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# Effects of Ionophorous Anticoccidial Drugs, Salinomycin and Lasalocid, on the Performance of Broiler Chicks and the Relationship of These Drugs to Supplementary Methionine

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**Abstract:** This experiment was carried out to study the effect of ionophore drugs (salinomycin, lasalocid and their combination) on the performance of broiler chicks. Also their relationship with methionine (three levels) was evaluated. 1620 one-day-old commercial broiler chicks (Arian) were divided in to 108 groups, 15 chicks per group, and tested in a completely randomized design with 3×3×3 factorial experiment and three levels (0, recommended and 1.5 times recommended) of drugs and three levels (0, 0.1% and 0.2%) of supplemental methionine. The results indicated that these drugs reduced body weight gain significantly ($P<0.05$) at 21 and 56 days of the experiment. Decreasing feed consumption and increasing feed conversion was significant ($P<0.05$) due to lasalocid supplementation. Increasing drug level significantly ($P<0.05$) reduced body weight gain and feed intake and feed conversion was increased at 21 to 42 and 0 to 56 days of the experiment. The effect of supplemental methionine on body weight of 42 days ($P<0.05$) and feed conversion at 21 to 42 and 0 to 56 days ($P<0.01$) were significant. The interactions between drug type and drug level on body weight gain, feed consumption and feed conversion were significant ($P< 0.05$). Lasalocid significantly ($P<0.05$) increased water intake. Drugs did not affect litter moisture and mortality. The results showed that salinomycin was better than Lasalocid. Also supplemental methionine was not effective in compensating for the growth depression caused by ionophore drugs.

**Key words:** Body weight, Broiler chicks, Feed consumption, Ionophore, Lasalocid, Salinomycin

## Introduction

Ionophore drugs are mono carboxylic polyesters antibiotics, which are the production of fermentation of *Streptomycis* types and are used in a large extent in poultry production industry to control and prevent coccidiosis disease. At present ionophore drugs include salinomycin, lasalocid, narasin, maduramycin and semduramycin. Ionophoric antibiotics combine with a number of mono and divalent cations and in the form of bi-complexes make it possible to transfer metal ions through lipid hydrophobic membrane, and when they are added to diet, they change bioavailability, gut uptake and absorption and reserves of nutrient tissues (Elsasser, 1984). As it is induced from different reports when these drugs are added to the diet, they cause growth reduction and this is while recommended level of drugs is taken into consideration and there is now coccidiosis infection in stock (Versteegh *et al*., 1990). Reports indicate that the use of salinomycin has reduced the growth of the chicks that receive this drug in comparison with control group (Migaki and Babcock, 1979; Patel *et al*., 1980; Yvore *et al*., 1980). Some have not come to this result yet (Chapman *et al*., 1993; Keshavarz, and McDougald., 1982; Leeson and Summers, 1983; Parsons *et al*., 1984). Also, a considerable growth reduction has been observed in floor pen experiment with the use of 125 mg/kg lasalocid in the diet.

Keshavarz and McDougald (1982) realized that the growth reduction with due to these drugs in high levels, are related to anorexia property of them drugs and they cause this decrease of feed consumption.

McDougald and Mequision (1980) have reported that feed consumption in birds that receive lasalocid and salinomycin are more than control group. The effect of ionophore drugs on methionine requirement was first reported by Damron *et al*., 1979. Some of the researchers that have reported the intraction between ionophore coccidiostat and methionine, believe that the growth reduction caused by these drugs can be removed by methionine (Patel *et al*., 1980; Versteegh *et al*., 1990; Willis, and Baker, 1981), while the other researchers did not find any relation between ionophore drugs and methionine (Damron *et al*., 1979; Keshavarz, and McDougald, 1982).

It is also reported that lasalocid increases the requirement of broiler chicks to inorganic sulphates. Perhaps this phenomenon is due to increasing broiler chick needs to sulphur amino acids (Karunajeewa and Barr, 1988).

The aim of this research is to study to types of ionophorous drugs and the mix of this to on performance of broiler chicks and also to study the effect of methionine supplement on improving the probable growth reduction due to the use of these drugs and their

relation with methionine supplement.

## Materials and Methods

This research made use of 1620 one-day-old commercial Arian chickens. The chickens were divided randomly in to 108 groups, each include 15 chicks. The chicken were kept in cages with 1×2 dimension in floor pen and shaving were used as litter. In each cage only one waterer and one feeder was used chicken *ad-libitum*. This experiment continued from the 1 day to 56 day, and it was done for each group with four replicate in a completely randomized design with a 3×3×3 factorial experiment. The present factors in this experiment include three types of drugs (salinomycin, lasalocid and equal combination of salinomycin + lasalocid), three levels of drugs (zero, the recommended level and 1.5 times of recommended levels) and three levels of methionine (zero, 0.1% and 0.2% diet). The treatments include 27 diets (Table 1), that were balanced in terms of age (starter, grower and finisher) and NRC (1994) recommendation. The combination of experimental diets in three periods is presented (Table 2). In 21, 42 and 56 days of age, the body weight gain and feed consumption were determined in groups and water intake was measured in the days 25 and 45 for 24 hours. At the end of period, with sampling the five point of cage in ×. The percentage of litter moisture was measured. The mortality percentage was calculated at the end of period. The data statistically were analyzed with general linear model method (GLM) in SAS Soft ware (1993). The comparison of means was done with Duncan (1955) method, and in order to get regression equation and correlation coefficients between the amounts of drugs and the body weight gain and feed consumption, The SAS program was used.

## Results and Discussion

The effect of the type of drug, the level of drugs and methionine on weight gain mean in different ages is presented in Table 3. The effect of type of drug in 56 day of age and the whole period (0-56 days of age) was significant (P<0.01), and according to the results lasalocid reduced weight gain mean in comparison with mix drugs (P<0.05). The drug level for 21, 42 and 56 days of age, and for the whole period was significant (P<0.01), as it is observed in Table 3. In chickens that receive the drug, with increasing the level of drug weight gain mean was severely reduced significantly (P<0.05). This results were in accordance with the findings of some researchers (Damron *et al.*,1979; Harms and Buresh, 1987; Migaki and Babcock, 1979; Yvore *et al.*,1980), and were not in accordance with the results of some other researchers (Chapman *et al.*, 1993; Keshavarz and McDougald, 1982; Leeson and Summers, 1983; Wheelhouse and Groves, 1985). It seems that the in significance of the effect of the level of the recommended drug in contrast with control group in 56 day of age induce to compensatory growth that it was done with removing this drugs from the diet in 49 days of age.

According to regression analysis (Table 8) per each unit increase in drug level, the reduction of weight gain for salinomycin, lasalocid and mixed drug was 4.7, 4.87, and 3.9 gram respectively. The interaction effect between the levels and type of the drug in 56 days of age and in the whole period (P< 0.01) and (P<0.05) was significant, in away that with increasing the level of lasalocid, feed consumption mean and body weight gain was reduced more in comparison with the increasing of the levels of the other two drugs (salinomycin and mixed drug). The absence of the interaction effect of the type the drug in methionine level makes, it seem that this drugs do not influence methionine requirements.

This is corresponding the results of other researchers (Damron *et al.*, 1979; Leeson and Summers, 1983; Patel *et al.*, 1980). The effect of drug in 0-21 days of age and in 42-56 days of age on the feed consumption is significant (P< 0.05) and (P< 0.01) respectively (Table 4). Lasalocid reduces the feed consumption more than the two other drugs that was significant (P< 0.05). It seems that the reduction of feed consumption due to using these drugs has two reasons:

1) It probably reduces the palatability of the diet and 2) the reduction of feed consumption in the presence of these drugs in the diet may be due to the Lack of balance of nutrients especially minerals which reduce the weight gain of chicks in addition to their feed consumption. Difference in 21-42 days of age, 42 -56 days of age and the whole period (P<0.01). According to the performed regression we observed the reduction of feed consumption for salinomycin, lasalocid and mixed drugs in the level of 5.49, 6.08 and 5.32 gram respectively per each unit increase in the level of drug (Table 8). It seems that the severe growth reduction which is caused by increasing the level of the drug is due to the reduction of feed consumption and this is against the results of McDougald and Mequision (1980), but corresponding with the results of other researcher (Harms *et al.*,1988; Keshavarz and McDougald, 1982; Leeson and Summers, 1983; Welch *et al.*, 1988). The interaction effect of the drug type × drug level was significant (P<0.05) for 42-56 days of age, that is to say, we did not observe any significant difference in the mean feed consumption with increasing the drug level of salinomycin and mixed drug and with increasing the drug level of lasalocid the mean of feed consumption reduced (P< 0.05). Therefore, we can say that anorexic effect of lasalocid is more than salinomycin and this is not corresponding with the finding of Keshavarz and McDougald (Keshavarz and McDougald, 1982). The type and of drug influenced the feed conversion ratio in the finishing period significantly (P<0.05). The comparison of the means of the types of drugs indicated that

Table 1: Experimental treatment

| | | | | | | |
|---|---|---|---|---|---|---|
| Basal diet | + | 0 mg/kg | Salinomycin | + | 0% | of Methionine diet |
| Basal diet | + | 0 mg/kg | Salinomycin | + | 0.1% | of Methionine diet |
| Basal diet | + | 0 mg/kg | Salinomycin | + | 0.2% | of Methionine diet |
| Basal diet | + | 60 mg/kg | Salinomycin | + | 0% | of Methionine diet |
| Basal diet | + | 60 mg/kg | Salinomycin | + | 0.1% | of Methionine diet |
| Basal diet | + | 60 mg/kg | Salinomycin | + | 0.2% | of Methionine diet |
| Basal diet | + | 90 mg/kg | Salinomycin | + | 0% | of Methionine diet |
| Basal diet | + | 90 mg/kg | Salinomycin | + | 0.1% | of Methionine diet |
| Basal diet | + | 90 mg/kg | Salinomycin | + | 0.2% | of Methionine diet |
| Basal diet | + | 0 mg/kg | Lasalocid | + | 0% | of Methionine diet |
| Basal diet | + | 0 mg/kg | Lasalocid | + | 0.1% | of Methionine diet |
| Basal diet | + | 0 mg/kg | Lasalocid | + | 0.2% | of Methionine diet |
| Basal diet | + | 100 mg/kg | Lasalocid | + | 0% | of Methionine diet |
| Basal diet | + | 100 mg/kg | Lasalocid | + | 0.1% | of Methionine diet |
| Basal diet | + | 100 mg/kg | Lasalocid | + | 0.2% | of Methionine diet |
| Basal diet | + | 150 mg/kg | Lasalocid | + | 0% | of Methionine diet |
| Basal diet | + | 150 mg/kg | Lasalocid | + | 0.1% | of Methionine diet |
| Basal diet | + | 150 mg/kg | Lasalocid | + | 0.2% | of Methionine diet |
| Basal diet | + | 0 mg/kg | Sal+0mg/kg Las | + | 0% | of Methionine diet |
| Basal diet | + | 0 mg/kg | Sal+0mg/kg Las | + | 0.1% | of Methionine diet |
| Basal diet | + | 0 mg/kg | Sal+0mg/kg Las | + | 0.2% | of Methionine diet |
| Basal diet | + | 30 mg/kg | Sal+50mg/kg Las | + | 0% | of Methionine diet |
| Basal diet | + | 30 mg/kg | Sal+50mg/kg Las | + | 0.1% | of Methionine diet |
| Basal diet | + | 30 mg/kg | Sal+50mg/kg Las | + | 0.2% | of Methionine diet |
| Basal diet | + | 45 mg/kg | Sal+75mg/kg Las | + | 0% | of Methionine diet |
| Basal diet | + | 45 mg/kg | Sal+75mg/kg Las | + | 0.1% | of Methionine diet |
| Basal diet | + | 45 mg/kg | Sal+75mg/kg Las | + | 0.2% | of Methionine diet |

Table 2: Ingradients and nutrient composition (g/kg) of diet

| Ingredient | Day | | |
|---|---|---|---|
| | 0-21 | 21-42 | 42-56 |
| Maize | 600 | 600 | 135.4 |
| Soybean Meal (44% CP) | 250.4 | 200 | 197.6 |
| Wheat | 56.8 | 125.2 | 9.1 |
| Fish Meal | 60 | 43.5 | 30 |
| Alfalfa Meal (15% CP) | 50 | 50 | 0 |
| Oyster Shell | 12.9 | 13.7 | 14.9 |
| Mono Calcium Phosphate | 7.1 | 50 | 6.3 |
| Salt (NaCl) | 1.5 | 1.5 | 1.5 |
| Dl- Methionine | 1.4 | 1.1 | 0.2 |
| Premix | 5 | 5 | 5 |
| Calculated | | | |
| ME (MJ/kg) | 12.12 | 12.33 | 12.54 |
| Crude Protein (%) | 20.86 | 18.44 | 17 |
| Calcium (%) | 0.92 | 0.84 | 0.85 |
| Available Phosphorus (%) | 0.41 | 0.33 | 0.32 |
| Methionine + Cystine (%) | 0.85 | 0.75 | 0.62 |
| Lysine (%) | 1.15 | 0.96 | 0.87 |

Vitamin and mineral mix supplied/ kg diet: vitamin A, 11000 IU; vitamin $D_3$, 1800 IU; vitamin E, 11 mg; vitamin $K_3$, 2 mg; Vitamin $B_2$, 5.7 mg; Vitamin $B_6$, 2mg; vitamin $B_{12}$, 0.024 mg; Nicotinic acid, 28 mg; folic acid, 0.5 mg; pantothenic acid, 12 mg; choline chloride, 250 mg; Mn, 100 mg; Zn, 65 mg; cu, 5 mg; Se, 0.22 mg; I, 0.5 mg; Co, 0.5 mg.

lasalocid has increased the feed conversion ratio in the finishing period and whole period more significantly ($P<0.05$), than the ratio of food conversion in two other treatments and this is corresponding with the finding Karunajeewa and Bar (1988). With increasing the drug level, the feed conversion ratio increases significantly ($P<0.05$) than control group (Table 5).

The above mention results approve the results of other researchers (Harms *et al.*,1988; Keshavarz and McDougald, 1982). It is that deleterious effect caused by lasalocid than salinomycin on feed consumption, weight gain and feed conversion ratio is due to this fact that lasalocid is the only ionophore that can form a complex with divalent cations such as $Ca^{2+}$, $Zn^{2+}$, $Cu^{2+}$, $Fe^{2+}$, $Mg^{2+}$ and $Mn^{2+}$ and reduces the availability and intake of minerals through intestine. Probably the improvement of feed conversion ratio in comparison with control group in finishing period (2.93 and 3.11 Vs 3.18) is due to the drug withdrawal at the end of period or better using of the minerals, that was only significant ($P<0.05$), for the recommended level of drugs. Methionine level influenced the conversion ratio significantly in the growth period and the whole period that may be due to the high requirement to methionine for optimum feed conversion ratio in comparison with weight gain and feed consumption, and with the increasement of methionine the diet has been balanced more.

Also, the interaction effect between the type of the drug and methionine level in the finishing period and the

Table 3: Main effect of drug type, drug level and methionine level on body weight gain at different ages (gr)

| Treatment | Age | | | |
|---|---|---|---|---|
| | 21 | 42 | 56 | 0-56 |
| Main effect | | | | |
| Drug type | | | | |
| Salinomycin | 447.8[a] | 914.8 | 758.5[a] | 2136.8[a] |
| Lasalocid | 432.0[b] | 899.5 | 630.95[b] | 1987.9[b] |
| Salinomycin+lasalocid | 444.4[ab] | 920.2 | 758.5[a] | 2130.0[a] |
| Drug level | | | | |
| 1 | 450.6[a] | 1150.8[a] | 741.3[a] | 2360.9[a] |
| 2 | 449.3[a] | 879.7[b] | 758.5[a] | 2098.1[b] |
| 3 | 424.2[b] | 704.0[c] | 645.65[b] | 1795.7[c] |
| Methionine level | | | | |
| 0 | 433.9 | 935.24[a] | 707.9 | 2093.6 |
| 0.1% of diet | 445.73 | 923.7[a] | 724.4 | 2109.2 |
| 0.2% of diet | 444.67 | 875.5[b] | 707.9 | 2051.9 |
| Mean ± SE | 441.4±35.1 | 911.5±333.4 | 707.9±1.2 | 2084.9±4539 |

Means within a column with no common superscript differ significantly (P< 0.05).

Table 4: Main effect of drug type, drug level and methionine level on feed consumption at different ages (gr)

| Treatment | Age | | | |
|---|---|---|---|---|
| | 0-21 | 21-42 | 42-56 | 0-56 |
| Main effect | | | | |
| Drug type | | | | |
| Salinomycin | 702.7[ab] | 2222.8 | 2303.7[a] | 5229.3 |
| Lasalocid | 680.8[b] | 2238.0 | 2138.0[b] | 5057.0 |
| Salinomycin+lasalocid | 718.2[a] | 2239.5 | 2247.3[a] | 5205.1 |
| Drug level | | | | |
| 1 | 709.6 | 2393.2[a] | 2411.1[a] | 5513.9[a] |
| 2 | 705.2 | 2235.1[b] | 2234.2[b] | 5174.5[b] |
| 3 | 687.0 | 2072.0[c] | 2043.8[c] | 4802.9[c] |
| Methionine level | | | | |
| 0 | 698.8 | 2211.6 | 2219.2 | 5129.7 |
| 0.1% of diet | 699.9 | 2255.8 | 2223.7 | 5179.5 |
| 0.2% of diet | 703.1 | 2232.9 | 2246.1 | 5182.2 |
| Mean ± SE | 700 ± 49.3 | 2233.4 ± 260.7 | 2229.7 ± 337.8 | 5163.8 ±595.0 |

Means within a column with no common superscript differ significantly (P< 0.05).

whole period on feed conversion ratio was significant in (P<0.05) and (P<0.01) respectively. For salinomycin and mixed form, with the increasement of methionine level the significant difference was observed in feed conversion ratio, while for lasalocid the feed conversion ratio got worse. That is, the control group and the group that receive 0.1% of methionine in the diet has significant difference with 0.2% of methionine (P<0.05). As a result it seemed that lasalocid reduces the need for sulphur amino acids.

These results corresponded with Willis and Baker results (1981). The comparison of means of the effect of type of the drug indicated that lasalocid increases the water consumption significantly than the two other treatments (P<0.05), (Table 6). The water consumption in the treatment using mixed drug was between lasalocid and salinomycin. These results corresponded only with the results of some of the researchers (Damron, 1994; Nan *et al*., 1979; Versteegh *et al*., 1990). The reason of increasement of water consumption with lasalocid is not clear but it seems that it should be in relation with imbalance of electrolytes in the body that leads to more excretion salts and consequently more water with them. So the water consumption increases the level of drug had a significant effect on water consumption (P<0.01) and with increasing of the drug level the water consumption rate decreased which was significant in different level (P<0.05). Therefore it seems that the reason for water consumption reduction with the increasement of drug level shall be in relation with the reduction of feed consumption rate. There wasn't any significant difference among the treatments for litter

Table 5: Main effect of drug type, drug level and methionine level on feed conversion at different ages

| Treatment | Age | | | |
|---|---|---|---|---|
| | 0-21 | 21-42 | 42-56 | 0-56 |
| Main effect | | | | |
| Drug type | | | | |
| Salinomycin | 1.56 | 2.49 | 2.98[b] | 2.45[b] |
| Lasalocid | 1.57 | 2.57 | 3.29[a] | 2.58[a] |
| Salinomycin+lasalocid | 1.61 | 2.48 | 2.94[b] | 2.45[b] |
| Drug level | | | | |
| 1 | 1.57 | 2.07[c] | 3.18[a] | 2.33[c] |
| 2 | 1.57 | 2.53[b] | 2.98[b] | 2.46[b] |
| 3 | 1.61 | 2.94[a] | 3.11[a] | 2.69[a] |
| Methionine level | | | | |
| 0 | 1.61 | 2.41[b] | 3.06 | 2.46[b] |
| 0.1% of diet | 1.56 | 2.5[b] | 3.06 | 2.48[b] |
| 0.2% of diet | 1.58 | 2.62[a] | 3.12 | 2.55[a] |
| Mean ± SE | 1.58 ± 0.09 | 2.51 ± 0.68 | 3.07 ± 0.45 | 2.49 ±0.33 |

Means within a column with no common superscript differ significantly (P< 0.05).

Table 6: Main effect of drug type, drug level and methionine level on water intake at 25 and 45 days of age (milliliter)

| Treatment | Age | |
|---|---|---|
| | 25 | 45 |
| Main effect | | |
| Drug type | | |
| Salinomycin | 111.4[b] | 226.91 |
| Lasalocid | 130.6[a] | 229.82 |
| Salinomycin+lasalocid | 116.74[b] | 229.15 |
| Drug level | | |
| 1 | 163.84[a] | 233.2[a] |
| 2 | 109.22[b] | 242.46[a] |
| 3 | 85.68[c] | 210.23[b] |
| Methionine level | | |
| 0 | 115.85[b] | 239.16[a] |
| 0.1% of diet | 128.05[a] | 231.07[ab] |
| 0.2% of diet | 114.84[b] | 215.64[b] |
| Mean ± SE | 119.58±64.31 | 228.62±38.51 |

Means within a column with no common superscript differ significantly (P< 0.05).

Table 7: Main effect of drug type, drug level and methionine level on litter moisture percentage and mortality percentage at the end of the period

| Treatment | Litter moisture (%) | mortality ( % ) |
|---|---|---|
| Main effect | | |
| Drug type | | |
| Salinomycin | 21.16 | 8.09 |
| Lasalocid | 22.38 | 7.4 |
| Salinomycin+lasalocid | 22.3 | 7.43 |
| Drug level | | |
| 1 | 22.1 | 5.45 |
| 2 | 20.53 | 9.36 |
| 3 | 23.21 | 8.09 |
| Methionine level | | |
| 0 | 22.67 | 7.38 |
| 0.1% of diet | 20.24 | 7.94 |
| 0.2% of diet | 22.24 | 7.58 |
| Mean ± SE | 21.94±5.9 | 7.63±7.48 |

Means within a column with no common superscript differ significantly (P< 0.05).

moisture percentage and for mortalities (Table 7). So we can come to the conclusion that lasalocid has not increased litter moisture and this does not correspond with the findings of Ward and Brewer (1981).

A significant difference was not observed among the treatments considering mortality percentage and the criteria surveyed have no effect on these characteristics (Table 7). These findings corresponded with the finding of other researchers (Leeson and Summers, 1983; Patel *et al*., 1980). We can induce from the results of this study that:

1) The ionophore of drugs used in this experiment caused the reduction of growth and feed consumption and getting worse of conversion ratio and also caused this order in digestion and absorbing nutrients especially mineral salts and enzymes that there activation is related to this elements and as a result disturb digestion and absorption of proteins and fats and the whole nutrients.
2) Deleterious effect caused by lasalocid was more on the studied parameters than the two other drugs (salinomycin and mixed drug).
3) Growth reduction caused by these drugs is not compensated with increasing extra methionine to the diet.
4) It seems that salinomycin is stronger than lasalocid be cause considering the weight gainand feed consumption and feed conversion ratio variables it is made clear that functioning of mixed drug

Table 8:Regression equation between performance (Y) and drug type (X)

| Dependent variable | Drug type | Equation | $R^2$ |
|---|---|---|---|
| Weight gain | Salinomycin | Y=2371.38-4.69X | 98 |
| Weight gain | Lasalocid | Y=2394.18-4.87X | 94 |
| Weight gain | Salinomycin+Lasalocid | Y=2990.51-3.9X | 90 |
| Feed intake | Salinomycin | Y=5504.22-5.49X | 99 |
| Feed intake | Lasalocid | Y=5563.9-6.08X | 92 |
| Feed intake | Salinomycin+Lasalocid | Y=5555.34-5.32X | 88 |

with salinomycin wasn't significant statistically and this indicates that the salinomycin which is present in mixed drug could have covered the effect of lasalocid.

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