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Original article

Effects of in-feed blend spices on growth performance, digestibility profile and production cost of Japanese quails (*Coturnix japonica*)

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A B S T R A C T

The side effects and banning of synthetic antibiotics made researchers to turn towards phytobiotics which has been hypothesise to act as synthetic antibiotics, having no side effects and having positive returns. The present study was assigned to evaluate the effects of in-feed blend *Afrostyrax lepidophyllus*, *Tetrapleura tetraptera, Dichrostachys glomerata* and *Syzygium aromaticum* on production performances of Japanese quails. A total of 144 two weeks old Japanese quails were randomly assigned to 6 treatments with 4 replicates of 6 birds each in a completely randomised design. The treatments consisted of incorporating in 1 kg of basal diet (T0), 1 g of antibiotic Doxycyclin (T0+), 4 g (2/2) blend *Dichrostachys glomerata - Afrostyrax lepidophyllus* (T1), 4 g (2/2) blend *Dichrostachys glomerata - Tetrapleura tetraptera* (T2), 4 g (2/2) blend *Dichrostachys glomerata - Syzygium aromaticum* (T3) and 4 g (1/1/1/1) blend of all four spices (T4). Throughout the study (35 days), feed intake, live body weight, weight gain significantly (p<0.05) decreased with in-feed blend spices while feed conversion ratio was comparable (p>0.05) in all treatments. Dry matter and organic matter digestibility were comparable (p>0.05) meanwhile crude protein (97.82%) and crude cellulose (87.79%) digestibility were highest (p<0.05) in animals fed on blend *D. glomerata* - *S. aromaticum*. Apart for quails fed on synthetic antibiotic treatment, intestine length was lowest (p<0.05) compared to all treatments, carcass characteristics and digestive organ's mensurations were comparable amongst treatments. Meanwhile, feed intake costs 223.25 and 238.95 Fcfa were respectively lowest (p<0.05) with blend *D. glomerata* - *T. tetraptera* and *D. glomerata* - *S. aromaticum*. It was concluded that incorporating 4 g (2/2) blend *Dichrostachys glomerata* - *Syzygium aromaticum* in quail's feed improve protein and cellulose digestibility and reduce feed intake cost.

1. Introduction

The necessity to improve animal health thereby increasing animal productivity has led to the extensive use of antibiotics (Mouiche et al., 2019). However, the ignorance of the hazards related to synthetic antibiotic therapy in food producing animals has escalated the emergence of antimicrobial resistance (Tadesse et al., 2017) and residues found in livestock products could be harmful for consumer's health (Necdem et al., 2020). Due to these, there has been an increasing interest in the use of natural plants or non-synthetic alternatives such as herbs, spices and essential oils as additives in animal diets (Owen, 2011). The beneficial effects of these natural plants or plant products resides in the presence of active substances such as phenols, tannins, alkaloids, flavonoids, terpenoids , eugenol and sulphur compounds (Alloui et al., 2011). These secondary metabolites when incorporated in animal feed can increase feed digestibility (Hong et al., 2012; Zulkifli et al., 2012) and improve growth performances through their increase gut secretions, anti-oxidative and anti-inflammatory actions (Alonge et al., 2017).

Garlic tree or country onion (*Afrostyrax lepidophyllus*) is a plant used for traditional dishes and also as a remedy for cough and boils (Tchamgoue et al., 2015). It has been reported that *Afrostyrax lepidophyllus* bark contains sulphur compounds and phenylpropanoids responsible for the garlic-onion taste or odour. Fogang et al. (2014) reported that these substances have the ability to stimulate the function of pancreatic enzymes (lipase, amylase and protease) and increase the activity of digestive enzymes of gastric mucosa. Also, this spice contains polyphenolic compounds (Moukette et al., 2015) possessing significant antioxidant and has protective potential on liver enzymes (Fai et al., 2017). The incorporation of 2 g of the bark of this spice per kg of feed increased body weight gain and reduced production cost in broilers compared to the control treatments (Kana et al., 2017c).

African porridge or aidan (*Tetrapleura tetraptera*) is a plant growing in tropical African countries (Ogbunugafor et al., 2017). It possesses a fragrant pungent aromatic odour and has been reported to have both nutritional and therapeutic effects to man and animals (Nweze et al., 2011). Its fruit is used as a flatulence, to control onset type 2 diabetes mellitus and hyperlipidemia (Atawodi et al., 2014). It has been reported to have anthraquinones, phenolic compounds, alkaloids, steroids and flavonoids (Ebana et al., 2016). These molecules could be subsumed to be responsible of the inhibition of lipid peroxidation, wound-healing, hypoglycaemic and muscle-relaxant properties in animals (Oguoma et al., 2015; Ogbunugafor et al., 2017). Recent findings of Kana et al. (2017b) revealed that 2 g of the fruit of this spice per kg of broiler feed improved growth performances.

Mimosa small bell (*Dichrostachys glomerata*) is a deciduous herbaceous plant found in tropical regions (Kothari et al., 2014). The phytochemical screening of *D. glomerata* has been reported to contain bioactive compounds such as flavonoids, anthocyanines, anthraquinons, phenols and triterpenoids (Ebile et al., 2018a) which are known for their taste enhancing and anti-inflammatory effects (Kuate et al., 2011; Jane et al., 2014). They have been reported to improve digestibility, growth rate and carcass traits (Kana et al., 2017a; Ebile et al., 2018b).

Cloves (*Syzygium aromaticum*) are small round headed aromatic dried flower buds with high mineral contents (Pavithra, 2014). They are used to enhance flavour in various dishes and are highly valued in medicine as a carminative and a stimulant (Khatri et al., 2014). The phytochemical analysis of this spice revealed the presence of eugenol, tannins, saponins, terpenoids, flavonoids and alkaloids (Shailesh, 2015; Akyildiz and Denli, 2016). Moreover, according to Agostini et al. (2012), in-feed clove at doses of 1-2 g/kg feed improved feed efficiency and interesting changes were observed on the intestinal microbial load and epithelium due to the secondary metabolite eugenol present in this spice.

The blending of phytobiotics has been reported to have synergistic and additive effects of several bioactive compounds as they improve feed digestion, affects the absorption rates or bioavailability of other components (Cetin et al., 2016). Regarding the chemical composition and zootechnical properties of *Afrostyrax lepidophyllus*, *Tetrapleura tetraptera, Dichrostachys glomerata* and *Syzygium aromaticum*, it could be hypothesised in the present study that the adequate blending of these spices in quail feed could produce synergistic effects on growth performance and digestibility profile and hence reduce production cost.

2. Materials and methods

2.1. Study area

This study was carried out at the Non-conventional Unit of the Teaching and Research Farm of the Faculty of Agronomy and Agricultural Sciences, University of Dschang, Cameroon. The farm is located in the Western Region highlands of Cameroon, at about 1420 m above the sea level, between 5°36′-5°44′ North Latitude and 9°85′-10°06′ East Longitude with an equato-guinean climate type. The area experiences a wet season from March to November and a hot dry season for the rest of the year with a maximum ambient temperature around 21°C.

2.2. Feed additives

The antibiotic (Doxycyclin®) was bought from a local veterinary pharmacy while dried samples of *Afrostyrax lepidophyllus*, *Tetrapleura tetraptera*, *Dichrostachys glomerata* and *Syzygium aromaticum* were bought from the local market. They were ground into powder in a harmed mill then a sample of each spice was collected in polyethylene plastic, sealed and stored at 4°C in a refrigerator for phytochemical analysis of flavonoids, tannins, phenols, alkaloids, saponins, steroids and terpenoids. All the spices had the above secondary metabolites except in *Afrostyrax lepidophyllus* where flavonoids, tannins and phenols were absent.

2.3. Experimental birds

A total of 144 two weeks old Japanese quails (*Coturnix japonica)* of average weight 40±5 g were bought from a local farm. They were randomly assigned to 6 treatments of 24 quails/treatment. Each treatment was divided into 4 replicates of 6 quails each (3 males and 3 females). Prophylactic measures against common infectious diseases were carried out and an antistress (AMINTOTAL®) was given in drinking water after every weighing of the animals.

2.4. Dietary treatments

Five dietary treatments were formulated per kg of basal diet (T0), by incorporating 1 g Doxycyclin®(T0+); 4 g (2/2) blend *A. lepidophyllus - D. glomerata* (T1); 4 g (2/2) blend *T. tetraptera - D. glomerata* (T2); 4 g (2/2) blend *D. glomerata - S. aromaticum* (T3) and 4 g (1/1/1/1) blend *D. glomerata - A. lepidophyllus- T. tetraptera - S. aromaticum* (T4). The proximate composition of the basal diet is summarised in Table 1.

2.5. Data collection

2.5.1. Growth performance

Data on feed intake (FI) and live body weight (LBW) were collected after every seven days then weight gain (WG) was obtained by doing the difference of two successively weekly weights while feed conversion ratio (FCR) was calculated by dividing the feed intake by the weight gain. At 35 days of trial, 16 birds per treatments were randomly selected, fasted for 12 hours then weighed, sacrificed, plucked and eviscerated for the evaluation of carcass characteristics. Carcass yield as well as the relative weight of organs was expressed as a percentage of live body weight. The intestine's length was measured with the cut done from the start of the duodenal loop to the end of the cloaca. The intestine's density was equally calculated by dividing the intestine weight by its length.

Table 1
Composition of basal diet.

Ingredients	**Quantity (%)**
Maize	60
Wheat brand	4
Soybean meal	22
Peanut meal	4
Fish meal	4
Bone meal	0.5
Oyster Shell	0.5
Premix 5%*	5
Total	100
Analysed nutrients composition	
Dry Matter	92.54
Ash (%)	8.28
Crude protein (%)	20.28
Crude cellulose (%)	7.41
Fat (%)	2.06
Calculated nutrients composition	
Metabolisable energy (kcal/kg)	3067.97
Lysine (%)	1.33
Methionine (%)	0.46
Calcium (%)	1.04
Available phosphorus (%)	0.54
Ca/P	1.93
Sodium (%)	0.02

*Vitamin premix provided per kilogram of diet: vitamin A: 3000000 IU; vitamin D3: 600000 IU; vitamin E: 4000 mg; vitamin K: 500 mg; vitamin B1: 200 mg; vitamin B2, 1000 mg; vitamin B6: 400 mg; vitamin B12: 4 mg; Mn: 80 mg; Fe: 8000 mg; Zn: 10000 mg; Cu: 2000 mg; Methionine: 200000 mg; Lysine: 78000 mg; Se: 20 mg. Metabolisable energy (kcal/kg Dry matter) = 3951 + 54.4lipids - 88.7Crude cellulose - 40.8Ash (Wiseman and Lesier, 1987).

2.5.2. Digestibility of feed components

During the 4th week of the trial period, individual sheets were placed under cages, faeces samples were collected every day between 6:00 and 7:00 a.m during 3 days. These faeces samples from each cage were weighed fresh and oven dried at 50°C until constant weight. Faeces from replicates/treatment were mixed, ground and used for the analyses of dry matter (DM), organic matter (OM), crude cellulose (CC) by the Scheerer method and crude protein (CP) by the Kjedhal method according to the procedure of A.O.A.C (1990),. The apparent digestibility coefficients (aDC) of DM, OM, CP and CC were calculated according to the following formulae:

- aDC DM= 100 x{Ingested DM (g) - Excreted DM (g)}/{ Ingested DM (g)}
- aDC OM= 100 x{Ingested OM (g) - Excreted OM (g)}/{ Ingested OM (g)}
- aDC CP= 100 x{Ingested CP (g) - Excreted CP (g)}/{ Ingested CP (g)}
- aDC CC= 100 x{Ingested CC (g) - Excreted CC (g)}/{ Ingested CC (g)}

2.6. Statistical analysis

Data collected from the studied parameters were submitted to one-way analysis of variance using the Statistical Package for Social Science (SPSS 20.0) software. Duncan’s Multiple Range test was used to compare treatments means at a 5% threshold level (Steel and Torrie, 1984), p-values less than 0.05 were considered as significant.

3. Results and discussion

3.1. Growth performances

Table 2 summarises the effects of in-feed blend spices on feed intake, live body weight, weight gain and feed conversion ratio of Japanese quails. It is observed that feed intake of quails fed on blend *T. tetraptera* - *D. glomerata* (T2) was comparable (p>0.05) to those fed on blend *D. glomerata* - *S. aromaticum* (T3) but lower (p<0.05) than all the other treatments.

In the same line, blend *T. tetraptera* - *D. glomerata* equally induced the lowest (p<0.05) live body weight and weight gain compared to all treatments. Meanwhile, no significant difference was observed on feed conversion ratio irrespective of the treatment.

Table 2

Effects of in-feed blend phytobiotics on growth performance of Japanese quails.

Growth parameters	Treatments						p
	T0	T0+	T1	T2	T3	T4	
Feed intake (g)	913.67±19.78[a]	907.19±27.63[a]	913.99±31.90[a]	834.04±44.61[b]	858.54±48.58[ab]	895.96±37.96[a]	0.026
Live body weight (g)	228.46±7.69[a]	232.72±5.76[a]	227.78±3.39[a]	205.79±11.22[c]	216.25±11.52[b]	223.92±9.43[ab]	0.001
Weight gain (g)	157.58±8.53[ab]	161.31±7.02[a]	156.74±5.58[ab]	134.83±10.88[c]	144.88±7.35[b]	153.04±10.61[ab]	0.004
Feed conversion Ratio	5.81±0.38	5.63±0.28	5.84±0.33	6.20±0.30	5.93±0.38	5.87±0.34	0.345

a, b, c: Means with different superscript on the same row are significantly (p<0.05) different. T0= basal ration; T0+= T0 + 1 g Doxycyclin®; T1= T0 + 4(2/2) g blend *A. lepidophyllus* and *D. glomerata*; T2= T0 + 4(2/2) g blend *T. tetraptera* and *D. glomerata*; T3= T0 + 4(2/2) g blend *D. glomerata* and *S. aromaticum*; T4= T0 + 4(1/1/1/1) g blend *D. glomerata*, *A. lepidophyllus*, *T. tetraptera* and *S. aromaticum.*

3.2. Digestibility of feed components as affected by in-feed blend phytobiotics

Digestibility of feed components with respect to in-feed blend spices is summarized in Table 3. Birds fed on blend *D. glomerata* - *S. aromaticum* (T3) excreted (p<0.05) less protein compared to all the other treatments. Meanwhile the apparent digestibility coefficient of protein and cellulose was highest (p<0.05) with blend *D. glomerata* - *S. aromaticum* (T3) with respect to the other treatments. In general, all animals receiving blend spices had a higher (p<0.05) apparent digestive coefficient of cellulose compared to all the control treatments (T0 and T0+).

Table 3

Digestibility of feed components as affected by in-feed blend phytobiotics.

Parameters	Treatments						p
	T0	T0+	T1	T2	T3	T4	
DM Ingested (g)	82.67±4.90	83.03±8.07	84.68±6.41	73.62±5.31	82.16±7.59	77.43±2.64	0.286
DM Excreted (g)	22.56±2.88	23.16±2.71	21.71±4.86	19.75±2.79	22.30±2.25	20.72±2.19	0.767
aDC DM (%)	72.74±2.72	72.13±1.19	74.54±3.67	73.26±1.89	72.86±0.62	73.27±2.04	0.850
OM Ingested (g)	81.94±4.86	82.29±8.00	83.92±6.35	72.97±5.27	81.43±7.53	76.74±2.61	0.286
OM Excreted (g)	22.75±2.92	23.31±2.78	21.94±4.76	20.00±2.91	22.62±2.26	20.76±2.23	0.764
aDC OM (%)	72.26±2.78	71.71±1.20	74.04±3.57	72.68±2.05	72.22±0.65	72.99±2.11	0.853
CP Ingested (g)	18.12±1.07	18.20±1.77	18.56±1.41	16.13±1.16	18.00±1.66	16.97±0.58	0.286
CP Excreted (g)	0.68±0.05[b]	0.89±0.09[ab]	1.06±0.23[a]	1.11±0.15[a]	0.39±0.04[c]	1.02±0.11[a]	0.000
aDC CP (%)	96.22±0.22[b]	95.12±0.25[c]	94.30±0.76[d]	93.13±0.45[e]	97.82±0.07[a]	93.98±0.49[d]	0.000
CC Ingested (g)	6.62±0.39	6.64±0.65	6.78±0.51	5.89±0.43	6.57±0.61	6.20±0.21	0.286
CC Excreted (g)	1.31±0.17[a]	1.39±0.16[a]	0.96±0.21[b]	0.79±0.11[b]	0.80±0.08[b]	0.95±0.10[b]	0.001
aDC CC (%)	80.24±1.96[c]	79.10±0.89[c]	85.99±2.02[ab]	86.62±0.94[ab]	87.79±0.28[a]	84.62±1.17[b]	0.000

a, b, c, d, e: Means with different superscript on the same row are significantly (p<0.05) different. DM= Dry Matter; OM= Organi Matter; CP= Crude Protein; CC=Crude Cellulose; aDC= Apparent Digestive Coefficient;T0= basal ration; T0+= T0 + 1 g Doxycyclin®; T1= T0 + 4(2/2)g blend *A. lepidophyllus* and *D. glomerata*; T2= T0 + 4(2/2) g blend *T. tetraptera* and *D. glomerata*; T3= T0 + 4(2/2) g blend *D. glomerata* and *S. aromaticum*; T4= T0 + 4(1/1/1/1) g blend *D. glomerata*. *A. lepidophyllus*. *T. tetraptera* and *S. aromaticum*.

3.3. Carcass characteristics

From Table 4 it is noticed that animals fed on the basal diet and blend *D. glomerata - S. aromaticum* (T3) registered the lowest carcass yield though statistically comparable to all the treatments. Equally, the relative weights of all the organs with respect to the live weight were comparable (p>0.05) among treatments.

Table 4
Effects of in-feed blend spices on carcass characteristics of Japanese quails.

Carcass characteristics (%LW)	**Treatments**						**p**
	T0	**T0+**	**T1**	**T2**	**T3**	**T4**	
Carcass Yeild	74.89±4.92	76.47±4.14	75.41±5.06	75.84±5.19	74.64±4.86	75.09±4.95	0.908
Head	4.32±0.63	4.56±0.65	4.13±0.67	4.63±0.59	4.26±0.51	4.51±0.53	0.158
Legs	1.90±0.19	1.84±0.21	1.83±0.09	1.87±0.23	1.78±0.16	1.84±0.23	0.562
Heart	0.81±0.09	0.81±0.11	0.87±0.15	0.86±0.11	0.82±0.11	0.85±0.13	0.524
Liver	1.85±0.55	1.68±0.41	1.84±0.39	1.79±0.60	1.95±0.60	1.92±0.34	0.690
Abdominal fat	1.67±0.93	1.30±0.73	1.30±0.96	1.45±0.85	1.54±0.74	1.41±0.76	0.787

T0= basal ration; T0+= T0 + 1 g Doxycyclin®; T1= T0 + 4(2/2) g blend *A. lepidophyllus* and *D. glomerata*; T2= T0 + 4(2/2) g blend *T. tetraptera* and *D. glomerata*; T3= T0 + 4(2/2) g blend *D. glomerata* and *S. aromaticum*; T4= T0 + 4(1/1/1/1) g blend *D. glomerata*. *A. lepidophyllus*. *T. tetraptera* and *S. aromaticum*.

3.4. Development of digestive organs

The mensurations of digestive organs of quails is summarised in Table 5. There was no significant (p>0.05) effects on the weight of the gizzard, pancreas, intestine's weight and density irrespective of the treatments. Meanwhile, the length of the intestine of birds supplemented with antibiotic (T0+) was significantly (p<0.05) lower than all the other treatments which were comparable amongst them.

Table 5
Digestive organs of Japanese quails with respect to in-feed blend phytobiotics.

Digestive organs	**Treatments**						**p**
	T0	**T0+**	**T1**	**T2**	**T3**	**T4**	
Gizzard (%LW)	1.53±0.32	1.43±0.32	1.53±0.30	1.50±0.34	1.52±0.23	1.57±0.22	0.843
Pancreas (%LW)	0.22±0.06	0.21±0.03	0.20±0.05	0.22±0.04	0.22±0.06	0.19±0.06	0.412
Intestinal weight (g)	5.91±1.81	5.03±1.30	6.24±1.81	5.41±1.34	6.14±1.61	6.15±1.27	0.163
Intestinal length (cm)	63.94±5.01[a]	56.53±4.74[b]	64.63±4.16[a]	61.25±4.68[a]	63.06±4.22[a]	63.66±4.62[a]	0.000
Density (g/cm)	0.09±0.02	0.09±0.02	0.10±0.03	0.09±0.02	0.10±0.02	0.10±0.02	0.726

a, b: Means with different superscript on the same row are significantly (p<0.05) different. T0= basal ration; T0+= T0 + 1 g Doxycyclin®; T1= T0 + 4(2/2)g blend *A. lepidophyllus* and *D. glomerata*; T2= T0 + 4(2/2) g blend *T. tetraptera* and *D. glomerata*; T3= T0 + 4(2/2) g blend *D. glomerata* and *S. aromaticum*; T4= T0 + 4(1/1/1/1) g blend *D. glomerata*, *A. lepidophyllus*, *T. tetraptera* and *S. aromaticum.*

3.5. Cost of production of quails fed on blend spices

Table 6 summarises the effects of in-feed blend spices on the cost of feed intake and cost of feed/kg body weight. From this table it is observed that antibiotics (T0+) induced the highest (p<0.05) cost of feed intake and feed/kg bodyweight. Meanwhile, birds fed on *T. tetraptera-D. glomerata* (T2) and control ration (T0) had respectively the lowest (p<0.05) cost of feed intake and feed/kg bodyweight compared to the other treatments.

Table 6
Cost of production as affected by in-feed blend phytobiotics.

Cost (Fcfa)	Treatments						p
	T0	T0+	T1	T2	T3	T4	
PF+FA	264	309	266.96	267.67	278.32	273.16	//
Feed Intake	241.21±5.22[b]	280.32±8.54[a]	244.00±8.52[b]	223.25±9.22[c]	238.95±9.48[b]	244.74±10.37[b]	0.000
Feed/kg BW	1534.60±93.71[b]	1740.09±86.70[a]	1558.69±88.74[b]	1659.39±79.40[ab]	1651.67±94.03[ab]	1602.88±89.55[ab]	0.045

a, b, c: Means with different superscript on the same row are significantly (p<0.05) different. PF+FA=Price of Feed/kg + Feed Additive T0= basal ration; T0+= T0 + 1 g Doxycyclin®; T1= T0 + 4(2/2) g blend *A. lepidophyllus* and *D. glomerata*; T2= T0 + 4(2/2) g blend *T. tetraptera* and *D. glomerata*; T3= T0 + 4(2/2) g blend *D. glomerata* and *S. aromaticum*; T4= T0 + 4(1/1/1/1) g blend *D. glomerata*, *A. lepidophyllus*, *T. tetraptera* and *S. aromaticum.*

3.6. Discussion

In-feed blend *T. tetraptera* - *D. glomerata* had the lowest feed intake compared to all other treatments. This might be due to the acute bitter taste and odour of *T. tetraptera* which might have reduced feed appetibility. In addition, Effiong et al. (2014) reported that high doses of *T. tetraptera* could cause weakness in animals and by so doing reduces feed intake. Also, *D. glomerata* being equally bitter, surely the blending of *T. tetraptera* and *D. glomerata* had a great effect on feed palatability and reduced feed intake. Martinez et al. (2013) reported that plant's action depends on the secondary metabolites present, their concentration, the relationship of these secondary metabolites and its inclusion in animal diets. This result correlates the findings of Aroche et al. (2018) who reported that dietary inclusion of 0.5% mixed *Anacardium occidentale*, *Psidium guajava*, and *Morinda citrifolia* reduced feed intake in broilers. In the same line, Ibrahim et al. (2019) recorded a feed intake drop when *Ocimum basilicum L*, *Foeniculum vulgare, Cinnamomum zeylanicum* and *Origanum vulgare L*. were blended and incorporated at 10 g/kg finishing broiler's feed. The above results contradict that of Onu (2010) who had no significant difference compared to the control group when 0.25% blend garlic–ginger was introduced in broiler's feed. Furthermore, Attia et al. (2017) had no significant difference compared to the oxytetracycline antibiotic treatment when blend extracts of oregano, fenugreek, chamomile and fennel were introduced in broiler's diet at a 200 ppm level.

Live body weight and weight gain were lowest (p<0.05) with in-feed blend *T. tetraptera* - *D. glomerata*. The feed conversion ratio was highest (p>0.05) with the latter treatment. This may be because since the birds consumed less feed due to the combined bitterness of these spices, less feed components (proteins) was metabolised to build muscles in the animals there by increasing the feed conversion ratio of the animals. This result is in accordance with the findings of Sugiharto et al. (2020) who recorded a drop in weight gain and an increase in feed conversion ratio when 2% blend turmeric-black pepper were acidified with *Averrhoa bilimbi* Linn. fruit filtrate. Moreover, Oso et al. (2019) had a drop in broiler's live body weight and weight gain compared to the negative control treatment when 2% blend *Aerva lanata, Piper betle, Cynodon dactylon*, and *Piper nigrum* was introduced in their feed. Meanwhile, Ibrahim et al. (2019) instead had an increase in live body weight, weight gain and a drop in feed conversion ratio in broilers when blend sweet basil , fennel ,cinnamon and oregano was incorporated at 1% level in their feed. In the same line, Syed et al. (2021) recorded a drop in broiler's feed conversion ratio when 65 g/ton of feed (0.065 g/kg of feed) blend carvacrol, thymol, carvone, methyl salicylate and menthol was encapsulated and used.

Excreted crude protein and apparent digestive coefficient were respectively lowest (p<0.05) and highest (p<0.05) with blend *D. glomerata* - *S. aromaticum*. This may result from the synergistic effect of eugenol from *S. aromaticum*, tannins and saponnins from *D. glomerata* highly present in these spices. These phytochemicals have been reported to stimulate intestinal mucus production, bile acid secretion, and activity of digestive enzymes such as trypsin and amylase as well as positively affect the intestinal morphology (Oso et al., 2019). Reyer et al. (2017) reported that phytobiotics possess an overlapping mode of action including local effects at the intestinal border and systemic macronutrient metabolism. This result concord those of Paraskeuas et al. (2017) who had an increase in crude protein digestibility when 100 mg of blend mint, star anise and cloves was introduced in broiler's feed. In the same line, Ibrahim et al. (2019) reported a significant increase in crude protein digestibility when 1% blend basil, fennel, cinnamon and oregano was incorporated in broiler chicken's feed. Oso et al. (2019) instead recorded a drop in crude protein digestibility when 1% blend *Aerva lanata, Piper betle, Cynodon dactylon*, and *Piper nigrum* was in broiler's feed. However, all animals receiving in-feed blend phytobiotics had higher crude cellulose digestibility with respect to the control treatments. This suggests that the blend of this photobiotic had high cellulose digestion stimulating properties as their blending brings in the synergistic effects of their respective phytochemicals. This might have boosted the action of endogenous enzymes or digestive secretions on cellulose there by breaking it into sugars necessary to produce energy. This result is in accordance with those of Ibrahim et al. (2019) who reported that 1% blend basil, fennel, cinnamon and oregano in feed induced an increase in crude fibre digestibility in broilers compared to the control group. On the contrary, Sa'aci et al. (2018) reported a drop in crude fibre digestibility compared to the negative control group when aqueous ginger extract was given to broilers drinking water at doses of 25, 50, 75, 100 and 125 ml/L. Nevertheless, the latter authors reported that increasing these doses progressively brought about a comparable digestibility as that of the control.

With the exception of the intestine length which had the lowest ($p<0.05$) value with the antibiotic treatments compared to the other treatments, all the other digestive organ measurements and carcass characteristics were comparable amongst treatments. This proofs that synthetic antibiotics dose not promote the growth of microvillus present on intestine walls and thus absorption of nutrients is not maximised. This result agrees with that of Mafouo et al. (2019) who had the intestine length of animals receiving antibiotic shorter than those fed on *Azadirachta indica* seed oil. In the same line, Kengni et al. (2020) recorded a shorter intestine length of broilers fed in-feed antibiotics compared to those fed 1.5 g methenamine in water.

Japanese quails fed on antibiotics had the highest ($p<0.05$) cost of feed intake and cost of production of a kg body weight compared to those receiving in-feed spices. This shows that synthetic antibiotics are very costly adding to the fact they cause health hazards to the animals which can later be transferred to humans. Meanwhile, blend *T. tetraptera* - *D. glomerata* and *D. glomerata* -*S. aromaticum* induced the lowest feed intake cost (223.25 and 238.95 Fcfa respectively). This results agrees with those of Kafi et al. (2017) as they recorded the lowest feed cost when 1% blend turmeric-ginger was incorporated in the diet of broilers compared those receiving the negative control treatment, 0.5% and 0.75% of these individual phytiobiotics. Whereas this result contradicts those of Karangiya et al. (2016) who instead recorded an increase ($p<0.05$) in feed intake cost when 1% blend garlic-ginger was added in broiler's diet compared to those receiving 1% of these individual phytobiotics.

4. Conclusion

From this study, the administration of blend *D. glomerata* and *S. aromaticum* in feed can be use as a substitute to synthetic antibiotics in order to enhance feed components digestibility and reduce feed intake cost in Japanese quails.

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