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Effect of Plant-Based Quorum Quenching Compounds as a Feed Additive on the Production Performance of Commercial Broiler Chicken

Gunasekaran, K.R.[1], N. Karthikeyan[2] and J. Ramesh[3]*

Optima Poultry Pvt. Ltd., OptimaSquare,46/2, Dhanalakshmipuram South, Central Studio backside, Singanallur, Coimbatore–641 005, India

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Abstract

A biological experiment with six treatment groups was conducted to study the effect of supplementation of plant-based Quorum quenching compounds on production performance and cost of production in commercial broilers (n=720) for a period of five-weeks. A total of 720 one-day-old commercial broiler (COBB 430) chicks (male) were placed in 36 deep litter pens. Each treatment group consist of six replicates with 20 birds per replicate which leads to 120 chicks per treatment. Six experimental diets were formulated based on COBB 430 (2022) specifications with or without antibiotic growth promoter(s) and or Gutsy - a proprietary feed additive developed with an objective to replace antibiotic growth promoters (AGPs) in poultry diet. The level of inclusion (mg/kg) of various products (in feed) such as chlortetracycline (CTC), enramycin, probiotic product and Gutsy are 75, 10, 100 and 150, respectively. The six treatment groups were (1) negative control (w/o AGPs, probiotic and Gutsy; T_1), (2) positive control (with both AGPs and probiotic; T_2), (3) Gutsy (w/o AGPs, probiotic; T_3), (4) combination of all the above (both AGPs, probiotic and Gutsy; T_4), (5) CTC and Gutsy (T_5) and (6) enramycin and Gutsy (T_6). Non-significant (P>0.05) differ- ences were observed in body weight, feed intake and feed conversion ratio (FCR) among the treatment groups during the entire period of study. But, there was a significant difference in livability observed among the treatment groups. The group supplemented with combination of both AGPs, probiotic and Gutsy (T_4), achieved the highest livability and European Efficiency factor (EEF; 348) and the lowest cost of production (COP) of Rs. 85.27/kg live weight. So, it can be concluded that Gutsy along with CTC and enramycincould be of highly beneficial for improving the overall performance (EEF) and reducing the COP. While utilizing the same as a replacement for AGPs (T_3), it could be of beneficial in improving EEF by 23 points (286vs 309) and reducing the COP by two rupees per kg live weight (89.31 vs 87.31) when compared to the negative control (T_1). So, it can be concluded that Gutsy can be incorporated in the diet as an alternative to antibiotic growth promoters (AGPs) in commercial broilers.

Keywords: Antibiotic growth promoters, alternative to AGPs, commercial broiler, production performance.

There is a substantial increase in poultry production when compared to other food producing animals over the past four decades. It plays a significant impact in developing and developed economies and the animal husbandry sub-sector act as drive engine for the agriculture. This trend is mainly due to the preference for poultry meat and eggs over the other protein sources worldwide and the poultry meat is the second most consumed meat globally (Alali and Hoface 2016; Mottet and Tempio 2017). In recent years poultry industry is facing the issue of bacterial

**Corresponding author* : Email : rameshnutrition@gmail.com
[1]Optima Poultry Pvt. Ltd., OptimaSquare,46/2, Dhanalakshmipuram south, Central Studio backside, Singanallur, Coimbatore–641 005, India
[2]Livestock Farm Complex, Veterinary College and Research Institute, Udumalpet
[3]Veterinary University Training and Resaerch Centre, Melmaruvathur

enteric diseases due to the ban in fed antibiot- ics for growth promotion in Europe (2006) and the increase in restrictions in North America and other developing countries on the utiliza- tion of antibiotic growth promoters (AGPs) in livestock farming as overuse of any antibiotic over a period of time may lead to resistance of pathogenic bacterial populations to the antibiotic utilized (Casewell *et al.,* 2003; Wallinga *et al.,* 2022). This willin-turn affect human health either directly through antibiotic residues in meat and eggs or indirectly through the selection of antibiotic resistance determinants that may spread to human pathogen. World Health

Table I. Ingredient (kg/MT) and chemical composition (%) of experimental diet

Ingredients	Pre-starter (0-13 days)	Starter (14-25 days)	Finisher (26-35 days)
Feed allocation (g/bird)	500	1250	Remaining
Maize	555.000	597.000	630.000
Soya bean meal	347.000	301.000	257.000
Corn gluten meal	30.000	30.000	30.000
Calcite powder	6.500	5.500	6.500
Dicalcium phosphate	16.000	15.000	14.000
Rice bran oil	25.000	31.000	42.000
DL Methionine	2.250	1.800	2.050
Lysine hydrochloride	3.000	2.500	2.550
Threonine	0.500	0.500	0.500
Sodium bicarbonate	1.000	1.000	1.000
Salt	3.500	3.500	3.500
Vitamin premix*	0.500	0.500	0.500
Choline chloride (60%)	1.000	1.000	1.000
Liver tonic powder	0.500	0.500	0.500
Toxin binder	1.000	1.000	1.000
Trace mineral mixture#	1.000	1.000	1.000
Salinomycin	0.500	0.500	0.500
Curacid	1.000	1.000	1.000
Ligosa M	1.000	1.000	1.000
Ligosa P	0.100	0.100	0.100
Nutrex	0.200	0.200	0.200
Protease	0.250	0.250	0.250
Oxycap (Antioxidant)	0.125	0.125	0.125
Chemical Composition *(analysed)*			
Moisture	11.00	11.03	10.32
C. Protein	21.69	21.02	18.44
C.Fibre	2.955	3.04	2.97
Calcium	1.306	1.20	1.17
Total phosphorus	0.62	0.51	0.52
Feed cost (Rs./kg)	39.64	38.46	37.70

*Each g of vitamin pre-mixture contains Vit. A 20 MIU, B2 12 mg, menodione sodium bisulphate (Vit K derivative) 6 mg, B1 4 mg, B6 8 mg, B12 0.04 µg, E 100 mg, niacin 10 mg, calcium D pantothenate 60MIU and carriers Q.S.

#Poultry TMO in PBS and BS; Ultima in BF

Organization (WHO) along with World Organization for Animal Health (OIE) encourages the health, agriculture, veterinary sector for reducing the injudicious use of antibiotics as growth promoters and further to decrease the spread of resistant bacteria (Cogliani *et al.*2011).

Therefore, other non-therapeutic potential alternatives such as probiotics, prebiotics, symbiotics, antimicrobial peptides, enzymes, essential oils, eucalyptus oil, other plant based products, organic acids, clay minerals, egg yolk antibodies, rare earth elements, recombinant enzymes and immunostimulants have been introduced in place of the antibiotic growth promoters to improve the intestinal microbiota or to prevent / treat the diseases like necrotic enteritis in chicken (Aruwa *et al.,* 2021).

Therefore, it is worthwhile to study the effectiveness of various sources of plant based products and probiotic combinations either replacing or along with AGPs available in the market on the growth performance of commercial broilers.

Materials and Methods

A biological experiment of five weeks duration was conducted at the R&D farm of Optima Poultry Pvt. Ltd., located at Pachagoundan palayam, Sencherimalai, Tiruppur Dt (TN).A total of 720 one day old male COBB 430 chicks were placed to 36 pens (5' x 5') allocated to six treatments each containing six replicates of 20 birds. Each pen was equipped with a separate feeder and drinker. Mortality and feed intake were recorded daily. Diets with the inclusion (mg/ kg) levels of chlortetracycline (CTC), enramycin, probiotic product and Gutsy at 75, 10, 100 and 150, respectively were formulated (Table1) based on COBB 430 specification. Standard managemental practices like fumigation and microbial load assessment with plate exposure technique were carried out before placing the day-old chicks in the farm. Six treatment groups subjected in this trial is shown in Table2 and the same were (1) negative control (w/o AGPs, probiotic and Gutsy; T_1), (2) positive control (with both AGPs and probiotic; T_2), (3) Gutsy (w/o AGPs, probiotic; T_3), (4) combination of all the above (both AGPs, probiotic and Gutsy; T_4),
(5) CTC and Gutsy (T_5) and(6) enramycin and Gutsy (T_6). Three type feeding regime (PBS, BS and BF) were followed.

Weekly body weight and feed consumption of each replicate were recorded and feed to gain ratio was recorded. From the mortality occurred during the period, livability percent- age was calculated. European efficiency factor (EEF) was calculated by the formula = [Livabil- ity x Average body weight) / (Mean Age (days)

Table II. Effect of incorporation of plant-based Quorum quenching compounds and probiotics on the live body weight (g) in commercial broiler chicken

Treatments	Day old	Age (in wks.)				
		1	2	3	4	5
T_1; Negative control	46.76 ± 0.74	175.66± 5.49	460.00± 12.30	903.83± 25.26	1393.33± 29.05	1974.00± 34.22
T_2; Positive control	48.12 ± 0.71	173.66± 3.39	452.50± 6.37	890.33± 25.92	1386.66± 39.21	1998.50± 33.01
T_3; Gutsy (only)	47.78 ± 0.75	178.00± 6.82	471.16± 12.56	912.16± 31.90	1403.33± 34.89	1986.33± 36.53
T_4; All the above	47.65 ± 0.72	206.83± 6.38	469.83± 11.22	926.50± 14.73	1410.00± 17.17	2039.50± 33.23
T_5; CTC & Gutsy	47.40 ± 0.77	181.66± 1.05	476.50± 5.40	942.83± 10.06	1413.33± 14.47	2011.16± 27.39
T_6; Enra& Gutsy	47.40 ± 0.77	177.00± 6.18	474.83± 10.36	936.16± 15.84	1448.83± 32.19	2034.16± 29.89
Significance	NS	*	NS	NS	NS	NS

Means bearing different superscripts within the same column differ significantly; **Highly significant (P<0.01); * Significant (P<0.05); NS – Non-significant (P> 0.05)

x FCR)] x 100. Cost of production (INR) was arrived by summing up all the input costs per kg live weight produced.

Data obtained in this study was analysed statistically on 'SPSS-16.0" software package as per standard methods (Snedecor and Cochran, 1997). All the data were subjected to ANOVA using General Linear Models procedure and the significant mean differences were tested as per Duncan's multiple range test and significance was declared at P<0.05.

Results and Discussion

The data pertaining to the live body weight of commercial broiler chicken as influenced by supplementation of various antibiotic growth promoters and their alternatives is presented in Table II. Non-significant (P>0.05) differences were observed in body weight, feed intake and feed conversion ratio (FCR) throughout the experimental period of 35 d. But there was a significant (P<0.05) difference in the livabil- ity was noticed during the entire period of five weeks.

There was only a numerical difference in the live body weight among the treatment groups supplemented with antibiotic growth promoters and their alternatives during the entire period of study. The final mean body weight obtained on 35th d was ranged from 1974 to 2039 g among the various treatment groups with the highest value recorded in the groups supplemented with a combination of all the products (both AGPs, probiotic and Gutsy; T_4).

Numerically lowest cumulative feed consumption was noticed in the treatment group supplemented with antibiotic growth promoter (CTC) and plant-based Quorum quenching compounds (T_5) during the entire period of experiment (35 d). As the age advances the numerical difference in cumulative feed consumption also widened with the lowest and highest mean values as 3309 and 3475, respectively.

Fig-1 shows the difference in FCR and CFCR (Converted FCR) among the various treatment

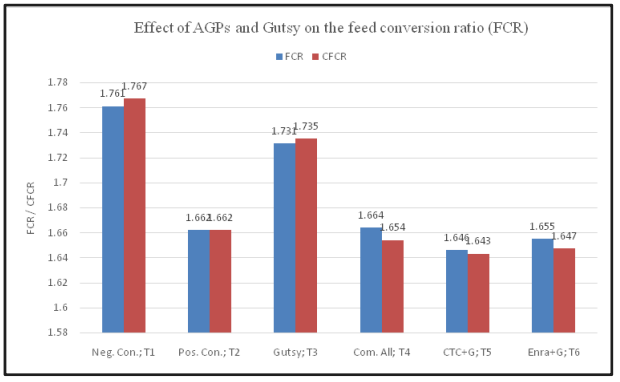


Fig 1.

Table III. Effect of plant-based Quorum quenching compounds and probiotics(Gutsy) on the cumulative feed consumption (g) in commercial broiler chicken.

Treatments	Age (in wks)				
	1	2	3	4	5
T_1; Negative control	202.83± 4.76	613.16± 7.50	1342.33± 13.63	2223.33± 32.93	3475.83± 88.60
T_2; Positive control	202.83± 8.39	605.83± 9.96	1290.83±13.80	2210.00± 39.91	3317.16± 40.56
T_3; Gutsy (only)	190.66± 4.73	605.83± 14.22	1324.66± 23.33	2271.66± 34.58	3434.16± 41.90
T_4; All the above	206.83±6.38	606.66± 12.45	1314.16± 18.80	2213.33± 32.00	3391.83± 43.57
T_5; CTC & Gutsy	203.33± 4.65	594.83± 10.57	1291.66± 26.14	2195.00± 25.13	3309.33± 35.97
T_6; Enra& Gutsy	197.83± 6.80	607.66± 15.09	1316.83± 25.02	2250.00± 47.34	3367.83± 58.88
Significance	NS	NS	NS	NS	NS

Means bearing different superscripts within the same column differ significantly; **Highly significant (P<0.01); * Significant

(P<0.05); NS – Non-significant (P> 0.05)

Table IV. Effect of plant-based Quorum quenching compounds and probiotics(Gutsy) on the feed conversion ratio (FCR) in commercial broiler chicken (Mean ± SE)

Treatments	Age (in wks)				
	1	2	3	4	5
T_1; Negative control	1.161± 0.050	1.339± 0.047	1.492± 0.050	1.597± 0.030	1.761± 0.037
T_2; Positive control	1.167± 0.039	1.340± 0.034	1.456± 0.046	1.600± 0.054	1.662± 0.034
T_3; Gutsy (only)	1.076± 0.034	1.289± 0.040	1.462± 0.060	1.624± 0.052	1.731± 0.034
T_4; All the above	1.000± 0.000	1.296± 0.049	1.419± 0.022	1.569± 0.015	1.664± 0.018
T_5; CTC & Gutsy	1.119± 0.028	1.248± 0.024	1.369± 0.017	1.553± 0.019	1.646± 0.014
T_6; Enra& Gutsy	1.119± 0.026	1.280± 0.016	1.406± 0.013	1.554± 0.026	1.655± 0.015
Significance	NS	NS	NS	NS	NS

Means bearing different superscripts within the same column differ significantly; **Highly significant (P<0.01); * Significant (P<0.05); NS – Non-significant (P> 0.05)

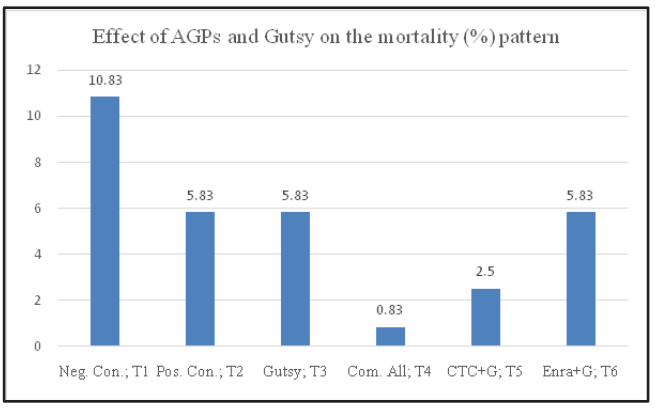
groups as influenced by plant-based Quorum quenching compounds and probiotics in the commercial broiler.

There was a non-significant (P>0.05) difference noticed in the FCR of commercial broiler during the entire five-week duration. Numerically (P>0.05) best FCR was noticed in the treatment group supplemented with plant-based Quorum quenching compounds and probiotics (T_3) during pre-starter period (14^{th} d).

The data on the mean livability of commercial broiler chicken as influenced by supplementation of plant-based Quorum quenching compounds and probioticsis presented in Table V.

The data on the mean mortality (%) of commercial broiler chicken as influenced by supplementation of plant-based Quorum quenching compounds and probioticproducts is presented in Fig 2.

During the biological experiment, acceptable low mortality was observed in all the treatment groups throughout the period. There was a significant (P<0.05)difference noticed



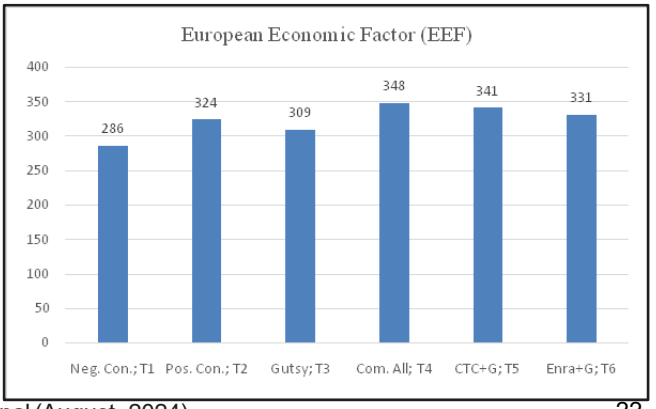


Table V. Effect of plant-based Quorum quenching compounds and probiotics supplements on the livability (%) pattern in commercial broiler chicken

Treatments	Age (in weeks)				
	1	2	3	4	5
T_1; Negative control	95.00^{b}± 1.29	92.50^{c}± 1.70	90.83^{c}± 2.00	90.83^{c}± 2.00	89.16^{b}± 2.38
T_2; Positive control	99.16^{a}± 0.83	95.83^{ab}± 1.53	95.83^{ab}± 1.53	94.16^{ab}± 2.38	94.16^{ab}± 2.38
T_3; Gutsy (only)	99.16^{a}± 0.83	98.33^{a}± 1.05	98.33^{a}± 1.05	98.33^{a}± 1.05	94.16^{ab}± 2.38
T_4; All the above	99.16^{a}± 0.83	99.16^{a}± 0.83	99.16^{a}± 0.83	99.16^{a}± 0.83	99.16^{a}± 0.83
T_5; CTC & Gutsy	100.00^{a}± 0.00	99.16^{a}±0.83	98.33^{a}± 1.05	98.33^{a}± 1.05	97.50^{ab}± 1.11
T_6; Enra& Gutsy	96.66^{b}± 1.66	95.83^{ab}± 1.53	95.83^{ab}± 1.53	95.83^{ab}± 1.53	94.16^{ab}± 2.38
Significance	*	*	*	*	*

Table VI. Effect of plant-based Quorum quenching compounds and probiotic supplements on the CFCR (FCR converted to two kg body weight),EEF and cost of production(COP) in commercial broiler chicken (Mean ± SE)

Treatment	CFCR	EEF	COP
T_1; Negative control	1.767±0.039	286±10	89.31
T_2; Positive control	1.662± 0.041	324±12	86.52
T_3; Gutsy (only)	1.735±0.042	309±9	87.31
T_4; All the above	1.654±0.024	348±11	85.27
T_5; CTC & Gutsy	1.643±0.019	341±8	85.42
T_6; Enra & Gutsy	1.647±0.017	331±11	86.56
Significance	NS	NS	NA

CFCR: FCR converted to 2 kg body weight = [(2.0 – body weight in kg)/0.04] x 0.01 + FCR

European efficiency factor (EEF) = [Livability x Average body weight) / (Mean Age (days) x FCR)] x 100.

COP: Cost of Production (Rs. /kg live wt); NA: Not analyzed

Means bearing different superscripts within the same column differ significantly; **Highly significant (P<0.01); * Significant (P<0.05); NS – Non-significant (P> 0.05)

in livability among the treatment groups. The groups supplemented with antibiotic growth promoters plus probiotic product (T_2) and plant-based Quorum quenching compounds plus probiotics(Gutsy; T_3) had an equal livability with the value of 94.16 per cent, whereas the treatment group (T_4) supplemented with the combination of the AGPs plus probiotics and Gutsy had the highest livability (99.16%) among the groups studied in this trial.

Fig 4 shows cost of production (Rs./kg of live weight) of commercial broiler as influenced by supplementation of plant-based Quorum quenching compounds and probiotics.

The treatment group supplemented with a combination of both AGPs, probiotic and Gutsy (T_4), achieved the highest production performance with European efficiency factor (EEF) value of 348 and the lowest cost of production

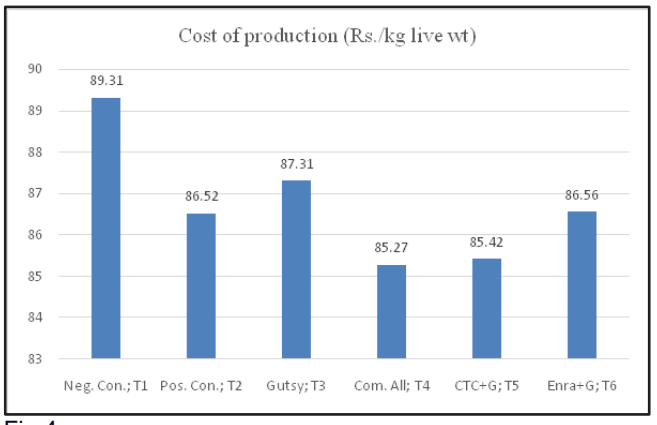


Fig 4.

(COP) with a value of Rs. 85.27/kg live weight. So, it is evident that the product available with the combination of plant-based Quorum quench- ing compounds and probiotics (Gutsy) could be of highly beneficial for improving the overall performance (EEF) and reducing the cost of production while combining with AGPs such as CTC and enramycin. Gutsy could be utilized as a replacement for AGPs (T_3) with the improvement in the performance parameters (EEF) by 23 points (286vs 309) and reducing the cost of production by two rupees per kg live weight (89.31 vs 87.31) when compared to the negative control (T_1).

Conclusion

From the above findings, it can be concluded that the plant-based Quorum quenching compounds along with probiotics(Gutsy) could be of highly beneficial for improving the livability, overall production performance (EEF) and the same can be incorporated in the diet as an alterna- tive to antibiotic growth promoters (AGPs) in commercial broilers.

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