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Guayaba foliage (Psidium guajava L.) as a phytobiotic in the feeding of broiler chickens

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***Abstract*---**In the different livestock production systems, feed represents the highest percentage of investment in poultry production. Producers are constantly seeking to improve their productive parameters by using different additives, among the most used are antibiotic growth promoters. In Ecuador, many plant species can be used as a source of nutrients or as medicinal additives. The objective of this research was to determine the effect of the addition of guava foliage levels on the productive behavior of broiler chickens. The work was carried out at the "Romero" farm located in the "Cuatro Mangas" enclosure on the Quevedo - Buena Fe Road, province of Los Ríos. A

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total of 160 Broilers Cobb 500 were used, distributed in a completely randomized design with 4 treatments and 5 replicates each, with 8 animals as experimental unit. No statistical differences were found concerning the productive parameters between the means of the Tukey treatments ($P \leq 0.05$); however, in the benefit-cost ratio, the 0.5% of guava foliage presented the best value ($1.83), which means that for each dollar invested, a profit of 0.83 ctvs was obtained, with a profitability of 82.67% and a mortality of 2.5%.

***Keywords*---**production parameters, growth promoter, profitability, fattening, probiotic.

Introduction

Poultry production has had great advances in recent decades, mainly due to improvements in genetics, health, nutrient availability and animal handling conditions (Chavez *et al.*, 2016). Poultry producers are always trying to improve their production parameters, and one strategy is to use antibiotics as growth promoters (APC) (Cancho *et al.*, 2000), which are pharmacological substances that are added to the balanced feed at a relatively low rate (Medina, 2014). Currently, the trend toward nature and the concern of some segments of society, due to the possibility of developing drug resistance of microorganisms, has led to the restriction or prohibition of the use of APCs in the production of animal protein for humans (Gonzales *et al.*, 2013). According to Cepero (Cepero Briz, 2007), he mentioned that in the European Union (EU), APCs have been eliminated over the years.

In our country, the Agency for Phytosanitary and Zoosanitary Regulation and Control (AGROCALIDAD) has banned the use of certain molecules that the agency considers harmful to health, highlighting Resolution 034 of December 19. In 2006, published in the Official Gazette No. 420, resolving to "Suspend the production, elaboration, importation, commercialization and registration of products containing chloramphenicol and nitrofurans as active ingredients", and Resolution No. 050 was published in the Official Gazette No. 226 on July 1, 2010. Salts and their esters and any veterinary products or animal feed containing Olaquindox and Carbadox due to their genotoxic, mutagenic, and cancer-causing nature (Narvaéz, 2016). Although the use of antibiotics plays an important role in the production of safe meat, their use is limited due to the consequences for consumers and there is a trend to look for alternatives to antibiotics (Méndez *et al.*, 2015).

The use of additives plays an important role in the production of safe meat but is limited by its consequences for consumers, creating a tendency to look for alternatives to additives (Méndez *et al.*, 2015). The beneficial effects of certain plants due to their healing properties have been known since ancient times, which is related to the compounds they contain, created as a defense mechanism against adversities (Almeida, 2012). These medicinal plants are used by humans for preventive and curative effects (Martínez *et al.*, 2012) (Más *et al.,* 2017). The term phytobiotic is used to describe natural compounds of plant origin, such as essential oils, extracts, etc., that have a known positive effect on animal health and performance, with antibacterial, endogenous secretion stimulating, and immunomodulatory properties. Some plants distinguished by these effects are oregano, garlic, mint, rosemary, and thyme (Revolledo, 2013). Substances with medicinal value are alkaloids, saponins, phenolic compounds, terpenes, tannins, and flavonoids, most of these compounds are present in essential oils (Oetting, 2005).

Phytobiotics from different plants have been studied to determine their role as growth promoters and enhancers of productive parameters in livestock species (Méndez *et al.*, 2015; Shiva *et al.*, 2012; Castillo et al., 2016; Ayala *et al.*, 2011). They can be present in different plant structures or added to diets, as they improve feeding conditions and animal performance by optimizing nutrient utilization (Fernandes *et al.*, 2015). The active ingredient content can vary considerably depending on the plant part being evaluated and the time of harvest and extraction technique (Nascimento, 2016). Although the mechanism of action of phytobiotic compounds has not been fully characterized, the antibacterial and modulating effects of their enzyme systems have been recognized, and their effects are achieved through copper synergistic effects between their different compounds, as their respective effects require much less (Shiva *et al.*, 2012).

Several compounds can be obtained from any part of the plant (dehydration and milling) and differ in form and function; They are essential oils, saponins, sharp and bitter substances, mucilages, flavonoids and other compounds present in lower concentrations with isolated or synergistic effects, so the potential effects may vary according to the uses (Fernández *et al.*, 2015). Phenolic compounds derived from the secondary metabolism of plants, besides being necessary for their growth, arise in stressful conditions such as infections or injuries and cause pigmentation, a common element in plants and forming a very diverse group of phytochemicals derived from phenylalanine and tyrosine (Fernandes *et al.*, 2015; Angelo & Jorge, 2007. Plants produce more than 100,000 natural products known as secondary metabolites, which, unlike primary metabolites, are not essential for plant life but are important for the development of defenses against microorganisms or insects; the most important groups are phenols, quinones, tannins, coumarins, flavonoids and alkaloids (Domingo & López, 2003).

Phenolic compounds are one of the main secondary metabolites of plants and are secreted by damaged plants to protect them from possible attack by fungi or bacteria (Gimeno, 2004). They have therapeutic effects on a large number of pathologies (Martínez *et al.*, 2002). Several plant species have long been used as an alternative medicine to improve human health or treat diseases, and the recent growing interest in these medicinal plants has led to a significant increase in study and enabled the identification of the active components of phytobiotics and their mechanisms of action in animal organisms (Roofchaee *et al.*, 2011). Guava leaves are characterized by the presence of essential oils rich in caryophyllene, nerodiol, beta-bisabolene, arylene, and parasites. They also contain beta-sitosterol, terpenoids, white anthocyanins, and about 10% tannins. They have recognized medicinal properties, act on the digestive system, and are widely used as antidiarrheals. For this, healthy leaves should be collected early in the

morning, preferably fresh in the form of decoction. Decoctions or infusions of the leaves are also used for their antibiotic properties (EcuRed, n.d.).
Guava is important for health, especially because it is rich in quercetin, an antioxidant that blocks enzymes responsible for building sorbitol, the sugar that creates cataracts and cataracts, a degenerative eye disease characteristic of the elderly. Because of its vitamin A content, it is known to promote overall eye health. Once the degenerative process begins, it can help reduce the appearance of cataracts, and macular degeneration and even improve vision (EcuRed, s.f.). Due to its high vitamin C content, guava is useful for relieving coughs and colds, disinfecting the respiratory tract, throat, and lungs, and inhibiting microbial activity thanks to its astringent properties. It helps reduce cholesterol in the blood and prevents it from thickening, which ensures proper blood flow and lowers blood pressure. It also contains vitamins B3 and B6. Vitamin B3 (also known as niacin) increases blood flow and stimulates cognition. Vitamin B6 is an important nutrient for nerve and brain function. Therefore, eating guava can help stimulate brain function and improve concentration (EcuRed, s.f.).

Guava is excellent for preventing and treating heart disease. Because of its balanced nutritional profile, and low in sugars and calories, it is an ideal food for overweight or obese people who wish to benefit from its high antioxidant content. One of its special ingredients is arjunolic acid, which is very rare in nature as this acid is a tonic for the heart and has antioxidant properties, used mainly in Ayurvedic medicine in India to prevent arrhythmias, blood clotting problems, and lower blood pressure. and to control cholesterol levels (Botanica Online, 2018). Another benefit of this fruit is that it is rich in alkaline astringents that have antiseptic and antibacterial properties that help calm the symptoms of diarrhea and cure dysentery (an inflammatory disease of the intestines, especially the colon). by inhibiting microbial growth and promoting the elimination of excess mucus from the intestines (EcuRed, s.f.).

On the other hand, guava nutrients such as vitamin C, carotenoids and potassium can strengthen and regulate the digestive system while cleansing it. Guava is also very good for treating gastroenteritis. The benefits of guava become even more important for children and moody, weakened people, for those who often suffer from inflammation of the gums, should use this fruit to gargle. It is one of the fruits with the highest antioxidant activity. It has antibiotic properties that fight bacteria that cause bad breath and is ideal for exercise, arthritis, stress and pregnancy (EcuRed, s.f.). Traditional medicine recommends guava leaf infusions as an antipyretic, which helps reduce fever, improves the body's immunity and fights infections due to its antiseptic effect (Botanica Online, 2018). The present study made it possible to determine the effect of the addition of guava foliage (*Psidium guajava* L.), which will contribute to reducing feed costs, since this represents the largest percentage in poultry production, and obtaining safe chicken meat.

Materials and Methods

This study was conducted at the “Romero” farm located in the “Cuatro Mangas" enclosure on the Quevedo-Buena Fe road, Los Ríos province, 0°56'33.5" south latitude and 79°29'06.8" west latitude, at an altitude of 80 masl, climatic conditions Tropical humid forest (bh-T), with average monthly rainfall 15.38 mm, average temperature 25.80 °C, Heliophany 755.2 daylight hours and relative humidity 83% (INAMHI, 2015). The present study had a duration of 42 days, a completely randomized design (CRD) was used with four treatments and five replications with eight broilers as experimental units (EU), with a total of 160-day-old Broilers.

Table 1 details the treatments for the application with the levels of Guava foliage meal plus commercial feed.

Table 1
Description of the Treatments of "Guava (Psidium guajava L.) Foliage as a Phytobiotic in Broiler Feeding", 2020

Treatments	Composition
T1	Balanced
T2	Balanced + 0.5% of Guava Leaf Flour
T3	Balanced + 1% Guava Foliage Meal
T4	Balanced + 1.5% Guava Foliage Flour

Source: Authors

The variables to be evaluated were feed consumption, weight gain, feed conversion, carcass yield, mortality and economic analysis. All data obtained through field collection were submitted to the Microsoft Excel 2013 program for recording and sorting; the free statistical package software was also used and the mean obtained was compared using Tuckey's multiple range test ($P \leq 0.05$).

Experiment management

The development of the research was carried out at the "Romero" farm of the "Cuatro Mangas" enclosure, where it began with the adequacy, cleaning and disinfection of the shed, the materials and equipment (cages, feeders and drinkers) were disinfected with iodine (2.0 cc L-1 of water), a lime slurry was prepared on all the walls of the shed. A layer of rice chaff 15 cm thick was placed in the cages, on the day the birds entered the cages, the weights were calculated taking this data as the initial weight of the whole investigation, after 3 days the birds were vaccinated against New Castle and Bronchitis, and the experimental units and treatments were randomly placed. There were 160-day-old chicks, with an average weight of 45 g, fed according to the treatments under study previously weighed (g) at (7H30 and 16H30), and after 7 days the surplus was collected to subtract from the amount fed to obtain the accumulated consumption. The experimental diets were fed daily ad libitum previously weighed on a precision balance. The experimental units were weighed every 7 days in grams to obtain the weight gain (g) and feed conversion index. To determine the carcass yield (%), 100% of the experimental units were slaughtered at the end of the study. The facilities were maintained in adequate physical and sanitary conditions. The diets were elaborated based on the nutritional requirements of the broilers in their two stages and also on the bromatological analysis of the guava foliage.

Table 2 shows the bromatological analysis of the guava foliage collected during the winter season.

Table 2
Bromatological analysis of "Guava (Psidium guajava L.) foliage as a phytobiotic in broiler chicken feed", 2020

Analysis	Unit	Value
Dry matter	%	19,8
Moisture	%	80,2
Organic Matter	%	96,1
Ash	%	3,9
Crude Protein	%	2,6
Crude Fiber	%	4,86
Energy	Kcal/kg	4909
Lysine	%	5,00
Threonine	%	26,50
Tryptophan	%	66,70
Valine	%	46,00
Arginine	%	4,70

Source: Authors

Table 3 and Table 4 detail the calculated analysis of the experimental diets proposed for the research in the initial and final stages.

Table 3
Calculated analysis of the experimental diet at the initial stage

RAW MATERIALS	T1	T2	T3	T4
Domestic corn	0,503	0,499	0,490	0,481
Cane molasses	0,020	0,020	0,020	0,020
Soybean Sis 44	0,367	0,368	0,368	0,368
Guava leaf sna.	0,000	0,005	0,010	0,015
Alfarina	0,062	0,060	0,064	0,068
Palm oil	0,020	0,020	0,020	0,020
Calcium carbonate	0,010	0,010	0,010	0,010
Bicalcium phosphate ANH.	0,015	0,015	0,015	0,015
Marine sodium chloride 98	0,0003	0,0003	0,0003	0,0003
DL Methionine	0,003	0,003	0,003	0,003
Sum	1,000	1,000	1,000	1,000

Calculated analysis

Protein	21,00	21,00	21,00	21,00
Fiber	4,86	4,99	5,23	5,48
Ca	0,94	0,93	0,94	0,95
ED	2740	2750	2750	2750
Lysine	1,13	1,16	1,19	1,21
M + C	0,90	0,90	0,90	0,90

Source: Authors

Table 4
Calculated analysis of the experimental diet in the final stage

RAW MATERIALS	T1	T2	T3	T4
Domestic corn	0,555	0,550	0,546	0,541
Cane molasses	0,020	0,020	0,020	0,020
Soybean Sister 44	0,314	0,315	0,316	0,317
Guava leaf sis.	0,000	0,005	0,010	0,015
Alfarina	0,054	0,063	0,062	0,061
Palm oil	0,020	0,020	0,020	0,020
Calcium carbonate	0,010	0,010	0,010	0,010
Bicalcium phosphate ANH.	0,015	0,015	0,015	0,015
Marine sodium chloride 98	0,0003	0,0003	0,0003	0,0003
DL Methionine	0,001	0,001	0,001	0,001
Sum	1,000	1,000	1,000	1,000

Calculated analysis

Protein	19,00	19,00	19,00	19,00
Fiber	4,73	4,86	4,98	5,11
Ca	0,93	0,93	0,92	0,92
ED	2790	2800	2810	2820
Lysine	1,00	1,03	1,06	1,08
M + C	0,72	0,72	0,72	0,72

Source: Authors

Results and Discussion

Table 5 shows the variables: feed consumption (FC), weight gain (WG), feed conversion ratio (FCR), carcass weight (CW), and carcass yield (CW) with their respective results obtained in the research.

Table 5
Variables studied on the effect of "Guava (Psidium guajava L.) Foliage as a Phytobiotic in Broiler Chicken Feeding", 2020

Variables	Treatments								CV (%)
	1		2		3		4		
GP (g)	2431,61	b*	2276,09	ab	2051,00	a	2092,78	a	6,51
CA (g)	4513,15	a	4321,44	a	4248,13	a	4184,59	a	4,50
ICA	1,86	a	1,90	a	2,07	a	2,02	a	8,65
PC (lb)	4,04	a	3,80	ab	3,48	a	3,62	ab	7,91
RC (%)	74,25	a	74,17	a	75,05	a	76,55	a	3,33

* Means with a common letter are not significantly different (P ≤ 0.05)
Source: Authors

Food consumption

Total feed consumption was higher for T1 (4513.15 g), followed by T2 (4321.44 g), T3 (4248.13 g) and T4 (4184.59 g) being this diet the one with the lowest consumption, no statistical differences were found between the means of the treatments, which means that the inclusion of guava foliage meal as phytobiotic in the feed does not produce an effect on feed consumption. Results are similar to those reported by Ebrahimnezhad et al. (2014), who observed that feed intake decreased significantly in treatments that received ginger compared to those not supplemented and Shiva et al (Shiva, et al., 2012), who they found no differences in feed consumption when oregano essential oil and ginger extract were included in the diets, cases similar to those of this research since throughout the development the highest consumption was recorded in the control treatment. While Acosta et al (Acosta, Acosta, Pasteiner, Rodríguez, & Mohnl, 2008), found in their investigation of probiotics and a phytobiotic mixture a positive influence on feed consumption.

Weight Gain

Total weight gain was higher for T1 (2431.61 g), followed by T2 (2276.09 g), having this treatment similarity with T4 (2092.78 g) and T3 (2051.00 g) being this diet the one with the lowest weight, finding statistical differences between the means of the treatments, which means that the inclusion of guava foliage meal as phytobiotic in the diet does not produce an effect on weight gain. Results are different from those reported by Ebrahimnezhad et al (Ebrahimnezhad et al., 2014), where they observed that weight gain increased significantly in treatments that received ginger compared to those not supplemented. While Acosta et al. (Acosta et al., 2008), found in their investigation of probiotic and a phytobiotic mixture numerical differences without finding statistical differences between treatments and Shiva et al. (Shiva et al., 2012), where found no differences in weight gain by including oregano essential oil and ginger extract in the diets.

Food Conversion

There is a numerical difference in the total feed conversion rate, with T1 (1.86) being the lowest, followed by T2 (1.90), T4 (2.02), and T3 (2.07) being the diet with the highest feed conversion rate, no statistical differences were found between the means of the treatments, which means that the inclusion of guava foliage meal as a phytobiotic in the feed does not produce an effect on the feed conversion rate. Results that resemble those reported by Shiva et al. (2012), where they found no differences in feed conversion rate when oregano essential oil and ginger extract were included in the diets. As did Ordoñez et al. (Ordoñez Rumiche et al., 2018), found no statistical differences in this parameter when using oregano and an enzyme complex in broiler diets. When working with guava foliage, it was possible to observe the individual behavior of the foliage and the effect it had on feed conversion in broiler diets, in comparison to what is reported by Lara et al. (2011), who with the combination of Oregano and Basil Flour in a 50:50 ratio obtained a conversion of 1.63, while when combining Hierba Santa and Basil they found a conversion of 1.70 and when combining Oregano flour and Hierba Sana they obtained a conversion of 3.53, which was due to the associative behavior of each aromatic plant, so it is an advantage to work with only one plant.

Carcass yield

In the carcass yield, there is a numerical difference being T4 (76.55%) the highest yield, followed by T3 (75.05%), T2 (74.17%) and T1 (74.25%) being this diet the one with the highest live weight and carcass weight so its yield is the best, no statistical differences were found between the means of the treatments, which means that the inclusion of guava foliage meal as phytobiotic in the feed does not produce an effect on the feed conversion ratio. Results that resemble those reported by Ebrahimnezhad et al. (2014), where they found no difference in carcass yield between treatments containing ginger and the control. As did Acosta et al. (2008), where they found no differences in carcass yield found in their investigation of probiotic and a phytobiotic mixture, while Ordoñez et al. (Ordoñez Rumiche et al., 2018) when using oregano and an enzyme complex in broiler diets obtained higher carcass weight in the control groups. Roldan (2010) reported in his research that he used plants such as rosemary and basil with values of 65.3% and 63.5% respectively, compared to the control treatments.

Profitability of Treatments

Table 6 shows the benefit/cost ratio who obtained the highest benefit was treatment T2 ($1.83), which means that for each dollar invested a profit of 0.83 ctvs. USD is obtained; followed by T4 ($1.63), T3 ($1.62), while T1 ($1.23) obtained the lowest benefit, values that are acceptable within poultry production. Results that are similar to those reported by Lozada (Lozada Ortiz, 2014), where he obtained a benefit of 0.28 ctvs. USD per dollar invested in the treatment that incorporated 0.3% of chili bell pepper meal, while in the control treatment he obtained a benefit of 0.08 ctvs. USD.

Table 6
Economic analysis of the effect of "Guava (Psidium guajava L.) foliage as a phytobiotic in broiler chicken feed", 2020

ITEMS	0% GUAVA FLOUR	0.5% GUAVA FLOUR	1,0% GUAVA FLOUR	1.5% GUAVA FLOUR
INCOME	T1	T2	T3	T4
Total, lbs.	200,38	199,07	176,47	177,55
Price per lb, USD	1,25	1,25	1,25	1,25
Total, Revenue, USD	250,48	248,84	220,59	221,93
COSTS				
Chicken bb (20 birds)	13,40	13,40	13,40	13,40
Labor	1,88	1,88	1,88	1,88
Depreciation of shed	0,032	0,032	0,032	0,032
Vaccines	0,99	0,99	0,99	0,99

Feed	187,00	120,00	120,00	120,00
Total of Costs, USD	203,29	136,29	136,29	136,29
Net Profit	47,19	112,54	84,30	85,64
Benefit / Cost	1,23	1,83	1,62	1,63
Profitability, %	23,21	82,57	61,85	62,83

Source: Authors

Mortality

In mortality, the treatment with the highest mortality rate was T1 (7.5%), followed by T3 (5%), T4 (5%) and the one with the lowest mortality rate was T2 (2.5%) with 0.5% of guava foliage in its diet, as shown in Table 7, while the average mortality rate for the entire study was 5% and for the treatments that received guava foliage meal was 4.17%.

Table 1
Percentage mortality of the effect of "Guava (Psidium guajava L.) Foliage as a Phytobiotic in Broiler Chickens Feed", 2020

TREATMENTS	NUMBER OF CHICKS AT START	NO. DEAD CHICKS	MORTALITY RATE
1	40	3	7,5
2	40	1	2,5
3	40	2	5,0
4	40	2	5,0

Source: Authors

Results similar to those reported by Iza and Quispe (2011), where they obtained a mortality of 2% when using chili bell pepper meal in Broiler chicken feed. As well as Ordoñez *et al.* (2018), who found no differences in this parameter when using oregano and an enzyme complex in broiler diets.

Conclusions

According to the results and under the conditions in which the present study was carried out, the following conclusions can be drawn: In the present investigation, no effect of guava (*Psidium guajava* L.) foliage meal as a phytobiotic in the feeding of broilers was found, since there were no significant differences between the groups with the inclusion of the foliage meal and the control group, indicating that how the phytobiotic was included and at the proposed doses have no improving effect on the zootechnical performance. In the benefit/cost ratio, the treatment with 0.5% guava foliage meal had the highest benefit and profitability. The one with the lowest mortality rate was that of 0.5% guava foliage meal in the feed.

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