2.5	77.69 ± 2.4	80.72 ± 1.1	80.48 ± 0.6	78.28 ± 2.8
Ether Extract (%)	15.00 ± 2.2	12.75 ± 2.2	13.08 ± 2.1	12.00 ± 2.9	12.30 ± 3.2
Crude Fibre (%)	0.88 ± 0.1	0.88 ± 0.1	0.86 ± 0.1	0.79 ± 0.1	0.88 ± 0.1
Ash (%)	2.00 ± 0.8	2.75 ± 0.6	2.20 ± 0.6	2.27 ± 0.5	1.61 ± 0.3
Nitrogen Free Extract (%)	6.27	6.00	3.10	4.50	6.90
Moisture (%)	84.70 ± 3.6	78.13 ± 6.1	68.40 ± 3.3	67.58 ± 3.1	65.18 ± 6.5
Dry Matter (%)	14.30 ± 3.6^{b}	$21,88 \pm 5.1^{b}$	31.60 ± 2.9^{a}	32.43 ± 2.9a	34.83 ± 5.7a

^{abc} Value within a row carrying identical superscripts are not significantly different ($P > 0.05$)

74.26, 69.67, and 68.80 for 0,2,4,6 and 8 hours partial water deprivation treatments respectively, were not statistically different ($P > 0.05$). The dressing percentage (77.76) and breast weight (277.23g) values obtained for the control agree with Bremner (1977) who reported a range of 72 – 77% as dressing percentage and 280. 5g as breast weight values for broiler chickens. The low breast weight values exhibited by the other treatment groups may be attributed to the fact that those birds were exposed to longer periods of water deprivation daily, which invariably affected their water balance and body weight dynamics and resulted in poor tissue synthesis and muscle development generally, including the breast muscle. The higher weight of the thigh/drumstick in the control, compared with other treatment groups, appears to be a function of the generous provision of water, which aided the overall process of metabolism. This also applies to wing weight of the control group.

ORGAN WEIGHTS:

Data on organ weights in this experiment are presented in Table 5. Although not significantly different, there was a slight decline in liver weight when the birds were partially deprived of water for 2 hours daily and beyond compared with the control. This may be due to the fact that the liver was able to draw water from the body reserve for its normal metabolic function. Bremner (1977) had reported that when the liver secretes its juice (bile) with its alkaline medium (sodium), it draws water from the body reserves for its normal metabolism. It appears that the liver in this study may have adopted this physiological principle in order to withstand the length of exposure to water deprivation intensities employed in this study.

The heart seemed to be affected beyond 2 hours daily of partial water deprivation while the spleen seemed affected when partial water deprivation exceeded 4 hours daily. The organs affected in this study were probably not performing their functions properly under the condition of extreme water deprivation, which probably stressed them With reference to the spleen Bremner (1982), reports that during stress the adrenal gland comes into play and becomes activated in stress response. The consequence of increased adrenal activity includes decrease in growth rate and regression of lymphoid tissues with concomitant reduction in the number of blood cells. Therefore, the spleen being a lymphoid tissue appears unable to escape the effect of prolonged or intense water deprivation as a stressor. This may have resulted in the reduced size of the spleen beyond 4 hours of daily partial water deprivation in this study.

EFFECTS ON CHEMICAL COMPONENTS OF THE MEAT:

The chemical composition of the meat of broiler chickens as effected by partial water deprivation is presented in Table 6. In terms of crude protein, ether extract, crude fibre, ash, nitrogen free extract, the values were within the ranges expected from poultry meat (Ihekoronye and Ngoddy 1985). However, the dry matter content of the meat was lowest (14.3%) in the meat of the control group of birds and increased progressively as the intensity of water deprivation increased. Moisture in the meat, on the other hand, was highest (84.7%) in the meat of the birds offered water *ad libitum* and decreased progressively as the intensity of water deprivation increased. According to Offer and Knight (1988), the functional properties of muscle protein lie largely in their ability to bind and retain water. Gain and loss of water from the muscle depend not only on he characteristics of the animal but also on how the animal was managed prior to slaughter. From this argument it may be surmised that the degree or level of water deprivation in the present study affected the characteristics of the meat in its ability to bind and retain water.

In conclusion, therefore, as a management measure, birds especially broiler chickens, should not be exposed to water deprivation. Doing so would create an unfavourable condition that upsets the full expression of their potential for growth, upsets the birds metabolism as well as the ability of the muscle to bind and retain water.

REFERENCES

AOAC., 1990. Methods of Analysis 15th Ed. Association of Official Analytical Chemist, Washington DC: 1091.

Arscott, G. H., 1969. The Effect of Varying Periods of Water Restriction at Different Ages in Broiler Chickens. Poultry Sci. 48 (2): 731-735.

Bierer, B. W; Barnett, B. D. and Eleazer, T. H., 1966. The effect of feed and water deprivation on water and feed consumption, body weight and mortality of broiler chickens of various ages. Poultry Sci. 45 (1): 10-45.

Bohra, H. G. and Ghosh, P. K., 1983. Nitrogen Metabolism in water restricted marian sheep of India Desert. J. Agric. Sci. 101: 735-935.

Bremner, A. S., 1977. Poultry Meat Hygiene and Inspection. Bailliere Tindall, London: 50.

Ewing, W. R., 1963. Poultry Nutition. Fifth Edition. The Ray Ewing Company Publishers, Pasadena, California. 106-109.

Fisher, H., 1964. Limiting amino acid in groundnut meal providing protein levels to growing chicks. J. Sci. Food and Agric. 15:539-542.

Herrick, J. B., 1971. Water quality for livestock and poultry. Poultry Sci. J. 32(3): 190-192.

Ihekoronye, R. I. And Ngoddy P. O., 1985. Integrated food Science and technology for the tropics. Macmillan Publishers Limited, London: 16-17.

Karmas, E., 1973. Water in Biosystems. Poultry Sci. J. 32(4): 186-187.

Kellerup, S. U. Parker, J E. and Arscott, G. H., 1965. Effects of restricted water consumption on broiler chickens. Poultry Sci. J. 3(2): 188-190.

King, J. M., 1983. Livestock water needs in pastoral Africa, in relation to climate and forage. Research report No. 7 International Livestock centre for Africa. Addis Ababa, Ethiopia: 15-18.

Offer, G. and Knight, A. P., 1988. Water Metabolism in water deprived chickens. Meat Sci. J. 5:26-28.

Ross, E., 1960. The effect of water restriction on chicks fed different levels of molasses. Poltry Sci. J. 30(2): 180-185.

Snedecor, G. W. and Cochran W. G., 1980. Statistical Methods. 7th Ed. Iowa State University Press. Ames Iowa USA P. 265-268.

Steel, R. G. and Torrie, J. H., 1980. Principles and procedures of Statistics A. biometrical approach. 2nd Edition, McGraw -Hill, Kagakusha Limited, Tokyo, P. 688.

Wagner, M. J., 1964. Thirst in the regulation of body water. World's Poultry Sci. J. 31(2):186.

Zeigler, H. P. Green, H. I. And Siegel, J., 1972. Food and water intake and weight regulation in the pigeon. Physical. Behav. 9: 127 - 129.