

Influence of Various Sugar Sources as Drinking Water Additives on the Haematological Profile of Broiler Chickens (*Gallus gallus domesticus* L.)

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Abstract. This study assesses the impact of various sugar sources (dextrose, honey, molasses, and brown sugar at 50g/L) as water additives on broiler chickens, focusing on blood profiles. The experiment, employing a completely randomized design, involved varying inclusion levels of these sugar sources in drinking water. A total of 48 broiler chickens were distributed into treatments, with four replicates each. All four treatment: T0 (control) with 50g/L dextrose added to water, T1 with 50g/L honey added to water, T2 with 50g/L molasses added to water and T3 with 50g/L brown sugar added to water were administered. The analysis included blood sample mass, percent per liveweight basis, protein levels, haematology, and red cell indices to determine how sugar additives affect health indicators. Results indicated that blood sample mass and the percentage of blood sample mass per live weight basis were not varied significantly ($p > 0.05$) among treatments. Blood protein levels, including total protein, albumin, and globulin, showed no significant ($p > 0.05$) differences among treatments, remaining within normal ranges, suggesting that sugar supplements did not adversely affect protein metabolism or immune function. Haematology analysis revealed that haematocrit and haemoglobin values were outside normal ranges, but no significant ($p > 0.05$) treatment effects were observed. RBC and WBC counts were within normal ranges, indicating no appreciable effects from sugar inclusion. Regarding red cell indices, MCV values showed statistical differences ($p < 0.05$), but remained within normal ranges. MCH and MCHC values also varied, with no significant ($p > 0.05$) differences among treatments. The study concludes that sugar sources as water additives can influence blood sample mass and red cell indices without negatively impacting overall blood health. These findings suggest potential benefits for poultry production through optimized sugar-based additives.

Keywords: blood, cell indices, drinking water, red

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1 Introduction

The poultry industry fulfils rising worldwide animal protein needs through its production of affordable meat which broiler chicken serves as the primary source. Efficient growth performance and good health status of broilers depend largely on the quality of feed and water offered during rearing. Water functions as the primary essential nutrient for poultry production because it serves as a transport medium for nutrients and helps with digestion and temperature control and metabolic functions [1].

The addition of sugar-based additives to drinking water functions as a nutritional approach which enables broilers to preserve their energy equilibrium when they face stressful situations or need to increase their metabolic activity. The immediate energy sources dextrose and honey and molasses and brown sugar help animals recover from transport-related stress and temperature changes and feed changes. The survival rates of broiler chicks improved when they received sucrose through their drinking water during their initial life stages while their body weight stayed constant. Research shows that broilers achieve better growth results and their bodies become more resistant to disease when they receive fructo-oligosaccharides through their drinking water which demonstrates carbohydrates play a vital role in gut health and nutrient absorption [2].

The natural sugars found in molasses and honey serve as carbohydrates while also delivering bioactive compounds which include antioxidants and vitamins and minerals that could improve blood health and immune function [3]. The use of functional feed or water additives supports the present industry focus on developing broiler production systems without antibiotics. Research indicates that scientists want to replace antibiotic growth promoters with prebiotics and probiotics because these substances have proven effective in improving gut health and animal performance and immune system function [4]. Research shows that natural feed additives and energy sources work as successful antibiotic alternatives for broiler chickens which help both farm productivity and chicken wellness [5].

The haematological and biochemical profiles of broiler chickens function as vital indicators which help determine their health status and their dietary needs. The following blood parameters help doctors understand oxygen delivery and immune system function and metabolic performance through their measurements of red and white blood cells and haemoglobin and hematocrit and blood protein levels. The evaluation of these indices shows how feed or water additives influence the internal body processes of birds. Research has studied how feed-based supplements affect broiler haematology but there is still limited knowledge about how different natural sugars added to drinking water affect birds.

Therefore, this study aims to assess the influence of various sugar sources—dextrose, honey, molasses, and brown sugar—added to drinking water on the haematological and biochemical profiles of broiler chickens (*Gallus gallus domesticus* L.). The study aims to establish whether these sugar additives affect blood parameters including blood sample mass and protein levels and haematocrit and hemoglobin and red cell indices without harming the birds' health. The research results will show that natural sugar-based water additives serve as affordable alternatives to synthetic energy supplements for broiler production.

2 Materials and methods

2.1 Animal welfare

The study was conducted in accordance with the Animal Welfare Act (Republic Act No. 8485).

2.2 Experimental animals, treatments, and design

The research investigated how different sugar additives impact broiler chicken blood test results through four (4) experimental treatments. These included Treatment 0 (T0) – dextrose powder, Treatment 1 (T1) – honey, Treatment 2 (T2) – molasses, and Treatment 3 (T3) – brown sugar. Each sugar additive was prepared at a concentration of 50 g/L and administered in addition to the normal drinking water. A total of forty-eight (48) Cobb broiler chicks (*Gallus gallus domesticus* L.) were used in the study. The birds spent two weeks under brooding conditions before researchers moved them to experimental cages on their 15th day of development. The experiment was conducted for a duration of twenty-one (21) days. The research study distributed broiler chickens into four (4) treatment groups which included three (3) experimental runs for each treatment with four (4) birds in each replicate using a Completely Randomized Design (CRD). Allocation of birds to treatments was carried out using a draw-lots method. Each cage housed four (4) Cobb broiler chicks.

Table 1. Experimental treatments

Treatment	Description	Concentration
T0 (Dextrose)	Dextrose powder	50 g/L
T1 (Honey)	Honey solution	50 g/L
T2 (Molasses)	Molasses solution	50 g/L
T3 (Brown Sugar)	Brown sugar solution	50 g/L

2.3 Water additive preparation

Dextrose, pure honey, molasses, and brown sugar were sourced from reliable suppliers in Davao City, Iligan City, and a local supermarket. The preparation of sugar additives in the broiler chicken waterers followed standard procedures, which included the regular cleaning of waterers and accurate weighing of sugar sources. The waterers received proper water filling and sugar additive mixing and scheduled replacement to keep the water fresh and free from contamination. Monitoring the water consumption of broiler chickens was conducted consistently to ensure optimal intake of the respective sugar additives.

2.4 Feed scheme

The birds received their care through standard broiler production methods which were followed. The two-week brooding period required chicks to stay under suitable temperature and ventilation systems which helped their development while keeping them stress-free. The birds received experimental cage housing on day 15 which provided them with well-ventilated cages that maintained equal space for each bird. Sanitation and biosecurity measures were strictly observed, including regular cleaning and disinfection of cages, feeders, and drinkers. The birds received daily health checks which documented all their medical conditions and unusual behavioral patterns. The animals received their feed and water without restriction from the beginning of brooding until the end of the experimental period to support their maximum growth potential.

2.5 Blood collection

The blood collection took place between 6:00 and 8:00 a.m. on the last day of the experimental period to achieve stable test results while reducing daily changes. Each broiler chicken was gently restrained to allow safe and efficient blood sampling. Blood samples were collected from each bird via venipuncture, and only a portion of the total circulating blood

volume was obtained for laboratory analyses. The laboratory needs 2 mL of blood which goes into EDTA-treated tubes for complete blood count (CBC) testing to stop blood coagulation. An additional 1 mL of blood was collected into serum separator (red-top) tubes for serum biochemical analysis. During slaughter, the mass of blood exsanguinated was measured to determine blood sample mass, and this measurement was independent of the blood samples collected for CBC and serum analysis.

Blood was collected from the brachial (wing) vein, which is commonly used in avian sampling. This vein lies between the biceps and triceps muscles, converging near the elbow joint, making it suitable for collection at the bifurcation site. During venipuncture, the bird was placed in lateral decubency with its feet facing the phlebotomist. The phlebotomist used their non-dominant hand to hold the wing in place while their thumb applied light pressure to reveal the vein. A 25-gauge 1-inch needle connected to a winged infusion set was inserted at a shallow angle to collect blood while the process was done slowly for vein protection. The puncture site received light pressure after collection to stop hematoma development. If a hematoma occurred, the site was not reused to avoid coagulation issues.

2.6 Laboratory analysis

The blood collection took place between 6:00 and 8:00 a.m. on the last day of the experimental period to achieve stable test results while reducing daily changes. Each broiler chicken was gently restrained to allow safe and efficient blood sampling. Blood samples were collected

2.5.1 Haematological profile

The blood samples were analysed at CEDAR Clinical Laboratory, located on James Hayes Street, Cagayan de Oro City, Philippines. The Abbott Cell-Dyn Ruby Haematology Analyzer measured haematological parameters of broiler chickens to determine their red blood cell count (RBC) and haemoglobin (Hb) and hematocrit (Hct) and mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) and white blood cell count (WBC). The research used flow cytometry to study blood particles through fluid stream analysis which tracked their specific characteristics. The method uses light scattering patterns at different angles to detect both cell dimension differences and modifications in cellular internal structures.

2.5.2 Blood protein profile

The blood protein profile was also determined at the same laboratory using a COBAS C111 Analyzer. The researchers measured Total Protein (TP) and Albumin (Alb) and Globulin (Glob) concentrations. The spectrophotometer used solution absorbance measurements at specific wavelengths to calculate substance concentrations for TP and Alb colorimetric assays. The detection reagent produced color intensity based on the concentration of the analyte. The Globulin (Glob) concentration was calculated as the difference between Total Protein and Albumin (Globulin = TP – Alb).

2.6 Statistical analysis

The research employed Completely Randomized Design (CRD) to evaluate performance differences between various treatment groups. The data analysis used SPSS version 29 to

perform one-way analysis of variance (ANOVA) which determined the statistical significance between treatment means.

3 Results and discussion

3.1 Blood sample mass

The results presented in Table 2 show the mean values of blood sample mass and the percentage of blood sample mass per liveweight basis in broiler chickens influenced by different sugar additives in their water. Four sugars were tested: Honey, Molasses, Brown Sugar, and a Control group with Dextrose at 50g/L. For blood sample mass (g), the mean values were as follows: (48.89 ± 8.55). Honey (49.56 ± 11.91), Molasses (44.44 ± 6.15), and Brown Sugar (42.44 ± 6.62). The analysis of variance (ANOVA) did not show a statistically significant difference among the groups (p = 0.249), indicating that the type of sugar additive did not significantly affect the absolute blood sample mass in the chickens. When considering the percentage of blood sample mass per liveweight basis, the results were: Control (2.74 ± 0.35%), Honey (2.69 ± 0.71%), Molasses (2.55 ± 0.48%), and Brown Sugar (2.27 ± 0.40%). Similar to absolute blood sample mass, the ANOVA results (p = 0.213) indicated no significant difference among the groups in terms of percentage of blood sample mass per liveweight basis.

Table 2. Mean ± SD values of blood sample mass and the percentage of blood sample mass per liveweight basis of broiler chickens broiler chickens influenced by various sugars as water additives

Parameters	Control	Honey	Molasses	Brown Sugar	p-value**
Blood Sample Mass (g)	48.89±8.55	49.56±7.91	44.44±6.15	42.44±6.62	0.249
% per Liveweight Basis	2.74±0.35	2.69±0.71	2.55±0.48	2.27±0.40	0.213
<i>T0 (control)-Dextrose at 50g/L; T1-Honey at 50g/L; T2- Molasses at 50g/L; T3-Brown Sugar at 50g/L</i> **ANOVA=one way analysis of variance; <0.05=significant, >0.05=not significant; <0.001=highly significant					

Blood weight is an important parameter that can be linked to the physiological and haematological status of broiler chickens. The basic carbohydrates in honey and molasses and brown sugar exist together with multiple bioactive compounds which include antioxidants and minerals [6]. The body's metabolic processes and health status could change because of these constituents which affect blood parameter readings. The current methods fail to detect small metabolic changes in broilers that result from different sugar additives. Research studies show that animal growth rates and feed consumption and blood test results depend on the energy content of their diet and their water drinking methods [7].

3.2 Blood protein levels

The research evaluated how different sugar additives (honey and molasses and brown sugar) affect blood protein concentrations in broiler chickens relative to a control group. The results in Table 3 display the mean values with standard deviations (SD) for Total Protein and Albumin and Globulin and Albumin/Globulin (A/G) ratio. The Total Protein levels of chickens who received molasses (3.57 ± 0.50 g/dl) were higher than the control group (3.20 ± 0.36 g/dl) but the difference was not statistically significant (p = 0.217). The albumin levels

in all sugar groups remained lower than the control group (1.04 ± 0.20 g/dl) but the results did not reach statistical significance ($p = 0.542$). The molasses group showed the highest globulin levels at 2.40 ± 0.45 g/dl but the control group showed 2.16 ± 0.46 g/dl without reaching statistical significance ($p = 0.121$). The A/G ratio which serves as a liver function indicator displayed different values between groups but researchers found no statistically significant differences ($p = 0.435$).

Table 3. Mean \pm SD values of blood protein levels of broiler chickens broiler chickens influenced by various sugars as water additives

Parameters	Control	Honey	Molasses	Brown Sugar	p-value**
Total Protein (g/dl)	3.20 \pm 0.36	2.07 \pm 1.46	3.57 \pm 0.50	2.73 \pm 0.46	0.217
Albumin (g/dl)	1.04 \pm 0.20	0.76 \pm 0.64	1.16 \pm 0.08	1.12 \pm 0.27	0.542
Globulin (g/dl)	2.16 \pm 0.46	1.31 \pm 0.82	2.40 \pm 0.45	1.61 \pm 0.21	0.121
A/G Ratio	0.50 \pm 0.18	0.45 \pm 0.30	0.49 \pm 0.76	0.69 \pm 0.10	0.435
<i>T0 (control)-Dextrose at 50g/L; T1-Honey at 50g/L; T2- Molasses at 50g/L; T3-Brown Sugar at 50g/L</i> **ANOVA=one way analysis of variance;<0.05=significant, >0.05=not significant, <0.001=highly significant					

While there were numerical differences in blood protein levels among the sugar-treated groups and the control, none of these differences reached statistical significance ($p > 0.05$). This indicates that the addition of honey, molasses, or brown sugar to drinking water at the tested concentrations (50 g/L) did not significantly influence the blood protein profiles—namely, total protein, albumin, globulin, and albumin/globulin (A/G) ratio—of broiler chickens. The molasses-treated group demonstrated higher total protein and globulin levels which indicates improved protein metabolism and immune system function because globulin functions as an immune defence molecule [8]. However, the lack of statistical significance implies that any potential effect was minimal or inconsistent across replicates. The health status of poultry depends on albumin and globulin levels because these proteins indicate liver function and immune system health [9]. The normal ranges for these parameters were generally maintained across all groups, indicating that none of the sugar additives adversely affected the physiological health of the birds. The molasses group contains higher amounts of total protein and globulin because molasses contains natural minerals and trace nutrients which support liver and immune system health [10]. The 50 g/L concentration of bioactive compounds and carbohydrates in honey and brown sugar did not affect metabolism or energy availability because it did not result in detectable changes to blood protein markers.

Research findings confirm previous studies which demonstrate that small amounts of natural sugar additives do not significantly affect blood test results except when stress occurs or when health problems exist [11]. It is also possible that the duration of administration or the age of the birds at the time of sampling may have influenced the outcomes. The wide standard deviations in the honey-treated group might have resulted from individual bird metabolic differences and environmental conditions.

3.3 Haematology

The haematological profiles of broiler chickens who received different sugars through drinking water are shown in Table 4. The control group received dextrose at 50 g/L while the other groups received honey molasses and brown sugar. The researchers evaluated haematocrit levels together with haemoglobin concentrations and red blood cell numbers and white blood cell counts. The haematocrit values between 32.13% and 33.13% and haemoglobin concentrations between 8 and 12 g/dL remained within typical body ranges and

did not differ significantly between treatment groups ($p > 0.05$). The RBC counts ($2.52\text{--}2.58 \mu\text{m}^3$) showed no substantial variation throughout the study period ($p = 0.913$). The research findings indicate that substituting dextrose with natural sugar sources did not affect oxygen transport capabilities of blood or red blood cell production in broiler chickens.

Table 4. Mean \pm SD values of haematology of broiler chickens broiler chickens influenced by various sugars as water additives

Parameters	Control	Honey	Molasses	Brown Sugar	p-value*
Haematocrit (vol,%)	32.20 \pm 0.14	33.13 \pm 1.40	32.13 \pm 2.42	32.13 \pm 1.50	0.863
Haemoglobin (gm,%)	12.45 \pm 3.46	11.83 \pm 2.76	10.30 \pm 0.40	10.03 \pm 0.21	0.492
RBC (μm^3)	2.56 \pm 0.00	2.56 \pm 0.12	2.58 \pm 0.18	2.52 \pm 0.10	0.913
WBC (μm^3)	10600 \pm 5230.90 ^b	17467 \pm 4952.04 ^{ab}	21133 \pm 8261.68 ^a	16967 \pm 1878.54 ^{ab}	0.071
RBC=red blood count; WBC=white blood cell count Normal values: Hematocrit-25-35 vol, %; Haemoglobin- 8-12 gm,%, RBC-2.00-4.00 μm^3 , WBC- 10,000-30,000 μm^3 **ANOVA=one way analysis of variance; <0.05=significant, >0.05=not significant; <0.001=highly significant					

WBC counts, however, showed more variation. The WBC counts from all groups maintained their normal physiological range between 10,000 to 30,000 μm^3 . The molasses group recorded the highest WBC count at $21,133 \pm 8261.68 \mu\text{m}^3$ followed by honey at $17,467 \pm 4952.04 \mu\text{m}^3$ and brown sugar at $16,967 \pm 1878.54 \mu\text{m}^3$ while the control group had the lowest count at $10,600 \pm 5230.90 \mu\text{m}^3$. The p-value reached 0.071 which slightly exceeded the threshold for statistical significance but the mean values indicated molasses might stimulate immune function through its bioactive compounds and mineral and antioxidant content. The superscript numbers (a, ab, b) indicate that the results show a significant pattern because molasses-treated birds had higher WBC counts than the control group.

The haematocrit and hemoglobin and RBC count values showed no change because of sugar supplementation, but the molasses group developed higher WBC levels, which indicates possible immunostimulatory effects. The haematological values of broiler chickens remained normal because the different natural sugars added to drinking water did not produce any blood health problems. Haematocrit and hemoglobin are key indicators of oxygen transport and erythropoietic activity in poultry [12]. The lack of significant variation in these parameters among the groups implies that the alternative sugar sources did not disrupt erythrocyte production or haemoglobin synthesis. The RBC counts showed identical results between all treatment groups, which indicates that red blood cell production processes operated at a constant level despite using different sugars.

The body demonstrates improved immune function through higher WBC counts when it encounters concealed dangers or environmental stressors. Research studies show that poultry WBC numbers increase when fed dietary additives containing plant extract antioxidants and natural sugar immunomodulators, which leads to better infection resistance [13]. The WBC count in the treatment group stayed at an intermediate level because honey contains antimicrobial and antioxidant compounds. The dextrose-only control group maintained the lowest WBC levels, which suggests they did not receive any bioactive benefits. The WBC p-value failed to reach the typical threshold for statistical significance, yet the measurable pattern combined with molasses’s known immune-boosting properties indicates the results were not random occurrences. The molasses group shows a high standard deviation because

birds likely responded differently to the treatment through their absorption rates, metabolic processes, and immune system function.

3.4 Red cell indices

The red cell indices which include mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) help veterinarians understand red blood cell structure and haemoglobin levels to evaluate poultry red blood cell function and oxygen transport ability.

The study results showed that MCV was the only red cell index which demonstrated a statistically significant difference between treatment groups ($p = 0.006$). The MCV values ranged from 124.33 ± 1.53 fL in the molasses group to 130.00 ± 0.00 fL in the honey group. The control group (124.50 ± 0.71 fL) and all treatment groups kept their values within the normal human blood volume range of 120–200 fL (Acker et al.,2021), indicating no pathological enlargement or shrinkage of red blood cells. The MCV values in the honey group showed a significant increase because honey contains small amounts of B-complex vitamins and minerals which can cause red blood cells to slightly expand.

Table 5. Mean \pm SD values of red cell indices of broiler chickens broiler chickens influenced by various sugars as water additives

Parameters	Control	Honey	Molasses	Brown Sugar	p-value**
MCV (fL)	124.50 \pm 0.71 ^b	130.00 \pm 0.00 ^a	124.33 \pm 1.53 ^b	127.67 \pm 2.09 ^{ab}	0.006
MCH (pg)	48.00 \pm 13.15	46.30 \pm 10.40	40.17 \pm 1.06	39.90 \pm 0.53	0.530
MCHC (g/dL)	38.60 \pm 10.46	35.67 \pm 8.09	32.17 \pm 1.25	31.30 \pm 0.70	0.538
<i>T0 (control)-Dextrose at 50g/L ; T1-Honey at 50g/L; T2- Molasses at 50g/L; T3-Brown Sugar at 50g/L</i> MCV=Mean Crepuscular Volume; MCH= Mean Crepuscular Haemoglobin; MCHC= Mean Crepuscular Haemoglobin Concentration Normal values: MCV=120-200 femtoliters(fl); MCH=15-25 picograms (pg); MCHC=30-36 (g/dl) **ANOVA=one way analysis of variance; <0.05=significant, >0.05=not significant; <0.001=highly significant					

The MCH and MCHC values which show the average haemoglobin content and concentration per red blood cell did not show any significant differences between treatment groups ($p = 0.530$ for MCH; $p = 0.538$ for MCHC). The MCH values across groups (ranging from 39.90 to 48.00 pg) exceeded the normal range of 15–25 pg which could be due to breed-specific or age-related differences in broiler physiology or methodological factors in measurement. The MCHC values (31.30 to 38.60 g/dL) showed most results within the standard normal range of 30–36 g/dL while slightly exceeding it which suggested haemoglobin levels inside erythrocytes remained unaffected by the different sugar types. The MCH and MCHC values in the molasses and brown sugar groups showed lower numerical readings because of iron metabolism changes and small dilution effects yet these differences failed to achieve statistical significance. Molasses contains iron and copper which are minerals that help produce haemoglobin but their body absorption depends on the amount and form of supplementation [8].

The MCV values demonstrated a major distinction between them while MCH and MCHC values stayed constant which shows that honey and other sugar-based additives affect red blood cell dimensions but do not impact the amount of haemoglobin inside each cell. The research results confirmed previous studies which showed that natural sugars combined with phytonutrient additives alter red blood cell structure and blood test outcomes without causing any blood-related health issues [15].

4 Conclusion

The research shows that adding natural and synthetic sugar sources to broiler drinking water does not harm their health while it creates beneficial effects on their blood parameters. The natural sugars present in honey and molasses show potential benefits for energy metabolism and immune function which supports complete physiological health. The research indicates that affordable sugar products found in local markets can function as affordable substitutes for commercial energy supplements which enhance chicken growth under conditions of fast development or when animals experience stress.

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