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Influence of drinking structured water on production performance, nutrient retention, carcass characteristics and economics in commercial broiler chicken

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ABSTRACT

Water from open and bore well are commonly used in majority of the poultry farms in India. When the drinking water is passed through specially designed apparatus in which tuned geometry creates an energy environment for the water to structure itself, it is claimed that surface tension of water is lowered with better hydrating properties. This geometric technology said to break up large low energy water molecule clusters into smaller high energy clusters which is called as structured water or structure-altered water. In order to study the influence of structured water on the performance of commercial broiler chicken, an experiment was conducted using 216 numbers of Vencobb broiler chicks up to 42 days of age. The birds were assigned to two groups comprising of twelve replicates per group with 9 birds per replicate. The control group (108) was offered tap water whereas the treatment group was offered structured water for drinking purpose. The body weight (g) was numerically higher in structured water group (2016 ± 28 vs 1989 ± 26) as compared to tap water offered group. Similarly, the feed conversion efficiency was relatively better (1.769 ± 0.02 vs 1.802 ± 0.02) in structured water group. The total quantity of water consumed (ml/bird) up to 6 weeks age was less in structured water group (11511±144) as compared to the tap water (11101±112) offered group. The digestibility of nutrients and retention of minerals were similar among the tap and structured water offered groups. The heart (10.12^b±0.34 vs 9.16^a±0.20) and spleen weights (2.73^b±0.012 vs 1.817^a±0.005) were significantly high and abdominal fat content was low (1.021^a±0.055 vs 1.204^b±0.061) in structured water group as compared to tap water offered group. The feed cost per kg body weight gain was comparatively low (₹1.03) in structured water group (₹54.88 ± 0.55 vs 55.91 ± 0.48). From this study, it can be inferred that structured water offered to commercial broiler chicken for drinking purpose resulted in extra profit of ₹2.06/ bird.

Key words: Broiler performance, Carcass quality, Production economics, Structured water

Now-a-days attempts are being made to modify the properties or quality of drinking water for improving the performance and health of livestock and poultry. When the drinking water is passed through specially designed apparatus in which tuned geometry creates an energy environment for the water to structure itself, it is claimed that surface tension of water is lowered with better hydrating properties (Ptok 2014). This geometric technology said to break up large low energy water molecule clusters into smaller high energy clusters which is called as structured water or structure-altered water (Voeikov and Giudice 2009). The structured water is different from bulk water and contains more oxygen (Pollack 2013). It has a high solubility for the minerals and vitamins, which are formed with structured water, tend to go from the digestive tract and bloodstream into the tissues. Sateash (2015) indicated that yield and quality of cotton, tomato, *bhendi* and tapioca increased by 36, 39, 35 and 19%, respectively due to the use of structured water when compared to conventional method of irrigation (Jayanthi 2015). Similarly, Nalayini (2016) reported that the structured water irrigated cotton produced significantly higher boll numbers (49.9/plant) as against bore well irrigated cotton (40.1 bolls/plant). Scientific reports on performance of livestock and poultry offered structured water for drinking are unavailable. Hence this study was conducted to assess the growth performance, retention of nutrients, carcass characteristics and economics of commercial broiler production as influenced by offering structured water for drinking purpose.

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MATERIALS AND METHODS

The structured water device marketed by Crystal Blue India erstwhile VWF Industries Private Ltd. based at

Mysore, India was used in this study. The tap water passed through this device is termed as structured water. The properties such as pH, conductivity, TDS and salinity of tap water as well as structured water (which was passed through the said device) were recorded daily during the experimental period using handheld portable water analysis unit. A broiler trial using commercial broiler chicks (216) was conducted for 6 weeks. The chicks were divided into 2 treatment groups, each group with 12 replicates and each replicate having 9 birds. The birds belonging to control group (108) were offered tap water whereas the treatment group was offered structured water for drinking purpose. All the birds were fed broiler chicken pre-starter ration up to 14 days of age, starter ration from 15 – 28 days of age followed by finisher ration up to 42 days of age. The ingredient and chemical composition of rations used during the biological experiment is given in Table 1.

Table 1. Ingredient and chemical composition (%) of broiler chicken rations

Feed ingredient	Pre-starter (1-14 days)	Starter (15-28 days)	Finisher (29-42 days)
Maize	55.00	57.00	59.00
Soybean meal	38.00	35.00	31.00
Salt	0.29	0.30	0.311
Calcite	1.60	1.03	1.000
Di-calcium phosphate (DCP)	1.15	1.81	1.599
Rice bran oil	2.61	4.33	6.038
Additives (%)			
NSP degrading enzyme	0.05	0.05	0.04
Phytase-2500	0.02	0.01	0.01
DL-methionine	0.30	0.30	0.26
Lysine	0.28	0.17	0.16
Threonine	0.03	0.03	0.16
Sodium bicarbonate	0.25	0.20	0.19
Broiler mineral premix (Trouw)	0.15	0.15	0.15
Broiler vitamin premix	0.04	0.04	0.04
US Curatox (toxin binder)	0.05	0.05	0.05
Oxytetracycline (oxyFS100)	0.05	0.05	0.05
Coxistac (coccidiostat)	0.05	0.05	0.05
Antioxidant (Endoxdry)	0.01	0.01	0.01
Vitamin E 50%	0.005	0.005	0.010
Lysoforte (emulsifier)	0.10	0.10	0.10
Choline chloride (60%)	0.15	0.15	0.15
Hepatocare (liver tonic)	0.10	0.10	0.10
Grand total	100.00	100.00	100.00
Chemical composition			
Dry matter (%)	89.82	89.29	90.98
Crude protein (%)	23.31	21.00	19.35
Crude fibre (%)	3.24	3.00	2.51
Ether extract (%)	5.23	6.35	8.81
Total ash (%)	6.87	6.35	6.21
Nitrogen free extract (%)	51.17	53.29	53.09
Calcium (%)	1.05	1.00	1.05
Total phosphorus (%)	0.66	0.61	0.62
Metabolisable energy (kcal/kg) (calculated)	2900	3100	3200

Body weight of all the birds and feed intake were recorded at weekly intervals whereas water consumption was recorded daily throughout the experimental period (up to 42 days). The feed conversion efficiency was worked out for different phases of growth. The litter moisture levels were estimated (AOAC 2012) at the end of the experiment. At the end of the experimental period, 48 birds i.e. 24 birds from each group (@ 2 birds from each replicate) were slaughtered to study the carcass quality. The total length of the intestine was measured and expressed as cm per kg body weight. The *in vitro* solubility of macro minerals such as calcium and phosphorus were tested using tap water and structured water. One gram sample of di-calcium phosphate was taken in a 250 ml beaker and 150 ml of 0.5% citric acid solution prepared from either tap water or structured water or distilled water was added. The solution was mixed well at 30–40 rpm using a magnetic stirrer for 1 h. The volume was made up to 250 ml using distilled water. The solution was filtered through Whatman No. 1 filter paper and the solubility of calcium and phosphorus were calculated. The amount of retention of minerals was determined by conducting a metabolic trial. Birds (10) from each group were randomly selected and subjected to metabolic trial for 7 days. The faeces excreted by all the birds were collected for 3 days consecutively and subjected to nitrogen, calcium, phosphorus, copper, manganese and zinc analysis (AOAC 2012). The quantity of feed consumed by the birds was measured individually and the feed samples were analyzed for nitrogen, calcium, phosphorus, copper, manganese and zinc contents (AOAC 2012) so as to calculate the retention of minerals. The data collected were subjected to statistical analysis as per 'student t test' (Snedecor and Cochran 1989).

RESULTS AND DISCUSSION

Properties of structured water: The quality of drinking water offered to the experimental birds is given in Table 2.

There was no significant difference between tap water and structured water with reference to pH, conductivity, TDS and salinity. Since no chemical process is involved in the apparatus during preparation of structured water, hence, no significant changes were observed in this study. Jayanthi (2015) also reported that properties of structured water are comparable to irrigated water.

Production performance of broiler chicken: Body weight of birds, feed intake, water consumption and feed

Table 2. Properties of structured water and tap water

Attribute	Tap water	Structured water
pH	8.13±0.01	8.05±0.01
Conductivity (μs)	285.10±1.37	282.41±1.51
TDS (ppm)	206.49±1.27	204.77±1.31
Salinity (ppm)	124.79±0.69	123.54±0.77
Temperature (°C)	31.00±0.11	30.81±0.10

Each value is mean of 39 observations.

Table 3. Influence of drinking structured water on the production performance of broiler chicken

Attribute	Pre-starter phase (0 - 14 days)	Starter phase (15 – 28 days)	Finisher phase (29 – 42 days)	Overall (0 - 42 days)
		*Cumulative body weight gain** (g)		
Tap water	270±2	805±10	914±18	1989±26
Structured water	272±2	816±10	928±23	2016±28
		*Cumulative feed intake*** (g)		
Tap water	393±6	1463^{b}±6	1726±28	3582±29
Structured water	407±5	1435^{a}±5	1721±27	3564±27
		*Feed conversion efficiency*** (FCR)		
Tap water	1.458±0.011	1.821±0.025	1.895±0.023	1.802±0.016
Structured water	1.496±0.026	1.765±0.027	1.868±0.035	1.769±0.018
		*Cumulative water consumption*** (ml/bird)		
Tap water	1292±23	4424±55	5794^{b}±104	11511^{b}±144
Structured water	1270±17	4358±47	5473^{a}±67	11101^{a}±112

*Each value is a mean of 108 observations, **Each value is a mean of 12 observations. #Means with different superscript in a column differ significantly (Pd"0.05).

conversion ratio recorded for different phases of growth are presented in Table 3.

The body weight (g) was numerically higher in structured water group (2016±28 vs 1989±26) as compared to tap water offered group. Similarly, the feed conversion efficiency was relatively better (1.769±0.02 vs 1.802±0.02) in structured water group. Relatively better performance observed in structured water group may be attributed to more intestinal length which might be responsible for better utilization of nutrients (Vasanthakumar *et al.* 2014). However, the total quantity of water consumed (ml/bird) up to 42 days of age was less (P<0.05) in structured water offered group (11511±144) as compared to the tap water (11101±112) offered group. This would be due to decreased viscosity and surface tension of structured water (Ptok 2014) and also decreased moisture excretion through poultry droppings.

Slaughter studies: The parameters related to slaughter studies, titre value against Ranikhet disease and litter moisture are given in Table 4.

The weights of skin plus feather, blood, liver, gizzard, thymus, bursa, feet and head (expressed as per cent body weight) did not vary significantly between the 2 groups. The heart and spleen weights were significantly (P<0.05) high and abdominal fat content was low in structured water group as compared to tap water offered group. Though statistically not significant, the intestinal length (cm per kg body weight) was relatively more (101.66±1.587 vs 96.42±1.879) and litter moisture content (%) was less (10.92±0.96 vs 11.51±0.94) in structured water group. However, the immune status of birds assessed in terms of titre value against Ranikhet disease during sixth week of age revealed that the titre value was high (P<0.05) in structured water offered group as compared to tap water offered group.

Minerals solubility and retention: The *in-vitro* solubility of minerals in citric acid solution (0.5%) and retention of minerals by the birds are given in Tables 5 and 6.

Table 4. Influence of structured water on carcass traits, differential organ weight, immunity and litter moisture (%) at 42 d

Attribute	Tap water	Structured water
Skin + feather weight (as BW%)	12.27±0.31	12.51±0.36
Blood weight (as BW%)	3.35±0.14	3.54±0.13
Liver weight (as BW%)	2.06±0.05	2.08±0.05
Heart weight (as BW%)	9.16^{a}±0.20	10.12^{b}±0.34
Gizzard weight (as BW%)	1.84±0.04	1.99±0.06
Dressing percentage	65.20±1.23	67.61±0.56
Thymus (as BW%)	0.256±0.027	0.294±0.019
Spleen weight (as BW%)	1.817^{a}±0.005	2.730^{b}±0.012
Bursa weight (as BW%)	0.072±0.008	0.099±0.010
Abdominal fat (as BW%)	1.204^{b}±0.061	1.021^{a}±0.055
Feet weight (as BW%)	4.06±0.11	4.19±0.09
Head weight (as BW%)	3.26±0.05	3.34±0.09
Intestinal length (cm/kg BW)	96.42±1.879	101.66±1.587
Hot carcass weight (g)	1355.46±21.98	1361.67±14.63
RD titre value ($\log_2$)	3.39^{a}±0.08	4.11^{b}±0.32
Litter moisture (%)	11.51±0.94	10.92±0.96

Each value is mean of 24 observations (except litter moisture in which n=12). Means with different superscript in a row differ significantly ($P \leq 0.05$).

Table 5. *In-vitro* solubility of calcium and phosphorus in 0.5% citric acid solution

Attribute	Distilled water	Tap water	Structured water
Calcium solubility (%)	89.7±2.76	85.3±2.91	86.1±2.52
Phosphorus solubility (%)	75.60±2.31	71.43±2.31	72.06±2.47

The 0.5% citric acid solutions were prepared using either distilled / tap or structured water. Each value is mean of 4 observations. Calcium and phosphorus source used in this experiment is di-calcium phosphate containing 25.2% Ca and 15.6% P.

Table 6. Nutrient digestibility and retention of minerals as influenced by drinking structured water in commercial broilers

	Treatment group	DM (g)	Nitrogen (g)	Ca (g)	P (g)	Cu (ppm)	Zn (ppm)	Mn (ppm)
Intake (per bird	TW	110.24±3.16	3.54±0.10	1.13±0.03	0.69±0.01	4.23±0.12	15.04±0.43	14.59±0.41
per day)	SW	109.23±2.45	3.51±0.79	1.13±0.02	0.69±0.01	4.15±0.09	14.94±0.33	14.48±0.32
Out go (per bird	TW	31.83±1.15	1.16±0.07	0.59±0.03	0.35±0.01	3.09±0.11	9.80±0.80	12.26±0.79
per day)	SW	31.97±1.37	1.17±0.05	0.57±0.05	0.34±0.02	3.11±0.12	9.89±0.67	12.09±0.43
Digested / retained	TW	78.41±4.16	2.38±0.60	0.54±0.01	0.34±0.01	1.14±0.03	5.24±0.13	2.33±0.11
(per bird per day)	SW	77.26±4.45	2.34±0.64	0.56±0.01	0.35±0.01	1.04±0.04	5.05±0.15	2.39±0.12
Digestibility/	TW	71.06±2.55	67.23±2.23	47.80±2.11	49.28±2.61	26.95±1.81	34.84±1.83	15.97±0.76
retention (%)	SW	70.73±2.76	66.67±2.59	49.56±2.05	50.72±2.46	25.06±1.74	33.80±1.90	16.51±0.71

TW, Tap water; SW, structured water. Each value is a mean of 10 observations.

The *in-vitro* solubility of calcium and phosphorus in 0.5% citric acid solution did not vary significantly. However, the solubility of both Ca and P were relatively low in tap / structured water as compared to the distilled water probably due to high pH (8.03). Similarly, the digestibility of nutrients and retention of minerals were similar among the tap and structured water offered groups which showed that utilization of minerals are not affected by the source of water used for drinking purpose (Pattanaik *et al.* 2015).

Since research reports or literature on the influence of structured water on the performance of livestock and poultry are not available, the results obtained in this study could not be corroborated and substantiated. The science of structured water is in infancy and more research is warranted to elucidate the underlying mechanisms and clear the uncertainties.

Economics: The economics of offering structured water over tap water is presented in Table 7.

The average feed cost per bird up to 6 weeks of age was ₹111.11±0.90 and ₹110.54±0.82 for tap water and structured water offered groups, respectively. The feed cost per kg live weight was low (₹1.03) for structured water group and the extra profit available was ₹2.07/bird.

From this study, it can be concluded that the properties such as pH, conductivity, TDS and salinity of tap water and structured water did not vary. Biological trial conducted in commercial broiler chicken revealed that the finished body weight (g) was numerically higher in structured water group as compared to tap water offered group. Similarly, the feed conversion efficiency was relatively better in structured water group. The extra profit earned due to offering structured was ₹2.07 (@ ₹1.03 / kg live weight) per bird.

Table 7. Influence of drinking structured water on the economics of commercial broiler production

Treatment	Tap water	Structured water
Feed cost (₹)		
Cost of pre-starter feed per kg	31.21	31.21
Cost of starter feed per kg	31.07	31.07
Cost of finisher feed per kg	30.93	30.93
Feed intake (g)		
Pre-starter phase	393±6	407±5
Starter phase	1463±6	1435±5
Finisher phase	1726±28	1721±27
Cost of feeding (in ₹) during different phases (INR.)		
Pre-starter phase	12.27±0.20	12.70±0.16
Starter phase	45.46^{b}±0.18	44.59^{a}±0.15
Finisher phase	53.38±0.87	53.24±0.84
Total feed cost (0 - 6 weeks)	111.11±0.90	110.54±0.82
Average weight gain (kg/bird)	1.989	2.016
Feed cost/kg body weight gain (₹)	55.91±0.48	54.88±0.55
Difference (₹/kg live weight)	-	+1.03
Extra profit per bird (₹)	-	+ 2.07

Each value is mean of 12 observations. Means with different superscript in a row differ significantly (≤0.05).

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