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Synergistic Effects of Phytogenic Compounds on Early Growth Parameters of Native Chickens

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ABSTRACT

The survival of native chickens during the first 6 weeks of growth is less than 50%. Hence, this study proposes the introduction of prophylactic antibiotics for poultry diseases prevention and treatment. However, the ban on antibiotics has prompted the search for plant-based biomedicines. Therefore, this trial aimed to determine the effect of phytogenic compounds (PC) of five herbs as water additives on the survival and growth responses of native chickens. A total of 204 Bisaya chickens (unsexed) were randomly assigned to 4 treatments replicated three times with 17 chickens in each replicate. Chickens were fed *ad libitum* and received water with 1.5 g antibiotics/1000ml water (control), 20 ml PC/1000ml water (T2), 40 ml PC/1000ml water (T3), and 60 ml PC/1000ml water (T4) for 35 days. No significant differences were observed on feed intake for chickens in antibiotics and PC treatments, however, the 60-PC group consumed slightly higher feed intake, compared to chickens under antibiotics and the other level of PC supplementation. Chickens in 60-PC ate 4-12% more feed than the others at the end of the trial period. Cumulative water used per kg feed did not differ among the experimental groups. The control and the PC supplemented chickens shared homogenous body weight and weight gains patterns, averaging 403.79 to 415.20g and 85.49 to 86.85g, respectively. Supplementation of 40-PC and 60-PC in drinking water for native chickens reduced the mortality rate and comparable feed conversion ratio with antibiotics. The 60-PC as a phytogenic water additive could enhance the growth performance, increase the survival rate, reduce mortality, and improve feed conversion ratio correlative to antibiotics.

Keywords: Antibiotic, Mortality, Native chicken, Phytogenic compounds, Synergistic effect, Survival rate

INTRODUCTION

The higher mortality rate for native chickens at the growing stage is a common problem mostly encountered by backyard and smallholder native chicken farmers. Mortality during the first week of life in chickens is an essential production criterion widely used in poultry production. These first days of life, many things happen to chicks in a relatively short period due to adjustments from a controlled environment in the hatchery to a more independent life on the farm and chicks' digestive systems are immature (Yassin et al., 2009; Yerpes et al., 2020). During this period of adjustment, some factors can negatively affect the chick morpho-physiological welfare.

In broiler chicken farming, housing factors and management routines are important for reducing the first-week mortality rate, rearing the chickens, and constructing new broiler houses (Yerpes et al., 2020). It requires reliable access to inputs, commercial stock, feed, labor, and health services, as well as efficient marketing channels (Mack et al., 2005; Thieme et al., 2014; Abebe and Tesfaye, 2017). Native chicken farming is a small-scale poultry production, mainly involving chickens of the poultry population in rural areas of low and medium-income countries (Gilbert et al., 2015). They engaged in free-ranging systems where chickens are scavenging for feed with minimal supplement and inadequate housing (Sonaiya, 2004; Thieme et al., 2014). The free-range chickens are commonly mixed with crops and other livestock and are vulnerable to environmental risks (Alders et al., 2014; Thieme et al., 2014).

Alfred et al. (2012) reported that the total chick deaths in the initial six weeks of age were 53%. The primary cause of chick deaths was predation (55%), diseases other than ectoparasites (30%), ectoparasites (5%), management

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factors (6%), and unknown causes (5%) for free-range chickens. Although free-ranging chick predation causes higher death rates than other problems, chicken keepers were more concerned about the diseases than predation. Moreover, predation losses can be addressed by the appropriate shelter of chicks from day-old to 6 weeks before free-range production. In diseases, prevention is worth better than treatment. However, rural areas are typically distant from markets and veterinary assistance (Thieme et al., 2014). The widespread rural areas and a scarcity of supplies and infrastructure can restrict veterinary and extension services (FAO, 2014). In most cases, services focused on crop or ruminant production, with little attention to the small-scale poultry raisers (Bagnol, 2009). Hence, they resorted to prophylactic treatment by antibiotics as means of preventing diseases in chickens. Antibiotics can prevent, control, and treat infectious diseases in humans and animals (Hao et al., 2014). In 1996, the use of antibiotic growth promoters (AGPs) in poultry diets was banned by the European Union (Saeed et al., 2017). The use of antibiotics in feed has improved growth performance and feed efficiency in livestock (Lin, 2014). The global emergency of antibiotic resistance has led to the prohibition of antibiotics worldwide (Marshall and Levy, 2011; Tang et al., 2017). A number of alternatives, including prebiotics, probiotics, symbiotics, and plant extracts have been proposed in this regard (Nikpiran et al., 2013; Vahdatpour and Babazadeh, 2016; Saeed et al., 2018; Vieco-Saiz et al., 2019).

Due to customers' choices, preferences, values, and desire for natural products, phytogenics (phytobiotics or botanicals) have drawn significant recognition from livestock, and poultry has shifted the fastest-growing segment of animal feed additives. However, adding extracts from single herbs (Chamomile, Lemon balm, and St John's wort) to water did not affect feed conversion and water use by broiler chickens (Skomorucha and Sosnówka-Czajka, 2013). Better effects are achieved when using a mixture of well-chosen herbs than incorporating the same herbs individually into the diet (Schleicher et al., 1996; Dahal and Farran, 2011). Cho et al. (2014) revealed that the combined extracts of four medicinal herbs (*Galla rhois*, *Achyranthes japonica* Nakai, *Terminalia chebula* Retz, and *Glycyrrhiza uralensis*) were effective against *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Pseudomonas aeruginosa*, and *Escherichia coli* and exhibited the highest DPPH radical-scavenging activity synergistic actions.

Therefore, the current trial aimed at determining the effect of five herbal extracts as phytogenic compounds in water on growth responses and the survival rate of native chickens under controlled growing conditions.

MATERIALS AND METHODS

Ethical approval

The study complied with the rules and regulations on the scientific procedures of using animals under the Philippines Republic No. 8485, otherwise known as the "Animal Welfare Act of 1998", and ethical standards at Surigao State College of Technology, Surigao City, Philippines.

Animals, experimental design, and location

A total of 204 one-day-old unsexed native chicks (Bisaya) with an average body weight of 53.05 ± 1.54g, were utilized from the college chicken hatchery unit and were randomly allocated to one of the four treatment groups with three replicates containing antibiotic or levels of phytogenic compounds (PC) in drinking water, such as T1 (Antibiotics 1.5 g/lit Water), T2 (20 ml PC/1000ml water), T3 (40 ml PC/1000 ml water), and T4 (60 ml PC/1000ml water). Doxycycline (PBAC Doxy 500 mg/g powder by Life Biopharma SDN BHD, Malaysia) was the most commonly available veterinary drug in the locality during the trial time. Basal diets were commercial ration and kept constant in all treatments throughout the 35 days trial period divided into two phases, including 1-14 days chick booster and 15-35 days chick starter period. The study was carried out at Surigao State College of Technology-Mainit Campus, Philippines from December 21, 2020, to January 25, 2021.

Twelve cages measuring 60 inches Wide × 70 inches Long × 20 inches Hight made of local materials were constructed and stationed in open-sided poultry housing. A total of 17 chicks occupied each cage provided with 24-hour light using 25 watts electric lamp as the heater and provide light during the night. The temperature was kept at 35°C in the first week of brooding and reduced gradually by reducing the wattage of the heated lamp until reached a normal room temperature of 32°C.

Preparation of phytogenic compounds

Phytogenic compounds consisted of five fresh herbs namely, ginger (*Zingiber officinale*), garlic (*Allium sativum*), red onions (*Allium cepa*), turmeric (*Curcuma longa*), and black pepper (Piper nigrum) sourced from the public market in the community. Each herb was prepared separately, then the preparations were combined to produce PC. The preparation of PC was the modification of Chang et al. (2014). Briefly, fresh herbs were sliced or crushed, weighed, and each herb was placed separately in a clean glass jar to fill 2/3 full. An equal amount of molasses was added to each jar and then the jars were covered tightly, sealed, labeled, and then sat for 7 days at room temperature. After 7 days, each jar was filled with pure coconut vinegar (1:1 solution), sat at room temperature, and stirred clockwise every morning for 14 days. The solutions from each jar were strained and labeled according to preparations. The phytogenic compounds (PC) were comprised of several herbal extracts (1 part from ginger, garlic, red onions, turmeric, and black pepper) and then were mixed in one jar before applying as treatments

Feed and water management

Chickens had unrestricted access to commercial maize-soybean basal diets and drinking water during the whole trial. The feed crumbles were offered in plastic feeders (60 cm) size. Plastic gravity-type drinkers (1000 ml round-shaped) were washed daily and refilled with potable water. The drinkers were apart from the feeders to avoid contamination. The feed and water intakes were calculated daily at 16:00 as the difference between the weight given and the remaining. The daily feed intake per bird (FI/bird) was the quotient between the feed intake per cage by the number of animals present in the cage: FI/bird = FI/cage/number of animals per cage. The water used per kg feed (Lit./kg feed) was the quotient between the water intake per pen by the total feed received on weekly basis. The BW was recorded on days 1, 7, 14, 21, 28, and 35.

Statistical analysis

All data gathered were subjected to analysis of variance (ANOVA) for a completely randomized design (CRD) using IBM SPSS (version 26) for windows. Treatment means were compared using Tukey's HSD test and differences were considered significant at 5% level of probability.

RESULTS

The data on the performance and survival of native chicken growers supplemented with levels PC is presented in tables 1-5. There was no significant change in the feed intake of chickens in antibiotics and PC-treated groups during 1 to 35 days of feeding ($p > 0.05$). However, the 60-PC treatments consumed slightly higher feed intake than chickens under control (antibiotics) and the rest of PC supplementation. Chickens in the 60-PC consumed 4-12% more feed than the others at the end of the trial period (Table 1). Throughout the experiment, cumulative water used per kg feed did not differ among the experimental groups (Table 2). The control and the PC supplemented chickens shared homogenous body weight and weight gains patterns ($p > 0.05$), averaging 403.79 to 415.20 g and 85.49 to 86.85 g, respectively, at the end of the experiments (Tables 3 and 4). Supplementation of 40-PC and 60-PC in water for native chicken growers reduced mortality rate (1.96%) with the higher percentage of survival (98.04%) apiece and shared a statistically similar feed conversion ratio with antibiotics treatment (Table 5).

Table 1. Feed intake of native chickens treated with different levels of phytogenic compounds as water additive

Treatment	Booster		Starter		
	1-7 days	**8-14 days**	**15-21 days**	**22-28 days**	**29-35 days**
Antibiotic (g/l^{-1})	1941.67	2653.33	3397.03	4187.43	5045.20
20ml PC/1000ml water	1948.67	2779.33	3637.70	4536.10	5493.20
40ml PC/1000ml water	1937.00	2764.67	3621.47	4520.73	5482.47
60ml PC/1000ml water	1955.67	2841.33	3754.27	4706.47	5715.60

(gl^{-1}): Grams per liter, PC: Phytogenic compound

Table 2. Water use of native chickens treated with different levels of phytogenic compounds as water additives

Treatment	Booster		Starter		
	1-7 days	**8-14 days**	**15-21 days**	**22-28 days**	**29-35 days**
Antibiotic (gl^{-1})	1.95	2.02	2.06	2.16	2.27
20ml PC/1000ml water	1.94	1.98	2.08	2.10	2.19
40ml PC/1000ml water	1.93	2.00	2.07	2.17	2.24
60ml PC/1000ml water	1.95	2.01	2.10	2.14	2.22

(gl^{-1}): Grams per liter, PC: Phytogenic compound

Table 3. Body weight of native chickens treated with different levels of phytogenic compounds as water additives

Treatment	Booster			Starter		
	Initial	1-7 days	8-14 days	15-21 days	22-28 days	29-35 days
Antibiotic (gl^{-1})	53.98	102.34	175.83	243.89	318.30	403.79
20ml PC/1000ml water	53.05	100.18	171.32	240.22	315.81	398.87
40ml PC/1000ml water	54.59	100.79	170.19	240.11	313.16	397.72
60ml PC/1000ml water	54.45	101.61	178.47	254.11	328.36	415.20

(gl^{-1}): Grams per liter, PC: Phytogenic compound

Table 4. Weight gain of native chickens treated with different levels of phytogenic compounds as water additives

Treatment	Booster		Starter		
	1-7 days	8-14 days	15-21 days	22-28 days	29-35 days
Antibiotic (gl^{-1})	48.36	73.49	68.06	74.41	85.49
20ml PC/1000ml water	47.13	71.13	68.90	75.59	83.06
40ml PC/1000ml water	46.19	69.40	69.92	73.05	84.56
60ml PC/1000ml water	47.17	76.86	75.64	80.24	86.85

(gl^{-1}): Grams per liter, PC: Phytogenic compound

Table 5. Feed conversion ratio, mortality rate, and the survival rate of native chickens treated with different levels of phytogenic compounds as water additives

Treatment	Feed conversion ratio	Mortality (%)	Survival (%)
Antibiotic (gl^{-1})	2.90	3.92	96.08
20ml PC/1000ml water	3.02	3.92	96.08
40ml PC/1000ml water	3.03	1.96	98.04
60ml PC/1000ml water	3.09	1.96	98.04

(gl^{-1}): Grams per liter, PC: Phytogenic compound

DISCUSSION

The antibiotic and PC treatments did not show any differences in feed intake and water used per kg feed at different ages of growing chickens. The 60-PC had the highest FI value among other PC treatments indicating that PC as water additives induce intake of feeds. The improved consumption of feed by chickens under 60-PC was probably due to concentrations of phytogens derived from various herbs used. The phytogens help the discharge of digestive enzymes in chickens, as the PC-enriched drinking water flows through their digestive tracts and thus enhanced the integrity of the intestinal mucosa (Herkel' et al., 2014). The phytogens stimulate the olfactory receptors and taste buds, which subsequently encourage intake, endogenous enzyme production and digestive fluids, and better nutrient digestibility of feed (Panda et al., 2009). The natural-growth promoting actions of feed additives phytogens are feed hygiene maintenance, including the beneficial effect on the gastrointestinal microbiota through regulatory pathogens (Roth and Kirchgessner, 1998), appetite, feed intake, endogenous digestive enzyme secretion, immune responses, antibacterial, antiviral, and antioxidant improvement and stimulations (Dorman and Deans, 2000; Hosseini-Vashan et al., 2012). The result of the current study was in line with other findings on the same herbs. For instance, garlic extract use of 0.75% in the diet was a more efficient growth enhancer of broiler chicks (Islam et al., 2018), dietary supplementation of ginger at 2 g/kg feed was beneficial on overall performance of broilers (Rafiee et al., 2014), and turmeric powder improved the performance of broiler using 7.5 g/kg concentration in the diet (Shohe et al., 2019).

The final mean values for water used per kg feed averaged 2.19 to 2.27 liters at the end of the experiment. Water use was 2-3 ml higher per gram feed intake for poultry. This finding indicated regular water consumption by chickens despite the varying levels of herbal extracts. A two to three times higher water intake per gram diet was also observed by broilers that received varied levels of aqueous *Moringa Oleifera* leaf extract, compared to those who received water with antibiotics and tap water (Alabi et al., 2017).

Varied PC in water did not significantly differ from antibiotics treatment in terms of body weight and body weight gain of native chicken growers across the trial period. However, the 60-PC-treated chickens had higher body weight and weight gain, compared to antibiotic treatments during the late booster phase until the entire starter phase feeding period. On days 8-35 of the experiment, chickens from the 60-PC groups showed a tendency for greater body weight compared to chickens not supplemented with herb extracts. The addition of herbal extracts to a poultry diet positively affects the body weight of chickens as confirmed by many studies (Buğdaycı et al., 2018; Abd El-Hack et al., 2020; AL-Sagan et al., 2020). According to Hippenstiel et al. (2011), the antibacterial behaviors of volatile oils improved the bacterial flora of the digestive tract which increased digestive enzymes and enhanced digestion. the increased digestive enzymes and enhanced digestion resulted from the antibacterial actions of volatile oils that help improve the bacterial flora of the digestive tract. However, other studies indicated contradictory effects of herbal medicines on the performance of chickens (Lee et al., 2003; Khalaji et al., 2011). A mixture of well-chosen herbs led to better results, compared to incorporating the same herbs individually into the diet (Schleicher et al., 1996; Dahal and Farran, 2011). The tendency for a greater body weight of chickens in 60-PC in this study was that antimicrobial combination involved in the ingredient of herb mixtures such as red onions, garlic, red onions, turmeric, and black pepper controlled the microflora in the gastrointestinal tract. Active ingredients are gingerol and shogaol for ginger (Rahmani et al., 2014), allicin, diallyl disulfide, diallyl trisulfide, and alliin for garlic (Shang et al., 2019), quercetin, cycloalliin, S-methyl-L-cysteine, S-propyl-L-cysteine sulfoxide, Dimethyl trisulfide, S-methyl-L-cysteine sulfoxide, N-acetylcysteine, alliuocide for red onions (Marrelli et al., 2018). Turmeric has three curcuminoids; curcumin, demethoxycurcumin, and bisdemethoxycurcumin (Dasgupta, 2019), and black pepper has the active ingredient piperine (Butt et al., 2013) that probably involved in enhancing the digestibility of feed and growth performance in native chickens.

Phytogenic compounds at 40 to 60 ml per liter in water reduced the mortality rate and improved the survival of growing chickens (Table 5). Polyphenolic and carotenoids content of the herbal extract activate lymphocyte proliferation and enhances cytoprotection against free radicals is higher (Geetha et al., 2002; Kalia et al., 2017). Though phenolics, flavonoids, and carotenoids content of the tested five herbs (ginger, garlic, red onions, turmeric, and black pepper) were not quantified as part of the limitations in this trial, it was presumed higher in amount considering the levels of supplementation and the number of utilized herbs extract might cause the synergistic effect those phytomolecules could have been stimulated the generation of T lymphocytes and support the immune system (Geetha et al., 2002; Dorhoi et al., 2006; Kalia et al., 2017). It also showed that the mitogenic activity of *Hippophae rhamnoides* in bird lymphocytic cells helps maintain feed intake under challenging conditions and modulates gut microbiota to decrease pathogenic bacteria pressure. Moreover, it minimizes intestinal stress, makes more nutrients available for production, enhances gut integrity, and improves immune resilience against stressors (Kalia et al., 2017). The improved feed conversion ratio of chickens receiving antibiotics in water was not significantly different from PC-treated chickens. The synergistic therapeutic mechanism of herbal medicines suggests that mixed drugs affect either the same or distinct targets in diverse pathways and interact in an agonistic, synergistic way (Yang et al., 2014). More specifically, enzymes and transporters involved in hepatic and intestinal metabolism that boost oral medication bioavailability also suppress microbial and cancer cell drug resistance mechanisms, reduce side effects, and increase pharmacological effectiveness (Yang et al., 2014).

CONCLUSION

Based on the results, it can be concluded that the 60 ml of phytogenic compounds as a water additive offered better growth and immune responses of the early growing Bisaya chickens on par with the antibiotic treatments. It increased the survival rate, reduced mortality, and improved the feed conversion ratio. Therefore, this dose is recommended as an alternative to Doxycycline. However, there is a need to conduct comparative studies on the effects of phytogenic compounds and other antibiotics.

DECLARATIONS

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Author's contribution

Taer A, contributed in the study design, gathering data, statistical analysis, and interpretation of data. Taer E contributed in conceptualization, writing the draft of manuscript, and revising the article. All authors confirmed the analyzed data and final proof of article.

Competing interests

The authors have not declared any conflict of interest.

Ethical consideration

The authors carefully checked all ethical issues concerning plagiarism, consent to publish, misconduct, data fabrication, falsification, double publication or submission, and redundancy of the manuscript.

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