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EVALUATION OF AMELIORATIVE EFFECTS OF MATURE COCONUT WATER SUPPLEMENTS ON *Cyrtosperma merkusii* ROOT MEAL INCLUDED DIETS FOR BROILER CHICKENS

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ABSTRACT: The simultaneous degradation of essential nutrients is the major drawback in detoxifying anti-nutrient toxic substances of root meal-based diets. An ameliorative dietary supplement for root meal-based diets without undergoing thorough detoxification is proposed. Therefore, this trial aims to determine the effects of mature coconut water (MCW) against the anti-nutritional factors (ANF)-containing *C. merkusii* root meal diet on growth performance, carcass characteristics, and organoleptic traits of broiler chickens. Cobb 500 (*n*=160) day-old (male) grouped into the standard diet (commercial maize-soybean) or ANF (15% raw *C. merkusii* + 85% commercial maize-soybean) diet group, and the birds every group further allocated into 0, 5, 10, and 15% MCW water treatment groups (*n*=5) with four replications. The trial lasted for 20 D (8 to 28 D of age). In the ANF diet, treatment with MCW significantly differs on feed conversion ratio (FCR). The 5-15% MCW treated chickens were more feed-efficient than the 0% MCW treatment. MCW treatments were not significant on body weight, weight gain, survival, carcass component, and organoleptic traits of broiler chickens under the standard or the ANF diets. However, significant diet*water interactions were observed on BW and dress weight, and significant gizzard weight due to diets. In general, the improved FCR may be the ameliorative effect of mature coconut water against ANF on raw *C. merkusii* root meal inclusion (15% + 85%) in the standard diets.

Keywords: Ameliorative effect, Anti-nutritional factor, *Cocos nucifera*, *Cyrtosperma merkusii,* Root meal.

INTRODUCTION

In livestock farming, reduced production costs without compromising the welfare and performance, quality of meat and meat products is the primary concern (Bonnet et al., 2020; Post et al., 2020). The primary feedstuffs used for providing energy and protein in commercial poultry diets are maize and soybean (Maisonnier-Grenier et al., 2004; Hussein et al., 2020) because of their high digestibility. Several ingredients were experimented with to replace maize or soybeans, but none was proven effective in nutrient composition and cost-effectiveness (Medugu et al., 2011; Uguru et al., 2022). *Cyrtosperma merkusii* tuber, on the other hand, showed economic and phytonutrient potential over the maize but is instead characterized; by the low density of nutrients (Temesgen and Retta, 2015; Temesgen et al., 2017), causing feed stress due to anti-nutritional factors (ANF) which are considered toxic (Kumar, 1992; Samtiya et al., 2020; Taer et al., 2022). Anti-nutrient substances interfere with average growth, reproduction, and health when consumed regularly and are considered harmful and toxic (Bora, 2014). To safely consume the root and tuber products, detoxify them directly by heating them beyond 150°C, breaking the tubers to allow more substantial contact, microbial detoxification, and combining the techniques above (Okereke, 2012). However, the simultaneous degradation of essential nutrients is the major drawback during the detoxification process (Latif and Müller, 2015; Araújo et al., 2017). Infusing supplements in addition to root meal-based diets rather than thorough drying at high temperatures and detoxification is an interesting intervention. In a recent study conducted on broiler chickens supplemented with fresh coconut milk (FCM) under *C. merkusii* root meal diets, the result showed that giant swamp taro *C. merkusii* can replace maize up to 25%, giving a better body weight, weight gain, and feed conversion ratio compared to corn-soya-based diets (Taer et al., 2022).

The coconut water from the endosperm of the coconut (*Cocos nucifera* L.) recently had increased demand in beverage industries worldwide due to its flavoring, nutritional and therapeutic potential. Mature coconut water is the by-product left over by many coconut industries that produce virgin coconut oil, coconut milk, and desiccated coconut (Vani et al., 2021). The majority of the coconut mills discharge mature coconut water of around 261 MT volume per year (Prades et al., 2012). In India, approximately 80% of the mature coconuts gone processed into the desiccated coconut, also known as copra (Vani et al., 2021). In the Philippines, the coconuts are mostly processed on-field (on coconut farms), leaving coconut water wasted and unutilized. Thus, this massive volume of mature coconut water leftover promotes environmental concerns. For this reason, various thermal, non-thermal processing, and preservation methods extend the shelf life of coconut water (Naik et al., 2020) to meet the global market demand and a strategy of utilizing the liquid waste discharge (Vani et al., 2021). However, the applicability of this processing and preservation strategy is limited to

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coconut processing plants. The widespread of the rural coconut field and the scarcity of farm-to-market roads restrict the collection and transport of coconut water wastes from the coconut fields to the processing plant.

Coconut water (CW) is a natural, nutrient-rich, and refreshing drink in Asia, Europe, North America, Australia, and other countries. In folklore medicine, coconut water is drunk for oral rehydration and treatment of childhood diarrhea, gastroenteritis, and cholera and is also known to possess antioxidant properties (Mandal et al., 2009; Elekwa et al., 2021). The efficacy of plant materials in the treatment of chemical toxicity is associated with the presence of phytochemicals and other nutrients and bioactive compounds, which are known to have antioxidant properties. Coconut water has a therapeutic effect, containing various nutrients such as minerals, vitamins, antioxidants, amino acids, enzymes, and growth hormones (Bhagya et al., 2012; Halim et al., 2018; Johnkennedy et al., 2013; Zulaikhah, 2019). Recent studies on CW showed that it contains L-arginine, a free-form amino acid, and vitamin C, which can prevent heart disease and lipid peroxidation (Bhagya et al., 2012; Prathapan and Rajamohan, 2011). L-arginine therapy reduces the effects of heavy metal poisoning (Kumar et al., 2013). Using L-arginine treatment was able to increase glutathione peroxidase (GPx) activity in mice exposed to Plumbum (Pb) (Tkachenko and Kurhalyuk, 2011). According to Van Harn et al. (2019), reducing crude protein by 1 to 3% of soybean meal with free amino acids (L-Isoleucine, Glycine, and L-Tryptophan) resulted in better growth performance and feed conversion ratio for male broiler chickens. The efficacy of CW in coping against stress was adequate to lower body temperature and increases the circulating blood glucose of chickens during heat spell periods (Abioja and Abiona, 2020).

Although various researchers have studied the ameliorative effect of CW against stress and toxicity using chickens and albino rats, the ameliorative impact of coconut water on toxins against ANF-containing broiler chicken diets has not been tested. Therefore, this study elucidates the ameliorative effects of mature coconut water against ANF-containing *C. merkusii* diet on broiler chickens' body weight, weight gain, feed intake, water intake, survival, and feed efficiency, carcass traits, and organoleptic properties.

Study significance

- Mature coconut water ameliorated stress effect of toxins induced by ANF on *C. merkusii* diet on performance and carcass characteristics of broiler chicken.
- Hence, MCW can serve as water supplement for reducing or preventing the toxic effect of *C. merkusii*-based chicken diets.

MATERIALS AND METHODS

Ethical regulation and study location

The experiment was conducted at the Poultry Laboratory Complex in Mainit Campus of Surigao State College of Technology (SSCT) in Magpayang, Mainit, Surigao del Norte from June 16 to July 21, 2021. The study was supervised by the research committee of the department of agriculture, in compliance with the rules and regulations on the scientific procedures using animals under the Philippines Republic No. 8485, otherwise known as the "Animal Welfare Act of 1998".

Research design, animals, and treatment

Cobb broiler 500 one-day-old (*n*=160) male were purchased from a reliable source and used in this experiment. The chicks were brooded in a communal system. They were fed with maize-soybean-based commercial chick starter crumbles (21% crude protein and 2800 kcal/kg) from days 1 to 7 of age and were managed according to standard broiler production practices and management. On the 8th day, the broiler chicks were randomly assigned to two separate groups. The first group received a standard commercial (maize-soybean) diet with composition (g/kg) was a trade secret by the manufacturer while ingredients and analyzed value were presented in Table 1. The second group of broiler chicks was fed with raw *C. merkusii* root meal (15% giant swamp taro + 85% standard commercial diet) having proximate nutritional composition presented in Table 2.

The experiment was designed by 2 × 4 factorial including two diets (standard commercial vs. ANF *C. merkusii* meal), and four levels of mature coconut water (MCW) as a supplement in drinking water that consisted of 0, 5, 10, and 15%. The chicks were reared in 32-floor pens representing four replicates per treatment. Each pen had five birds with a 0.074 m2/bird floor space allotment. Feeding on experimental diets with levels of MCW in drinking water was initiated from 8 until 28 days of age. The provision of feed and water was ad libitum throughout the experimental period.

Standard diet *and C. merkusii* meal

The standard commercial diets (Sarimanok by UNAHCO, Incorporated, Philippines) were sourced from Agrivet supply stores. The preparation for *C. merkusii* root meal was following the procedures of Taer and Taer (2020) with modifications. Briefly, raw corms were thoroughly washed with tap water, hand peeled, and were finely chopped manually. Thereafter, the chopped corms were subjected to a dehydrator (± 40 ^{0}C) to preserve nutrients (Araújo et al., 2017). Once dried, the chopped corms were ground finely using the hammer mill and the resulting powder was mixed thoroughly with the standard commercial diets. The mixture of *C. merkusii* root meal and standard commercial diets was 15% *C. merkusii* root meal + 85% standard commercial (wt./wt.) basis respectively.

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Table 1 - Ingredients and guaranteed analysis for standard commercial diets based on product label

Starter diet*		Finisher diet*	
Corn		Corn	
Soybean meal		Soybean meal	
Fish meal		Fish meal	
Copra meal		Copra meal	
Corn bran		Corn bran	
Rice middlings		Rice middlings	
Rice bran (D1)		Rice bran (D1)	
Wheat pollard		Wheat pollard	
Cassava meal		Cassava meal	
Sorghum		Sorghum	
Wheat		Wheat	
Salt		Salt	
Calcium carbonate		Calcium carbonate	
Calcium phosphate		Calcium phosphate	
Vegetable oil		Vegetable oil	
Molasses		Molasses	
Dl methionine		Dl methionine	
L-lysine		L-lysine	
Vitamins		Vitamins	
Trace minerals		Trace minerals	
Anti-oxidant		Anti-oxidant	
Mold inhibitor		Mold inhibitor	
Guaranteed Nutrient Analysis			
Crude Protein	Min. 19.50%	Crude Protein	Min. 18.00%
Crude Fat	Min. 5.00%	Crude Fat	Min. 5.00%
Crude Fiber	Max. 4.50%	Crude Fiber	Max. 4.50%
Moisture	Max 12.00%	Moisture	Max 12.00%
Calcium	0.80 – 1.10%	Calcium	0.80 – 1.10%
Phosphorus	Min 0.70%	Phosphorus	Min 0.70%

* Standard commercial (maize-soybean) diet with composition (g/kg) was a trade secret by the manufacturer while ingredients and analyzed value were presented in Table 1.

Table 2 - Proximate nutritional composition of *Cyrtosperma merkusii* root meal

Constituents	*C. merkusii meal*
Moisture	13.91±1.03
Ash	4.82±0.05
Crude Protein	5.94±0.09
Crude fiber	7.15±0.00
Crude fat	0.063±0.005
Nitrogen free extract	68.12±0.020
Metabolizable energy	2635.58±0.070
Calcium	0.50±0.07
Phosphorus	0.073±0.055

Source: Taer and Taer (2020)

Production of drinking water and MCW

The chickens in every group were offered drinking water with 0, 5, 10, and 15% mature coconut water (MCW) concentrations. Water from mature coconuts (*Cocos nucifera* L.) of 10-12 months of age, (Tacunan tall variety) was purchased and used for this study. The preparation of MCW was achieved by modifications of Vani et al. (2021) procedures. Briefly, mature coconuts were dehusked and washed thoroughly with tap water, then air-dried at room temperature (± 25 ^{0}C). Liquid endosperm was collected, filtered the dust and husk particles using the clean and sterile fabric, and stored the filtrate in a refrigerator (± 30 ^{0}F) before using it as a supplement to drinking water for broiler chickens. To avoid spoilage, the unused MCW in the refrigerator was replaced after three days of storage.

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Meat sensory assessment

Samples from breast meat of broiler chickens were obtained for sensory assessments. The meat was steamed (no spices and seasoning) for 30 minutes, and cooked samples were sliced to 10g and served in a clean plastic cup (Taer et al., 2019). Meat sensory attributes viz. tenderness, juiciness, taste, aroma, and general acceptability were evaluated by untrained panel evaluators (n=20) in the Food Laboratory Complex of SSCT, Mainit Campus, Surigao del Norte, Philippines. Using the 5-point hedonic scale (1 being very poor and 5 being very good), the obtained results were tabulated and subjected to ANOVA.

Data collection, measurement and calculation

Live bodyweight of the chickens was measured two times during the 8 D and at the 28 D treatment period. Weight gain was the difference between the starting weight and the ending weight of chickens. Percentage weight gain calculation was done by dividing the weight gain by the initial weight multiplied by 100. Daily feed intake was determined by the weight of feed given minus the refused. Similarly, the water consumption was calculated by the volume of water given minus the leftover. The total feed consumed was divided by the total weight gain of birds to account for the feed conversion ratio (FCR). On termination, two birds per pen were selected, fasted for 10 hours, and then slaughtered. Dress weight was expressed as warm carcass weight (without head, shank, and digesta), while dressing percentage was calculated as a percentage g/kg live weight. The weight of breast and thigh meat was expressed as a percentage of dress weight. The weight of edible organs such as the heart, liver, and gizzard was determined as a percentage of dress weight using the 0.1 g sensitive balance.

Statistical analysis

All data collected having replicate as the experimental unit were subjected to analysis of variance (ANOVA) using International Business Machine (IBM) SPSS Statistics version 26, and the means were separated using Bonferroni Test at $P<0.05$ of the same packages.

RESULTS

Body weight and weight gain

Table 3 shows the effects of MCW supplementation in drinking water of broiler chicken feed standard or ANF diets on live body weight (BW), weight gain (WG), and percent weight gain (%WG). The interaction effect (diet × water) was observed on the final live body weight of broiler chickens. Under the standard and the ANF diets, no differences were noticed among groups regardless of MCW concentrations in drinking water. However, ANF diets tended to have lower live body weights than the standard commercial diet from 8-28 D experimental feeding. The use of top water alone for both standard and feed stress diets likely had a depressed WG (941.25 g and 783.74 g) and lower %WG (69.01% and 67.78%), respectively, compared to MCW supplemented water (Table 3).

Table 3 - Broiler body weight, weight gain, and % weight gain following supplementation of mature coconut water in drinking water under standard or ANF-containing C. *merkusii* root meal diet

Diet	Water	BW (g/bird)	WG (g)	% WG
Standard	Top water	1334.5	941.25	69.01
	5% MCW	1454.25	1051.5	72.34
	10% MCW	1112.25	783.25	69.8
	15% MCW	1411.75	1029.75	72.95
ANF	Top water	1142.25	793.75	67.78
	5% MCW	1323	974	73.44
	10% MCW	1430	993	69.45
	15% MCW	1374.25	1018.5	74.06
SEM		84.136	87.745	3.162
ANOVA	Diet×Water	0.026*	0.916	0.945
	Diet	0.175	0.186	0.32
	Water	0.857	0.227	0.977

*Significant difference ($P<0.05$), BW= body weight; WG= weight gain; %WG= percent weight gain; MCW= mature coconut water; SEM= Standard error mean; ANOVA= Analysis of variance

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Intake of feed, water, survival rate and FCR

Table 4 presents feed intake, water consumption, survival rate, and FCR affected by supplementation of MCW in broiler drinking water under ANF diets. The results indicated feed intake, water consumption, and survival rate were not significantly different among the ANF diets and/or the MCW water supplements. However, chickens in ANF diets tended to consume more feed and water compared with the standard diet-fed chickens. Significant differences were noticed in the FCR (g feed/g WG) due to supplementation of MCW in drinking water (Table 4). The lowest yet most efficient feed converter was on 5% MCW supplements under standard diet compared to chickens on TW on the ANF diets.

Carcass characteristics

The results for dress weight, dressing percentage, thigh, breast, heart, liver, and gizzards are shown in Table 5. Chicken dress weight was significantly affected due to the interaction of diet x water effects. Chickens supplemented with 10% MCW had the lowest dress weight under the standard diet. However, dress weight for chickens on standard diets tended to be higher over ANF diets. A significant difference for gizzard (% g/g DW) was found between diets. ANF diet groups significantly had higher gizzard as a percentage dress weight over standard diet group. Moreover, chickens on 0 – 15% MCW supplements in the water had a non-significant difference within each diet.

Meat sensory attributes

Table 6 shows the impact of diets, water supplements, and their interactions on customer assessment of broiler chicken breast meat. The main effects of diets, water, and diet*water interactions showed no significant differences as scored by the taste panel on a scale of 1-5. However, meat from chickens given 15% MCW under standard diet was scored as juicier (4.48) than those with counterpart 15% MCW in feed stress (3.93).

Table 4 - Feed, water intake, survival rate and FCR of broiler chicken affected by supplementation of mature coconut water in drinking water under standard or ANF-containing C. *merkusii* root meal diet

Diet	Water	FI (g)	WI (lit)	Survival rate (%)	FCR (g feed/g WG)
Standard	Top water	2085.92	2	95	2.00[b]
	5% MCW	2077.32	1.74	100	1.73[b]
	10% MCW	1902.67	2.14	90	2.14[ab]
	15% MCW	2036.57	1.74	90	1.74[b]
ANF	Top water	2322.25	2.54	90	2.54[a]
	5% MCW	2200.28	2.03	100	2.03[b]
	10% MCW	2180.64	1.87	95	1.86[b]
	15% MCW	1937.74	1.96	100	1.95[b]
SEM		121.135	292.721	4.33	0.153
ANOVA	Diet×Water	0.422	0.197	0.364	0.083
	Diet	0.129	0.836	0.422	0.085
	Water	0.302	0.142	0.287	0.043*

[a-b] Means with varying superscripts differ significantly (P<0.05). * Significant difference (P<0.05). FI, feed intake; WI, water intake; FCR, feed conversion ratio

Table 5 - Carcass characteristics of broiler chickens affected by supplementation of mature coconut water on drinking water under standard commercial or ANF-containing C. *merkusii* root meal diet

Diet	Water	DW (g)	DW (%)	Thigh (%)	Breast (%)	Heart (%)	Liver (%)	Gizzard (%)
Standard	Top water	1087.75	84.38	28.98	30.44	0.67	2.71	1.51
	5% MCW	1082.75	74.44	28.36	30.37	0.73	2.93	1.73
	10% MCW	826.5	76.68	33.86	31.52	0.74	2.88	1.84
	15% MCW	953	67.73	31.16	33.42	0.73	3.04	1.72
Feed stress	Top water	875.25	78.12	32.4	33.56	0.79	3.3	2.38
	5% MCW	1001.75	75.72	28	30.13	0.66	2.68	2.13
	10% MCW	1003	70.13	29.54	32.03	0.7	2.78	2.24
	15% MCW	961.25	69.89	29.69	31.03	0.75	2.96	2.43
SEM		54.574	5.767	2.223	1.647	0.059	0.225	0.165
ANOVA	Diet×Water	0.012*	0.801	0.393	0.43	0.43	0.275	0.407
	Diet	0.488	0.571	0.667	0.831	0.865	0.797	<0.001
	Water	0.156	0.217	0.459	0.63	0.903	0.707	0.79

* Significant difference (P<0.05). DW, dress weight

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Table 6 - Meat sensory attributes of broiler chicken affected by supplementation of mature coconut water in drinking water under standard or ANF-containing C. *merkusii* root meal diet

Diet	Water	Tenderness	Juiciness	Taste	Aroma	General acceptability
Standard	Top water	3.99	3.75	3.86	3.59	3.73
	5% MCW	3.68	3.79	3.9	3.77	3.82
	10% MCW	3.73	3.85	3.65	3.72	3.64
	15% MCW	3.94	4.48	3.96	3.87	3.84
ANF	Top water	3.85	3.82	4.01	4.08	3.95
	5% MCW	3.68	3.64	3.87	3.53	3.62
	10% MCW	3.68	3.78	3.93	3.75	3.81
	15% MCW	3.77	3.93	4.02	3.76	3.77
SEM		0.105	0.182	0.093	0.188	0.102
ANOVA	Diet×Water	0.844	0.384	0.385	0.261	0.158
	Diet	0.222	0.191	0.093	0.752	0.655
	Water	0.099	0.054	0.199	0.76	0.57

DISCUSSION

The study aimed to determine the effects of MCW concentrations in the drinking water of broiler chickens raised under standard or ANF diets. The induction of ANF diets did not influence the body weight, weight gain, and survival of chickens. Similarly, the effects of MCW supplements in drinking water did not affect the same. However, diet*water cross-over interacts significantly with the live body weight of chickens. The bodyweight of chickens was lowest for 10% MCW concentrations under standard diet but turned out to be the highest when offered ANF diets using the same concentration of MCW in water. The BW and WG in ANF diets decreased slightly (1142.25 and 793.75g, respectively) when the chickens received only top water. As the level of anti-nutritional factors ANF in *C. merkusii*-containing diets, broiler chicken performance is more likely to be adversely affected. Anti-nutritional factors can cause detrimental effects on human and animal growth and performance by impairing intake, uptake, or utilization of other foods and feed components or causing discomfort and stress to humans and animals (Bora, 2014). The results of the present study confirmed the many studies using *C. merkusii* and other root meal-based diets in various concentrations (Abdulrashid and Agwunobi, 2009; Getiso et al., 2021; Taer et al., 2022). Anti-nutritional elements commonly observed in all species of the Araceae family are abundant in most parts of the plant, causing throat irritation and mouth epithelium and indirectly reducing the digestibility (Temesgen and Retta, 2015; Taer et al., 2022). However, WG on ANF diets tended to increase (18.50, 20.06, and 22.01%) more than the controls when chickens received 10, 15, and 25% levels of MCW in water (Table 3). Anti-nutritional factors include oxalates, proteinase inhibitors, phytates, tannins, alkaloids, steroids, and cyanogenic glucosides (Kumar, 1992; Steiner et al., 2007; Temesgen and Retta 2015; Hyacinthe et al., 2018; Taer et al., 2022) have a negative impact on digestibility and nutritional quality (Amin et al., 2022) and are low toxic substances that cause severe pathological conditions (Bora, 2014). Having established that the MCW supplemented chickens tended a higher LW and WG performances over the TW chickens given ANF diets is indicative of the protective effects of coconut water (CW) against toxins in the diets. Coconut water has a therapeutic effect (Bhagya et al., 2012; Halim et al., 2018), containing various nutrients such as minerals, vitamins, antioxidants, amino acids, enzymes, and growth hormones (Johnkennedy et al., 2013; Zulaikhah, 2019). Conventionally coconut water has been used as an excellent hydrating drink that maintains the electrolyte balance and helps treat diverse ailments related to oxidative stress, including liver function (Manna et al., 2014). Recently, CW was found rich in L-arginine, a free-form amino acid, and vitamin C, which can prevent heart disease and lipid peroxidation (Bhagya et al., 2012; Prathapan and Rajamohan, 2011). L-arginine can be used for therapy and to reduce the effects of heavy metal poisoning (Kumar et al., 2013). Treatment with L-arginine was able to increase glutathione peroxidase (GPx) activity in mice exposed to Plumbum (Pb) (Tkachenko and Kurhalyuk, 2011). Based on the electrolyte profiling, potassium yielded the highest amount (ranging from 237.41 to 361.20 mg/100 mL), followed by sodium, magnesium, calcium, iron, manganese, copper, selenium, and zinc across varieties of mature coconut water (Halim et al., 2018). Selenium is one of the micronutrients usually acquired through the dietary consumption of plants and animals (Whanger 2002; Eiche et al., 2015) that form the GPx enzyme as a protective agent in neurological and cardiovascular diseases (Lubos et al., 2011). The study of palm oil and coconut water was proven to ameliorate the toxicity-induced cadmium chloride contaminated diet in rats (Mordi et al., 2015) and coconut water against carbon tetrachloride-induced toxicity in rats (Elekwa et al., 2021). According to the Coconut Development Board (CBD), Indonesia, tender coconut water can detoxify toxins in case of poisoning (Zulaikhah, 2019).

In the standard and the ANF diets in each MCW concentration group, treatment-related changes in feed and water intake at the end of experimental treatment were not noticeable. Per survival rate, a slightly decreased in the standard diet group, but this decrease was considered incidental and not a diet-related change. The absence of apparent adverse

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effects of diets agrees with the available literature (Abdulrashid and Agwunobi, 2009) but disagrees with the published findings (Getiso et al., 2021). Water used per kg feed average was 1.74 – 2.14 lit. in standard and 1.86 – 2.54 lit. in ANF diets during the entire trial period. Coconut water stimulates higher water consumption, which ensures the availability of enough water in the body to facilitate evaporative cooling (panting) under hot environmental conditions. Chickens under heat-stress conditions ingested more water (Abioja and Abiona, 2020). This finding was not observed in chickens receiving MCW treatment under ANF diet groups. Broiler chickens on 5% and 10% MCW treatment showed 20.00 and 26.37%, respectively, lower than the controls (Table 4). However, it follows the ratio of water consumption to dry matter intake (DMI), which remained constant at about 2:3 for chickens (Degen et al., 1991; Taer and Taer, 2022).

The effect of MCW supplementation affected the FCR (g feed/g WG) of broiler chickens raised on ANF diets. Chickens in 15% MCW treatment efficiently convert feed into WG ($P < 0.05$) than chickens in TW. The problem with root crop-based diets was lower nutrient densities affecting performance and efficiency (Temesgen and Retta, 2015; Temesgen et al., 2017; Taer et al., 2022), such that the induction of MCW in the drinking water of chickens in this study is speculative to amelioration impact in nutrient-deficient *C. merkusii* diet resulting to improved feed efficiency. Coconut water contains 9 essential amino acids as Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine, Tryptophan, Valine, and Histidine, while it has 9 Non-essential amino acids such as Alanine, Arginine, Aspartic acid, Cystine, Glutamine, Glycine, Proline, Serine, and Tyrosine (Twishsri et al., 2012). A study of reduced crude protein in 1 to 3% units by replacing soybean meal with free amino acids (L-Isoleucine, Glycine, and L-Tryptophan) resulted in better growth performance and feed conversion ratio for male broiler chickens (Van Harn et al., 2019). Moreover, Coconut water contains growth-promoting phytohormones auxin, cytokinin, gibberellin, inorganic ion, and vitamin (Yong et al., 2009) that play a wide range of developmental processes for plant and mammal general cellular growth (Estevez, 2021). Nitrogen and total protein content of coconut water increased gradually with maturation (Twishsri et al., 2012).

The nutrition of birds has a significant impact on poultry meat quality and safety. In this research, the diet or the MCW as a water supplement did not affect most of the observed carcass characteristics. However, diet × water treatments interact significantly with dress and gizzard weight. Improved gizzards were noted on ANF diet chickens than chickens on standard diets. The result is not consistent with the observation of Abdulrashid and Agwunobi (2009) who reported no significant influence of root meal-based *Colocasia esculenta* diet on gizzard weight. Other studies also reported that dress weight, meat cuts, and other organ weights from root meal-based diets were not significant to those in standard maize-soybean-based diets (Dei et al., 2011; Sultana, 2012; de la Cruz, 2016; Okechukwu and Jiwuba, 2018). Contrarily, some other studies found that root meal-based diets had significant carcass weights, breast, thigh, and edible viscera relative to standard diets (Okpanachi et al., 2014; Getiso et al., 2021; Uguru et al., 2022).

The most influential and perceptible meat features that influence consumers before purchasing meat products are the appearance, texture, juiciness, wateriness, firmness, tenderness, odor, and flavor (Mir et al., 2017). Table 6 showed that 15% of MCW supplementation under the standard diet was juicer among MCW supplements in both diets. Juiciness is related to characteristics of more or less dryness of meat during mastication (Geay et al., 2001). There are two components of juiciness; the sensation of water released during the first bites and juiciness induced by the rapid release of fluid from meat and the influence of lipids on the secretion of saliva (Geay et al., 2001; Chriki et al., 2013). The fatty acid profile of coconut water was capric acid, lauric acid, myristic acid, palmitic acid, stearic acid, oleic acid, and linoleic acid, which is a possible link to juiciness. However, this study does not have enough evidence of the link between CW lipids and juiciness in broiler breast meat. These present findings need substantial evidence in future studies.

CONCLUSION

This study demonstrated the effect of supplementing mature coconut water in the drinking of broiler chickens raised under the ANF *C. merkusii* diets. The influence of MCW treatment on body weight, weight gain, survival, carcass component, and organoleptic traits of broiler chickens under the standard or the ANF diets was insignificant. However, 5-15% MCW treatment within the ANF diets showed an improved FCR better than 0% MCW treatment. The result revealed the ameliorative effects of mature coconut water against anti-nutrients on raw *C. merkusii* root meal inclusion (15% + 85%) in standard diets. Further research is required to corroborate these findings and verify the link between fatty acids and meat juiciness. This will ensure that the nutritional potential of water from mature coconuts can be fully harnessed as a drinking water supplement for broiler chickens.

DECLARATIONS

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Authors' contribution
Cordova S, the sole author who conceptualizes, conducts the investigations, data curation, data analysis and manuscript writing.

Conflict of interests
The author has not declared any conflict of interests.

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