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EVALUATION OF USING SOME ORGANIC ACIDS AGAINST SALMONELLA INFECTION IN BROILER CHICKENS EXPERIMENTALLY

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ABSTRACT

A total 110 one-day-old chicks were used in this study to investigate antibacterial effects of organic acid (formic and propionic acid) either alone or together against *Salmonella pullorum (Sal. pullorum*). 10 chicks were slaughtered and examined bacteriologically to prove that chicks free from *salmonella*, the remender100 broiler chicks were divided into 5 groups (20 chicks/each), 1st group healthy chicks (negative control), At 14th day of age broilers in group 2nd, 3rd, 4th and 5th experimentally infected with *Sal. pullorum*, 2nd group infected chicks (positive control), 3rd group chicks received 0.1 ml formic acid /liter drinking water from 1st to 35th day of age and infected with *Sal. pullorum*, 4th group chicks received 0.1 ml propionic acid/liter drinking water from 1st to 35th day of age and infected with *Sal. pullorum*. 5th group received formic acid and propionic by same dose, period and route of infection with *Sal. pullorum*. At 1st day post supplementation 5 chicks from each group were slaughtered and two blood samples were taken for estimation of hematobiochemical parameters. Cloacal swabs were collected for salmonella reisolation. Infected broilers showed clinical **signs** represented by anorexia, closed eyes diarrhea, dehydration, mortality rate 30% and reduction in body weight gain, RBCs, Hb, PCV%, MCHC, lymphocytes total protein, albumin, CAT and SOD beside significant increase in FCR, MCV, MCH, WBCs, heterophil, monocyte globulin, ALT, AST, ALP, uric acid ceatinine and MDA, associated with insignificant decrease in esinophil and basophil. Broilers received formic acid or propionic acid either alone or together for 35 days and infected with *Sal. pullorum* showed no clinical signs, insignificant decrease in RBCs, Hb, PCV%, MCHC, lymphocyte eosinophil, T. protein, albumin, A/G ratio, CAT, SOD and insignificant increase in weight gain, MCV, MCH,WBCs, heterophil, basophil, monocyte globulin, ALT AST, ALP, **uric** acid, creatinine and MDA, improved FCR, reduced mortality rate to 5% but both acids together induced zero mortality beside reduction in re-isolation of *Sal. pullorum*. It could be concluded that, **formic** and propionic acid play an important role in control of salmonellosis in broiler and act as growth promoters beside improved hematobiochemical parameters so we recommend using formic acid and propionic acid allover fatting period.

Keyword: Sal. Pullorum-formic - propionic-hematobiochemical – broiler chickens

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INTRODUCTION

Chicken meat is considered one of the most desirable meats allover worlds (Karine, 2002). Control of broilers diseases leading to increase poultry production (Hassan *et al.,* 2010). *Salmonella* in poultry inducing many diseases (pullorum, typhoid & paratyphoid) (Tatiane *et al.,* 2013). *Salmonella i*s a bacterial pathogen caused enteritis and high mortality (Kee *et al.,* 2015). Salmonella is transmittal by vertical and horizontal (Eriksson *et al.,* 2018). Pullorum disease is septicaemic disease in poultry mostly infects young chicks (Marwa *et al.,* 2021).

Antibiotic growth promoters induce antibiotic resistant strains of bacteria has compelled the researchers to use other non therapeutic alternatives like organic acids as feed additives in poultry production (Gunal *et al.,* 2006). Organic acids are used as growth promoters and stimulate growth performance in poultry (Dibner, 2004). Organic acids have antimicrobial benefits (Hajati, 2018). Organic acids to date has focused on food safety aspects due to lowering incidence of foodborne pathogens in poultry and other livestock (Oakley *et al.,* 2014). Organic acids continue to receive considerable attention as feed additives for animal and poultry production and poultry because organic acids inhibit growth of bacteria (Pande and Akoh 2010). It has an antimicrobial action in gastrointestinal tract of animal (Nour *et al.,* 2011) and lowering pathogenic bacteria in intestine (Artur *et al.,* 2020). Formic acid induce reduction in *Sal* spp. in feed and potentially in gastrointestinal tract (Ricke *et al.,* 2020).

The present study was carried out to evaluate the efficacy of formic and probionic acid either alone or together for control Salmonellosis in broiler chickens, with regard to its effects in some blood constituents in broiler chickens.

MATERIALS AND METHODS

Experimental chicks:
About 110 one day old chicks, the average body weight 45.22- 48.10 gm body weight were used in this study. Ten chicks were slaughtered and examined bacteriological to prove chicks free from *salmonella*. Chicks reared under hygienic condition, fed balanced starter fresh ration free from any medications and given water ad-libitum.

***Salmonella pullorum* titration**
At 14th day of age 80 broilers were infected by *Sal pullorum* (1x10^{4}CFU via crop) (Corrier *et al.,* 1990) (*Sal pullorum* obtained from Fac.of Vet. Med Zag Univ).

Experimental design:
At 14 day of age, 100 broilers were divided into 5 groups (20/ each), 1st group healthy chicks (negative control), 2nd group infected chicks with *Sal. pullorum*. (positive control), 3rd group chicks received 0.1 ml formic acid/liter drinking water from 1st to 35th day of age and at 14 day of age infected with *Sal. pullorum*, 4th group chicks received 0.1 ml propionic acid / liter drinking water from 1st to 35th day of age and at 14 day of age infected with *Sal. pullorum*, 5th group received formic and propionic acid together by same dose for each type, period and infected with *Sal. pullorum*.

Body weight Chicks were individually weighed at 14th day of age and at 36th day of age) for determination body performance.

Blood samples two blood samples were collected from 5 chicks from each group at 1st day post supplementation. 1st sample was taken in test tube contain EDTA for estimation blood picture (Jain, 1986). 2nd sample was taken for obtain serum for estimation AST and ALT (Reitman and Frankel 1957), ALP (John 1982), T. protein (Doumas *et al.,* 1981) albumin (Doumas, 1971), uric acid (Trinder, 1969) Creatinine

(Bartels 1971) SOD (Nishikimi *et al.*, 1972), CAT (Sinha, 1972), MDA (Nielsen *et al.*, 1997)

Salmonella reisolation

Cloacal swabs were taken from all chicks under aseptic condition, inoculated into Selenite F broth, then incubated at 37°C for 24h. in Mac Conkey's agar media incubated at 37°C for 24-48h. Positive plates give pale colony (Waltman *et al.*, 1991). Suspected colony was identified morphologically and biochemically (Cheesbrough, 1985).

Statistical analysis was performed using analysis of variance (ANOVA). Duncan's Multiple Range (Duncan, 1955)

RESULTS

Infected broilers with *Sal. pullorum* showed clinical signs represented by anorexia, closed eyes, diarrhea, dehydration, mortality rate 30%, reduction in body weight gain, RBCs, Hb, PCV% MCHC, lymphocytes, total protein, albumin, CAT, SOD and significant increase in FCR, MCV, MCH, WBCs, heterophil ،monocyte globulin, ALT, AST, ALP, uric acid ceatinine, MDA beside insignificant decrease in eosinophil and basophil (Tables 1-5).

healthy broilers received formic acid or propionic acid either alone or together for 35 days and infected with *Sal. pullorum* showed no clinical signs, insignificant decrease in RBCs, Hb, PCV%, MCHC, lymphocyte eosinophil, T. protein, albumin, A/G ratio, CAT, SOD and insignificant increase in weight gain, MCV, MCH, WBCs, heterophil, basophil, monocyte globulin, ALT AST, ALP, uric acid, creatinine and MDA, improved FCR, reduced mortality rate to 5% but both acids together induced zero mortality beside reduction in reisolation of *sal. pullorum* (Table 1-5).

Table 1: Effect of salmonellosis on mortality rate and reisolated *salmonella* of chicks.

Parameters / Groups	total number	Mortality rate		Reisolated *Salmonella* at 1st day post supplementation
		No	%	
Gp (1)	20	0	0	0
Gp (2)	20	6	30	14/14
Gp (3)	20	1	5	4/19
Gp (4)	20	1	5	4/19
Gp (5)	20	0	0	1/20

Table 2: Effect of organic acid and *Sal Pullorum* on body performance of broiler (n= 5).

Parameters / Group	IW(14th day of age) (gm)	FBW (36thday of age) (gm)	Weight gain (gm)	FC	FCR
Gp (1)	582.31±1.64a	2190.09±4.27a	1607.78±5.16a	2017.03	1.26
Gp (2)	577.89±1.84a	1998.58±9.49b	1420.69±6.89b	1899.40	1.34
Gp (3)	581.44±1.88a	2178.76±9.87a	1597.32±8.63a	2036.64	1.28
Gp (4)	591.06±1.79a	2178.43±9.48a	1587.37±8.30a	2014.54	1.27
Gp (5)	584.18±1.63a	2181.55±9.72a	1597.37±8.86a	1969.21	1.23

Initial weight=IW final body weight=FBW feed consumption= FC feed conversion rate=FCR

Means with different superscripts of same column indicate significant difference at P< 0.05

Table 3: Effect of organic acid and *Sal. pullorum* on blood picture of broiler (N=5).

Group		Gp(1)	Gp(2)	Gp(3)	Gp(4)	Gp(5)
RBCs $10^6/mm^3$		4.17±0.21a	3.12±0.18b	4.05±0.21a	4.18±0.30a	4.09±0.33a
Hb gm/dl		13.14±0.3a	9.78±0.64b	12.89±0.28a	12.94±0.32a	13.05±0.41a
PCV (%)		28.21±0.24	25.97±0.6b	27.96±0.42a	27.97±0.36a	28.02±0.27a
Blood indices	MCV(fL)	67.21±1.43b	83.24±1.42a	69.04±1.54b	68.84±1.55b	68.63±1.9b
	MCH(pg)	31.14±1.65a	31.35±1.93	31.82±1.46a	31.82±1.46a	31.91±1.43a
	MCHC(gL)	6758±0.76	37.66±0.76c	46.10±0.76b	46.40±1.16b	46.57±0.76b
WBCs $X10^3/\mu l$	Total WBCs	12.19±065b	14.08±0.3a	12.64±0.27b	12.92±0.32b	12.88±0.3b
Deferential	Heterophil	3.23±0.21b	5.83±0.42a	3.94±0.69b	3.68±0.38b	3.61±0.55b
	Lymphocyte	5.11±0.25a	3.84±0.87b	4.69±0.83a	4.60±0.55a	4.64±0.60a
	Esinophil	1.42±0.05a	1.32±0.09a	1.40±0.08a	1.41±0.09a	1.41±0.08a
	Basophil	1.12±0.08a	1.05±0.16a	1.09±0.13a	1.13±0.19a	1.11±0.18a
	Monocyte	1.31±0.08b	2.04±0.12a	1.53±0.11b	1.91±0.12b	1.84±0.12b

Means with different superscripts of the same column indicate significant difference at P < 0.05

Table 4: Effect of organic acid and *Sal. pullorum* on liver function of broiler (N =5).

Group		Gp(1)	Gp(2)	Gp(3)	Gp(4)	Gp(5)
Protein profile (gm/dl)	T.Protein	5.73±0.27a	4.93±0.17b	5.61±0.21a	5.70±0.17a	5.69±0.19a
	Albumin	3.03±0.17a	2.08±0.30b	2.91±0.16a	2.96±0.18a	2.96±0.18a
	Globulin	2.70±0.11a	2.85±0.12b	2.70±0.14a	2.74±0.13a	2.74±0.14a
	A/G ratio	1.12±0.19a	0.73±0.08b	1.12±0.14a	1.09±0.17a	1.08±0.19a
Liver enzymes (U/L)	AST	47.71±0.48a	49.88±0.28b	48.14±0.21a	48.06±0.16a	47.85±0.4a
	ALT	36.12±0.59a	38.51±0.26b	37.01±0.41a	36.71±0.32a	36.62±0.2a
	ALP	33.42±0.53a	36.31±0.64b	34.36±0.44a	33.71±0.21a	343.7±0.23a

Means with different superscripts of the same column indicate significant difference at P < 0.05

Table 5: Effect of organic acid and *Sal. pullorum* on MDA, SOD & CAT of broiler (N =5).

Group		Gp(1)	Gp(2)	Gp(3)	Gp(4)	Gp(5)
kidney (mg/dL)	Uric acid	5.57±0.33a	7.02±0.36b	5.76±0.41a	5.79±0.32a	5.66±0.31a
	Creatinin	1.53±0.15a	2.09±0.13b	1.62±0.19a	1.63±0.22a	1.65±0.25a
MDA (mmol/ml)		20.52±0.89b	29.17±1.12a	23.19±0.68b	23.08±0.89b	21.32±0.76b
Antioxidant (U/mL)	CAT	56.17±1.62a	46.43±1.23b	52.28±1.08a	51.97±1.15a	53.21±1.05a
	SOD	179.17±1.8a	165.38±1.3b	175.05±1.2a	174.32±1.4a	176.19±1.2a

Means with different superscripts of the same column indicate significant difference at P < 0.05

DISCUSSION

In the present study, the main clinical signs appeared on broiler chickens infected with *Sal pullorum* were ruffled feather, emaciation, dropy wings, aneroxia, diarrhea, dehydration, decreased body weight and mortality rate was 30 % beside reduction in body weight gain and increase FCR (table 1 and 2). Reduction in body weight due to deleterious effect of *Sal pullorum* in intestinal tract (Shivaprasad, 2000). Typical clinical signs and reduction in body performance of Salmonellosis were recorded by Eslam (2000) in broilers and Garcia *et al.* (2010) in layers infected with *Sal pullorum*. Broilers suffering from ruffled feathers, dullness, droppings, huddled together, white diarrhea, loss of appetite and mortality rate 24.4% (Gemechu and Abdisa 2021).

Our obtained results revealed that infected broilers received formic acid or propionic acid either alone or together from 1st to 35th day of age showed no clinical signs with significant increase in weight gain, improved FCR and reduced mortality rate to 5% but combination of both acids induced zero mortality beside reduction in reisolation of *sal pullorum* (table 1 and 2). Similar results were agreed with (Al shawabkeh and Tabbaa 2002) reported that broilers received propionic acid improved body performance and reduced intestinal *Salmonella* colonization. Formic acid decreased salmonella in intestinal tract in broilers (Bourassa *et al.,* 2018 and Ricke *et al.,* 2020). Dietary formic acid and propionic acid lowered *Sal. pullorum* in intestine and reduced mortality rate (Al-Tarazi and Alshawabkeh, 2003). Reduced shedding of *salmonella* in poultry received organic acid may be due to penetration of organic acids bacterial cell wall and disrupt the normal physiology of bacteria (Dhawale, 2005). Same results were reported by Cengiz *et al.* (2012) stated that broilers received formic acid-propionic acid mixture not isolate *Salmonella* from caecal contents. Organic acids reduced pH and dissociation capacity of their carboxyl groups so gut environment is acidic and prevent growth pathogenic bacteria (Ganguly, 2013). Also, Marin *et al.* (2014) stated that organic acids improve feeding efficiency and reduce mortality due to the reduced toxin excretion by bacteria and colonization of pathogens on intestine. Broilers received organic acids in diets decreased *salmonella* in intestine and improved body performance (Ghazvinian *et al.,* 2019).

Hematological parameters in broilers suffering from salmonellosis revealed significant decrease in RBCs, Hb, PCV%, MCHC, lymphocyte and increase in MCV, MCH, WBCs, heterophil, monocyte beside insignificant decrease in eosinophil and basophil (table 3). Change in blood picture may be due to bacterial toxins cause intravascular destruction of RBCs in body leading to haemolysis with breakdown of hemoglobin (Karaivanov, 1984). Leukocytosis in infected broiler may be due to inflammatory response in intestinal tract (Kaneko, l989). Also, Shand ah *et al.* (2013) stated that salmonellosis induced reduction in RBCs, Hb, PCV% and increase in WBCs. Our results were in agreement with El Sayed *et al.* (2014) in broilers suffering from salmonellosis. Salmonellosis induced acute anaemia, leukocytosis, heterophilia, lympho-penia (Ahmed and Mahmoud 2014).

Our results revealed that, infected broilers received formic acid or propionic acid either alone or together from 1st to 35th day of age showed insignificant decrease in RBCs Hb PCV%, MCHC, lymphocyte, esinophil beside insignificant increase in MCV, MCH, WBCs, heterophil, basophil and monocyte (table 3) Similar result was observed by Talebi *et al.* (2005) stated that organic acid induced increase in RBCs, Hb, PCV % and WBCs count. Organic acid induced leukocytosis in broilers (Sabry *et al.,* 2016).

Salmonellosis in broilers revealed significant decrease in serum total protein, albumin, A/G ratio beside increase in globulin, ALT, AST, ALP (table 4). Reduction in total protein and albumin in infected chicks with *Sal Pullorum* may be due to a state of anorexia and male absorption of nutrients from inflamed intestine leading to inability of liver to synthesis albumin (Kaneko, 1980). Decrease in serum albumin beside increase AST, ALT and ALP in broiler infected with *Sal. pullorum* may be due to destruction liver cells by bacterial toxin (Macpherson, 1986). *Salmonella* toxins induce liver cell damage and liberation of liver enzymes lead to increase in liver enzymes (Doxy, 1983). Elevation in globulin may be due to antigenic stimulation of infectious agent (Azza *et al.,* 2012). Also Ahmed and Mahmoud (2014) stated salmenlosis in broilers induce significant reduction in total protein and albumin beside increase in globulin, ALT, AST and ALP. *Sal pullorum* induced significant decrease in serum total protein, albumin and A/G ratio associated with increase on serum globulin (Belih *et al.,*

2017). Salmonellosis induces decrease in liver enzyme and increase in globulin, ALT, AST, ALP (Belih *et al.,* 2017).

Broilers received formic acid or propionic acid either alone or together from 1st to 35th day of age and at 14th day of age artificially infected with *sal. pullorum* showed insignificant decrease in total protein, albumin, A/G ratio and insignificant increase in globulin, AST, ALT, ALP (table 4). Organic acids reduced *salmonella* colonization in intestine and improved absorption of nutrient beside improvement of protein picture and liver enzymes (Coax *et al.,* 1994), Also, Van Immerseel *et al.* (2002) stated that organic acids are used in poultry farms to control salmonellosis beside improved protein picture and liver enzymes. Increase in protein profile in broiler fed organic acid may be due to improvement in intestinal environment leads to an improve digestion and absorption of nutrients with increase amino acids and protein (Samanta *et al.,* 2010). Organic acids induced insignificant increase in AST ALT, ALP, albumin and protein of broilers (Adil *et al.,* 2010). Same results were reported by Ezzat *et al.* (2015) in broilers received formic acid. Broilers suffering from salmenloisis and received organic acids showed insignificant decrease in total protein, albumin and insignificant increase in globulin, AST ALT and ALP (Jing *et al.,* 2019).

Infected broilers with *Sal. Pullorum* showed significant increase in uric acid, ceatinine, MDA beside significant decrease in CAT and SOD (table 5). Elevation in uric acid and creatinine in broilers suffering from salmonellosis due to kidney damage by *salmonella* toxins (Doxy, 1983). *Salmonellosis* induced increase oxidative stress leading to increase in uric acid, ceatinine and MDA beside decrease in CAT and SOD (Mine, 2009). In addition, Ismail *et al.* (2013) mentioned that oxidation induced increase serum uric acid, ceatinine, MDA beside significant decrease in CAT and SOD. Salmonellosis induces increase in uric acid and creatinine in broiler (Rauber *et al.,* 2014). Salmonellosis in broilers induces marked increase in creatinine and uric acid (Ahmed and Mahmoud, 2014). Our finding agreed with Belih *et al.* (2017) in broilers suffering from salmonellosis. Salmonella infection leads to a significant increase of serum MDA and decreased SOD and CAT (Sokoudjou *et al.,* 2019).

Broilers received formic and propionic acid either alone or together from 1st to 35th day of age and at 14th day of age infected with *Sal. pullorum* showed insignificant increase in Uric acid and creatinine, MDA beside insignificant decrease in CAT and SOD (table 5). Organic acids in diet reduced *salmonllae* in hens intestine leading insignificant increase in uric acid and creatinine (Thompson and Hinton 1997). Our data coincide with results of Abdel-Fattah *et al.* (2008) stated that organic acid induced insignificant increase in uric acid and creatinine in broilers. Organic acids induced insignificant increase in uric acid and creatinine of broilers (Adil *et al.,* 2010). These results agreed with those stated by Abudabos and Al-Mufarrej (2014) stated that organic acids reduced oxidative stress in broilers infected with *Salmonella* improving serum uric acid and creatinine, MDA, SOD and CAT. Organic acid had positive influence on *Salmonella* and reduced oxidation stress beside improve serum antioxidant enzymes and MDA (Alaeldein *et al.,* 2017). Propionic acid induces decrease in MDA and increase in CAT and SOD (Huda *et al.,* 2020).

Finally, it could be concluded that, formic and probionic acid play an important role in control salmenlosis in broilers and act as growth promoter beside improved liver and kidney function so we recommend using formic acid and propionic acid alleover fatting period due to its low side effect and improved feed conversion rate and boy weight.

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التقييم المعملى لاستخدام بعض الأحماض العضوية فى مقاومة عدوى السالمونيلا فى دواجن التسمين

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كان الهدف من هذه الدراسة هو معرفة تأثير حمضى البربيونك والفورمك منفردين أو معا على السالمونيلا وعلى وزن الجسم وبعض وظائف الدم الكيميا-حيوية. تم استخدام ١١٠ كتكوت عمر يوم تم ذبح ١٠ منها وأخذ مسحات للفحص البكتريولوجي للتأكد من خلو الكتاكيت من الأصابة بالسالمونيلا. باقى الكتاكيت (١٠٠ كتكوت) تم تقسيمهم الى ٥ مجموعات (٢٠ / بكل منها) . الأولى تركت بدون إصابة أو علاجات (ضابطة سالبة),عند اليوم ١٤ من العمر الكتاكيت بالمجموعات ٢, ٣, ٤, ٥. تم عمل عدوى اصطناعية بالسالمونيلا بلورم, المجموعة الثانية مصابة ولم تعالج (مجموعة موجبة) , المجموعة الثالثة تم إعطائها ٠,١ ملي لتر من حمض الفورمك/ لتر من اليوم الأول من العمر حتى اليوم ٣٥ من العمر وعند اليوم ١٤ تم عمل عدوى اصطناعية بالسالمونيلا بلورم , المجموعة الرابعة تم اعطائها ٠,١ ملى من حمض البربيونك/ لتر ماء من اليوم الأول من العمر حتى اليوم ٣٥ من العمر وعند اليوم ١٤ تم عمل عدوى اصطناعية بالسالمونيلا بلورم أما المجموعة الخامسة تم عطائها حمض البربيونك والفورمك معا بنفس الجرعة والمدة وعند اليوم ١٤ تم عمل عدوى اصطناعية بالسالمونيلا بلورم.عند اليوم الاول من نهايه الإمداد تم ذبح ٥ كتاكيت من كل مجموعة وتم أخذ عينتين دم لتعيين بعض وظائف الدم الكيميا-حيوية. وتم تجميع مسحات من المجمع لاعادة عزل السالمونيلا.

الإصابة بالسالمونيلا فى الكتاكيت أدت إلى ظهور أعراض تتمثل فى: عدم الأكل، قفل العيون، الإسهال، الجفاف، ونقص فى الوزن ونسبة الوفيات ٣٠% ونقص معنوي فى وزن الجسم المكتسب، عدد كرات الدم الحمراء, تركيز الهيموجلوبين ، حجم خلايا الدم المرصوصة,MCHC الخلايا الليمفاوية، البروتين الكلي ،الزلال ,CAT, SOD , بجانب زيادة معنوية فى معدل التحويل الغذائى, MCV, MCH, WBCs الخلايا المتعادلة, الخلايا الملتهمة الكبيرة, الجلوبيولين, -ALT–AST ALP, حمض البوليك والكرياتينين MDA ونقص غير معنوى فى الخلايا القاعدية والحامضية.

الكتاكيت التى تم اعطائها حمض البربيونك والفورمك سواء منفردين أو معا من اليوم الأول حتى اليوم ٣٥ من العمر وعند اليوم ١٤ تم عمل عدوى اصطناعية بالسالمونيلا بلورم أدت الى عدم ظهور أعراض مرضية ونقص غير معنوى فى RBCs, Hb, PCV%, MCHC، الخلايا الليمفاوية والخلايا الحامضية البروتين الكلي ،الزلال CAT SOD, A/G ratio وزيادة غير معنوية فى وزن الجسم المكتسب MCV, MCH, WBCs الخلايا المتعادلة الخلايا القاعدية الخلايا الملتهمة الكبيرة,الجلوبيولين, انزيمات الكبد, حمض اليوريك والكرياتينين ,MDA وتحسن فى معدل التحويل الغذائى ونسبة الوفيات ٥%. ولكن البربيونك والفورمك معا أديا إلى عدم وجود نسبة وفيات كما قلل عدد السالمونيلا المعزولة.

يتبين لنا أن حمضى البربيونك والفورمك لهم دور فى مقاومة السالمونيلا و يعملان كمحفز للنمو وأديا إلى تحسين وظائف الكبد والكلى. لذلك نوصى باستخدام حمضى البربيونك والفورمك طوال مدة تربية كتاكيت التسمين نظرا لتأثيره المهم على وزن الجسم ومعامل التحويل الغذائى ولقله إثاره الضارة