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# EFFECT OF COMMERCIAL ENZYMES AND\OR MANNAN OLIGOSACCHARIDE SUPLEMENTATION ON PRODUCTIVE PERFORMANCE, NUTRITIVE VALUES AND METABOLIC INDICES OF BROILER CHICKS

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**Running title:** ***Effect of enzymes and\or MOS onperformance***

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**SUMMARY**

*This study was conducted to evaluate the effect of using feed additives in Sasso broiler chicks as growth promoters on productive performance, digestibility coefficient of nutrients, blood indicates, carcass and gastrointestinal measurements and economic return. A total number of 120, one - day old, unsexed Sasso chicks were assigned randomly to four groups. Each group included three replicates. The first group was kept as control and fed the basal diet. The 2nd, 3rd and 4th groups were fed the basal diet (+ 1.00 g Frazyme), (2.50 g mannan oligosaccharides) and (1.00 g Frazyme + 2.50 g MOS)\ kg diet respectively during whole experimental period (1-58) days of age. The obtained results showed that the better (P<0.05) values of LW, WG and FCR were recorded to group four followed by group three at the end of experimental period. There were no significant differences among all experimental treatments in feed intake during the whole experimental period. Significant (P<0.05) improvement has been recorded in digestibility of CP and CF for group four and two respectively. Group four showed the highest values (P<0.05) of breast yield and spleen weight compared to other groups. There were no significant differences of gastrointestinal lengths among all experimental groups Regarding blood parameters, broilers in group two had significantly (P<0.05) Hct, Lipase and Amylase. While, group four broiler's were recorded the highest (P<0.05) TP, Alb., Hb and TAC compared to others. The chemical analysis of meat revealed that greatest (P<0.05) CP of breast meat for group four. However, Thigh meat analysis for birds in control and group four achieved high significant values of fat and ash contents. The lowest mortality and highest PI and economic efficiency were related to groups four and three respectively. On the basis of these results, it can be concluded that adding enzymes combination, MOS or their mixture (Enz+MOS) as feed additives were suitable and had good role in improving productive and economic efficiency of Sasso broiler chicks.*

***Keywords: commercial enzymes, mannan oligosaccharides, productive, broiler chicks***

## INTRODUCTION

In past, antibiotic growth promoters have been widely used in all types of livestock production systems particularly poultry (Alhidary *et al*., 2017 and Chand *et al*., 2018) at sub therapeutic level they are used as feed additives to improve growth and nutrient availability by regulating microbial populations (Abudabos *et al*., 2017).On the other hand, it has negative effects as it increases microbial resistance to antibiotics and results the residues in chicken meat products which might be harmful to consumers (Diarra *et al*., 2007 and Koc *et al*., 2010). Recently, feed additives are being tested to relieve the problems connected with the elimination of antibiotics from food (Attia *et al*., 2014a). The alternative feed additives include products such as enzymes, prebiotics, probiotics, appetizers, yeast, growth promoters or combinations of all those products, which are classified as non-nutrient feed additives (NNFA). They are added to the feed to improve or to accelerate the rate ofnutrient utilization (Altafur *et al*., 2007 and Midilli, *et al*., 2008).

Several studies on the supplementation of exogenous enzymes to broiler diets have been performed. Addition of exogenous enzymes in broilers diets improved broilers performance, daily gain, feed conversion (Wang *et al*., 2005), they were found to enhancethe food digestibility, minimize the anti-nutritional effects. Reduction of the adverse impacts of NSPs, correlated with the degradation of NSPs for better energy utilization and availability in broiler’s intestinal tract (Abdollahi *et al*., 2016). They promoted the productivity indices (Hooge *et al*., 2010) due to its vital role in the diets. Olukosi *et al*. (2015) found that a combination of enzymes cocktail produced a greater effect in improving energy and protein values, as well as increasing the solubilization of diets given to broilers. Also, Stefanello *et al*. (2015) demonstrated that the growth Performance was improved when broilers were fed diets supplemented with addition of enzymes.

The use of prebiotics instead of antibiotics is becoming increasingly popular in feeding of birds to improve the useful microbial population in the gut (Kermanshahi, 2006). Mannan oligosaccharides are commonly used in the same manner as prebiotics with the due to their ability to selectively enriching the beneficial bacterial populations (Patterson and Burkholder, 2003).

Mannanoligosaccharides (MOS) or Y-MOS is a natural extract from natural yeast compound; it is a derivative of the cell wall of yeast *Saccharomyces cerevisiae* (Chand *et al*., 2016). Many studies evaluated the effects of MOS on growth performance, feed efficiency, blood chemistry, and intestinal environment. Chand *et al*. (2018) reported that addition MOS to basal diet of broiler improved; the number of goblet cells in the gut, pH alteration of intestine, enzyme production, antagonist for intestinal adhesion receptors, and opposition to feed ingredients. Improved structure of intestine (Iji *et al*., 2001), and reducing toxin level, and stimulation of the immune system. The main effect of Y-MOS yeast supplementation to basal diet was to increase weight gain and overall growth measurements when compared to control group, Those positive attributes have been reported by Mohamed and Mukhtar (2016) and Habib *et al*., (2017). Feeding of prebiotic has been useful to improve carcass quality of broiler chickens **(**Tavaniello, 2018). The productive efficiency can be achieved when obtaining maximum production with minimum cost and using the least amount of resources to produce a given output level (Emara, 2009; Romero *et al*., 2010 and Mohamed, 2016).

Therefore, the aim of this study was to evaluate the effect of commercial enzymes, mannan oligo-saccharides and its mixture on growth parameters, hemato-biochemical parameters, digestibility of nutrients, carcass characteristics, gastrointestinal tract characteristics and economic analysis when fed to Sasso broiler chicken.

## MATERIALS AND METHODS

### *Experimental chicks, Management and Housing:*

The current study was carried out at the Animal and Poultry Research Farm, Animal and Poultry Production Department, Faculty of Agriculture, Minia University. All experimental procedures were carried out in accordance with the local Experimental Animal Care Committee and authorized by the Institutional Committee of the Department of Animal Production, Faculty of Agriculture, Minia University, Egypt. A total number of 120, One day- unsexed Sasso broiler chicks were purchased from Cairo Company for Poultry. The chicks were weighted and randomly allocated to four experimental groups (30 chicks/group). Each group consists of three replicates (10 chicks/replicate). The chicks were housed in an open house, two-tiers floor batteries (100× 60 × 40 cm\cage), for length, width and height, respectfully. Gas heater were placed in the house to control the interior temperature. Brooding temperature started at 33- 34°C during the first 3 days, then 31°C till the end of the first week, followed by reduction of 2°C/week until the temperature reached 28°C at the end of experiment according to Marwa, (2013) and Mohamed, (2016). Feed and water were offered continuously. The lighting was 24 hr of light during first three days, then 23h until the 7$^{th}$ day followed by 20 h light from the 8$^{th}$ day until 15$^{th}$ days of age. Then natural day light only until the end of the experimental period, which was provided according to farmer's guide of Sasso colored broiler chicks.

### *Experimental Diets:*

Chicks were fed on balanced diet as shown in Table 1.

The test diets for the starter and grower phases (1-28 and 29-58 days of age) were formulated to be iso-caloric and iso-nitrogenous, and containing adequate levels of all other nutrients to meet the requirements of starter and grower of Sasso broiler. The first group was fed the basal diet without supplementation (control); while the 2nd, 3rd, and 4th groups were fed basal diet supplemented with 1.00, 2.50 and 1.00 + 2.50 g\kg diet of commercial enzymes mixture (Frazyme), mannan oligosaccharides (MOS) and mixture of frazyme and MOS respectively. Frazyme was purchased from ATCO Pharma Company for Animal Health – Cairo, Egypt. While, MOS was purchased from Khayrat El-Nile Company for feed additives, Cairo, Egypt.

Frazyme components were Alpha-amylase 2100 IU, Xylanase (*Trichoderma Reesi*)16000U, 1.3(4) Beta-glucanase 2400 U,Pictinase 210U, Mannanase 3000U, Proease 600 U and Carrier: Ceplolite up to 1g.

MOS components were yeast cell wall (*Saccharmyces Cerevisiae*) 100%, Beta glucanase 25% and Mannanoligosaccharides 18.5%.

**Table 1. The composition and chemical analysis of starter and grower diets**

| Ingredients % | Starter diet | Grower diet |
|---|---|---|
| **Yellow corn** | 50.00 | 55.00 |
| **Soybean meal, 44%** | 32.00 | 27.00 |
| **Corn gluten, 62%** | 5.00 | 4.00 |
| **Wheat bran** | 5.50 | 6.00 |
| **Vegetable oil** | 4.00 | 4.90 |
| **Limestone** | 2.00 | 1.6 |
| **Di-calcium phosphate** | 1.00 | 1.00 |
| **Nacl** | 0.25 | 0.25 |
| **Vit. & min. *** | 0.25 | 0.25 |
| **Total** | 100.00 | 100.00 |
| **Price\ kg** | 5.50 (EGP) | 5.00.(EGP) |
| **Calculated analysis** (NRC,1994)**:** | | |
| **CP%** | 22.07 | 19.67 |
| **ME, k cal\kg** | 2996.00 | 3100.21 |
| **CF%** | 3.54 | 3.62 |
| **Ca%** | 1.03 | 0.95 |
| **Av. Ph%** | 0.69 | 0.65 |
| **Lys. %** | 1.10 | 0.95 |
| **Meth+Cys.** | 0.52 | 0.50 |
| **Chemical analysis:** | | |
| **DM%** | 93.02 | 92.78 |
| **Ash%** | 7.20 | 6.76 |
| **CP%** | 22.00 | 19.80 |
| **CF%** | 3.35 | 3.72 |
| **EE%** | 4.69 | 6.21 |
| **NFE%** | 62.76 | 63.51 |

According to NRC,1994 and Sasso farmer's guide* Each 3 kg contains contain: Vitamin A = 12,000,000 IU, D3 = 2,000,000 IU, E = 10,000 mg, K3= 2000mg, B1 = 1000 mg, B2 =5000 mg, B6 =1500 mg, B12= 10mg, Biotin= 50 mg, pantothenic acid= 10000 mg, Nicotinic acid = 30000 mg, Folic acid =1000 mg, Zinc = 50,000 mg, Manganese = 60,000 mg, Iron = 30,000 mg, Copper = 10,000 mg, Iodine =1,000 mg, Selenium = 100 mg, Cobalt = 100 mg, Cobalt = 1000 mg, and Calcium carbonate up to 3 Kg.

***Growth measurements:***

Live body weight and feed intake were recorded every two weeks, from 1 to 14, from 15 to 28, from 29 to 42 and from 43 to 58 days of age. Body weight gain and feed conversion ratio were calculated for the same periods during starter and grower phases. Mortality rate was estimated at the end of the experimental period by the number of dead birds during the whole period m, divided by the initial number of bird in each group, and multiplied by 100. Performance index (PI) and economic efficiency were calculated according to North (1981) and Waheed and ElTaieb (2005) respectively.

***Slaughter test:***

Slaughter test was done with randomly selected three birds from every group at the end of experiment (58 days of age) to determine carcass characteristics as dressing, breast, thigh percentages and liver, gizzard, heart, abdominal fat and spleen weights. Gastrointestinal tract was removed after evacuation the carcass and lengths of duodenum, jejunum, ileum, cecum and colon were measured in centimeter.

***Chemical analysis of meat, diets and excreta:***

Samples of breast and thigh meat from slaughtered broilers and the experimental diets and excreta were dried in Muffle oven at 60̊ C over night, and then were crushed into fine powder and saved in glass jars to be chemically analysis according to (AOAC, 2010) to determine content of dry matter, crude protein, crude fat and ash.

***Digestibility trail:***

At the end of the experimental period (8 weeks of age) digestion trial was conducted for 3-days to estimate the digestion coefficient of nutrients; dry matter, organic matter, crude protein, crude fiber, and nitrogen free extract. The feed consumption was recorded, and the manure, which fell on polyethylene sheets, was collected quantitatively for each replicate (6 birds/group) every 24 hour. Fecal nitrogen was determined according to Jakobsen *et al*. (1960) as follow:

1- About 2 gm of dried excreta in a 300 ml glass beaker plus 70 ml of distilled water.
2- 20 ml of sodium borate and 6 ml of potassium permanganate were added.
3- The beaker was placed in a water stirred bath at a temperature of 50°C for an hour.
4- The beaker was raised and left to slow down for at least one hour, at room temperature.
5- Addition about 30 ml tri-choloro acetic acid (10%) to the beaker and stirred with glass straight stick.
6- The beaker was left again for 30 minutes at room temperature, then filtered in ashless filter paper (15 cm).
7- The residual washed four times with 25-30 ml tri-choloro acetic acid (2%).
8- The filter paper with the sample was dried in an oven at 90°C for three hours.
9- Finally, determination the nitrogen content of feaces with kjeldahle method.
10- Calculation digestion coefficient = digested feed/feed intake×100.

***Blood measurements:***

Blood samples were taken during slaughter into two tubes/bird to obtain plasma and serum, from coagulated blood. Plasma or serum were separated by centrifugation of the blood at 3000 rpm for 20 minutes and stored at –20°C for later analysis. Heparinized tube was used to estimate the total count of red blood cells (RBC) white blood cells (WBC), packed cell volume (PCV), and hemoglobin (Hb%). Un heparinized tube was used to determine serum biochemical parameters as total protein (TP), albumin (Alb.), globulin (Glob.) was calculated, total lipids (TL), glucose (Glu), uric acid (UR), alkaline phosphatase (ALP), tri-iodothyronine (T3), thyroxin (T4), total antioxidants capacity (TAC), and some digestive enzymes like as lipase, amylase and protease. The colorimetric methods were used to assess blood biochemistry and radioimmunoassay technique to concentration of total T3 and T4 using commercial test kits that were obtained from Biomed Diagnostic Company, Giza, Egypt.

***Statistical analysis:***

The obtained results were subjected to statistical analysis using one-way analysis of variance (ANOVA) using the SAS, 2002. The significance of differences among means was determined by using Duncan's new multiple range test (Duncan, 1955.) and the following statistical model was used,

$Y_{ik} = \mu + T_i + e_{ik}$

Where:

$Y_{iK}$ = Experiment observations.

$\mu$ = the overall mean.

$T_i$= the effect of dietary treatment.

$e_{iK}$= the experimental error.

## RESULTS

***Productive performance:***

***Growth performance:***

The effect of different additives on productive performance indicators such as live weight (LW), weight gain (WG), feed intake (FI) and feed conversion ratio (FCR) at different ages for Sasso broilerchicks is shown in Table 2. Sasso broiler chicks fed basal diet supplemented with feed additives had significantly (P<0.05) recorded linear increase in LW and WG at (1-14), (15-28), (29-42), (43-58) days of age and total experimental period (1-58 days of age) compared to broiler chicks fed control basal diet without supplements. The greater LW and WG was noted in chickens of group four that were supplemented with mixture of (1.00g Frazyme + 2.50g MOS/kg) followed by broiler chicks in group three that were fed (1.00g MOS/kg) compared to control chicken group. Moreover, Chicks fed the basal diet or basal diet with feed additives had no significant differences in feed intake (FI). The lowest value of FI has been recorded for broilers that were fed diet with 2.5 g MOS (4330.54g/bird) followed by broilers fed diet with enzyme + MOS (4362.76 g/bird) compared to broiler fed the control diet (4455.47 g/bird) or broilers that were fed control diet plus commercial enzymes addition (4433.90 g/ bird) during whole experimental period (1-58 days of age). The enhancement in FCR values was significant (P<0.05) in line of treated groups during (1-14), (43-58) and whole period (1-58) days of age. The best value of FCR was calculated for broiler chicks fed diet with MOS (group three) at starter phase, while, during grower phase the significant improve was shared for birds in group four (Frazyme + MOS) then birds in group three (MOS) compared to control or enzyme groups during periods (43-58) and (1-58 days of age).

**Table 2. Effect of different additives on productive performance of Sasso broiler chicks**

| Parameter | Treatments | | | | Statistics | |
|---|---|---|---|---|---|---|
| | Con. | Enz. | MOS | Enz.+ MOS | SEM | P-value |
| **LW at 01** | 40.83 | 41.30 | 40.17 | 40.00 | 0.86 | 0.699 |
| **At 14** | 200.23$^{b}$ | 213.51$^{ab}$ | 220.98$^{a}$ | 224.84$^{a}$ | 4.15 | 0.013 |
| **At 28** | 618.16$^{b}$ | 634.84$^{ab}$ | 641.08$^{ab}$ | 670.23$^{a}$ | 13.69 | 0.132 |
| **At 42** | 1328.34$^{b}$ | 1351.97$^{ab}$ | 1354.90$^{ab}$ | 1395.03$^{a}$ | 17.56 | 0.135 |
| **At 58** | 2087.75$^{b}$ | 2109.61$^{b}$ | 2204.45$^{b}$ | 2392.20$^{a}$ | 39.73 | 0.002 |
| **WG (1-14)** | 158.39$^{b}$ | 171.51$^{a}$ | 180.53$^{a}$ | 183.73$^{a}$ | 3.90 | 0.007 |
| **(15-28)** | 418.10 | 421.15 | 422.19 | 446.10 | 14.67 | 0.539 |
| **(29-42)** | 698.68 | 715.31 | 713.05 | 723.14 | 19.85 | 0.847 |
| **(43-58)** | 719.41$^{c}$ | 757.64$^{bc}$ | 849.53$^{b}$ | 995.83$^{a}$ | 33.33 | 0.001 |
| **(1-58)** | 2039.24$^{b}$ | 2067.94$^{b}$ | 2164.00$^{b}$ | 2350.13$^{a}$ | 38.97 | 0.001 |
| **FI (1-14)** | 313.27 | 308.22 | 308.24 | 320.35 | 4.65 | 0.282 |
| **(15-28)** | 844.83 | 838.82 | 803.00 | 817.20 | 26.54 | 0.672 |
| **(29-42)** | 1440.27 | 1442.23 | 1408.10 | 1404.96 | 34.06 | 0.805 |
| **(43-58)** | 1857.10 | 1844.20 | 1811.86 | 1818.26 | 24.25 | 0.540 |
| **(1-58)** | 4455.47 | 4433.90 | 4330.54 | 4362.76 | 51.49 | 0.338 |
| **FC (1-14)** | 1.98$^{a}$ | 1.79$^{b}$ | 1.67$^{b}$ | 1.74$^{b}$ | 0.05 | 0.014 |
| **(15-28)** | 1.97 | 1.98 | 1.90 | 1.84 | 0.07 | 0.484 |
| **(29-42)** | 2.06 | 2.03 | 1.98 | 1.94 | 0.06 | 0.630 |
| **(43-58)** | 2.60$^{a}$ | 2.45$^{ab}$ | 2.13$^{bc}$ | 1.82$^{c}$ | 0.11 | 0.006 |
| **(1-58)** | 2.19$^{a}$ | 2.14$^{ab}$ | 2.01$^{bc}$ | 1.86$^{c}$ | 0.04 | 0.005 |

a,,b and c means in the same rows for each treatment having different letter(s) are significantly different ($p<0.05$), LW= live weight, WG= weight gain, FI= Feed Intake, FC= Feed conversion, Con.= control, Enz.= enzymes mixture and MOS=mannan oligosaccharides

***Carcass and intestinal parameters:***

Effects of different additives on carcass parameters of Sasso broiler chicks are shown in Table 3. Addition of commercial enzymes, MOS and their mixture had insignificant effects on dressed weight (DW) or dressing percentage (Dress%), thigh weight (ThW), thigh yield%, liver weight (Liv.W), gizzard weight (Giz.W), heart weight (Hrt. W), abdominal fat weight (Ab, Fat) compared to unsupplemented group. Sasso broiler chicks fed control diet supplemented with mixture of (Enz.+ MOS) had significant($P<0.05$) values in breast weight (BW), breast yield % and spleen weight followed by chicks in group three that fed MOS compared to the others.

**Table 3. Effect of different additives on carcass organs weights of Sasso broiler chicks**

| Parameter | Treatments | | | | Statistics | |
|---|---|---|---|---|---|---|
| | Con. | Enz. | MOS | Enz. + MOS | SEM | P-value |
| **LBW, g** | 2070.00 | 2179.33 | 2212.67 | 2339.00 | 91.15 | 0.292 |
| **DW, g** | 1415.47 | 1496.87 | 1549.03 | 1765.80 | 102.07 | 0.171 |
| **Dress. %** | 68.41 | 68.57 | 70.25 | 75.15 | 2.98 | 0.398 |
| **Breast W., g** | 360.07$^{b}$ | 409.59$^{b}$ | 461.92$^{ab}$ | 541.27$^{a}$ | 38.10 | 0.048 |
| **Breast %** | 25.38$^{b}$ | 27.17$^{b}$ | 29.86$^{a}$ | 30.60$^{a}$ | 0.742 | 0.003 |
| **Thigh W., g** | 234.71 | 258.09 | 256.21 | 276.020 | 14.31 | 0.313 |
| **Thigh %** | 16.41 | 17.23 | 16.47 | 16.05 | 0.77 | 0.750 |
| **Liv. g** | 47.28 | 47.69 | 49.45 | 53.90 | 6.48 | 0.881 |
| **Giz., g** | 35.53 | 37.97 | 34.48 | 34.15 | 4.44 | 0.925 |
| **Hrt, g** | 13.26 | 11.31 | 15.98 | 10.71 | 2.29 | 0.414 |
| **Spleen, g** | 4.75$^{b}$ | 4.11$^{ab}$ | 4.71$^{ab}$ | 5.20$^{a}$ | 0.26 | 0.098 |
| **Ab. Fat, g** | 28.45 | 25.91 | 30.33 | 21.76 | 4.28 | 0.552 |

a,b and c means in the same rows for each treatment having different letter(s) are significantly different ($p<0.05$), LBW= live body weight, DW= dressed weight, Dress= dressing, Liv= liver, Giz =gizzard , Hrt=heart, Ab.fat= abdominal fat , Con.= control, Enz.= enzymes mixture and MOS=mannan oligosaccharides

The results in Table 4 showed that feed additives of Enz., MOS and Enz. +MOS as growth promoters for Sasso broiler had not significant differences on gastrointestinal tract lengths (cm) or its percentages i.e. duodenum, jejunum, ileum, colon or cecum in comparison with the control group.

**Table 4 Effect of different additives on intestinal parts lengths of Sasso broiler chicks**

| Parameter | Treatments | | | | Statistics | |
|---|---|---|---|---|---|---|
| | Con. | Enz. | MOS | Enz. + MOS | SEM | P-value |
| Doud., cm | 27.83 | 32.86 | 29.00 | 28.66 | 1.73 | 0.250 |
| Doud. % | 12.85 | 13.94 | 12.68 | 12.50 | 0.97 | 0.733 |
| Jej., cm | 83.86 | 86.43 | 83.06 | 89.66 | 5.63 | 0.839 |
| Jej., % | 38.73 | 36.42 | 36.23 | 38.61 | 1.83 | 0.666 |
| Ileum, cm | 88.33 | 90.40 | 90.40 | 86.73 | 5.64 | 0.958 |
| Ileum % | 40.86 | 38.26 | 38.96 | 37.51 | 1.86 | 0.634 |
| Colon, cm | 7.23 | 7.56 | 8.16 | 8.33 | 0.81 | 0.757 |
| Cecum, cm | 16.33 | 19.33 | 19.83 | 18.00 | 1.36 | 0.333 |

Doud. = duodenum, jej. = jejunum, Con.= control, Enz. = enzymes mixture and MOS=mannan oligo-saccharides

***Mortality, production index and economical return:***

Results in Table 5, enclosed values of mortality rate, production index, total feed costs, total revenue, net revenue, economic efficiency and relative economic efficiency. Sasso broiler chicks fed diet supplemented with Enz.+MOS (group four) and MOS (group three) achieved the lowest mortality %, the highest production index, economic efficiency and relative economic efficiency respectively rather than control (group one) or Enz. (group two).

**Table 5. Effect of different additives on mortality, production index, economic efficiency and relative economic efficiency of Sasso broiler chicks**

| Parameters | Treatments | | | |
|---|---|---|---|---|
| | Con. | Enz. | MOS | MOS+Enz. |
| Mortality% | 10.00 | 6.66 | 3.33 | 3.33 |
| Production index*% | 95.29 | 98.55 | 109.65 | 128.60 |
| FI, kg(starter) | 1.158 | 1.147 | 1.111 | 1.137 |
| Price of starter, EGP | 6.369 | 6.320 | 6.188 | 6.244 |
| FI, kg(grower) | 3.297 | 3.286 | 3.219 | 3.22 |
| Price of grower, EGP | 16.49 | 16.46 | 16.29 | 16.37 |
| Total feed price, EGP# | 22.86 | 22.78 | 22.48 | 22.72 |
| Total revenue** | 54.26 | 54.83 | 57.30 | 62.19 |
| Net revenue | 31.40 | 32.05 | 34.82 | 39.47 |
| EE | 1.37 | 1.41 | 1.55 | 1.74 |
| REE | 100.00 | 102.92 | 113.14 | 127.00 |

*Production index value was calculated throughout the experimental period according to (North, 1981) as follow PI=(body weight, kg/FCR)×100, ** total revenue= LW(kg)× price (26.00 EGP kg LW), one kg frazyme= 100.00 EGP (using one g/kg diet), one kg MOS = 65.00 EGP (using 2.5 g/kg , # prices of feed ingredients, feed additives and live broilers during experiment time

***Digestibility of nutrients:***

The apparent digestibility of nutrients of Sasso broiler chickens fed diet supplemented with enzyme, MOS or their mixture during the whole period of study (1-58 days of age)are shown in Table 6. The obtained data cleared that addition of growth promoter (Frazyme, MOS and Frazyme + MOS) had insignificant effect on digestibility of nutrients such as dry matter (DM), organic matter (OM), ether extract (EE) or nitrogen free extract (NFE) except crude protein (CP) and crud fiber (CF)which were significant. Sasso broiler chicks fed basal diet supplemented with additives had significantly ($P<0.05$) better digestibility values of CP and CF than birds in control group. The highest values of digestibility coefficients of CP and CF were pertained to group four and group two respectively in comparison of the other groups.

**Table 6. Effect of different additives on nutrients digestibility's of Sasso broiler chicks**

| Parameter | Treatments | | | | Statistics | |
|---|---|---|---|---|---|---|
| | Con. | Enz. | MOS | Enz. + MOS | SEM | P-value |
| DM% | 69.42 | 72.38 | 72.63 | 75.94 | 2.63 | 0.433 |
| OM% | 72.65 | 71.75 | 70.83 | 70.50 | 1.69 | 0.804 |
| CP% | 73.87$^{b}$ | 78.15$^{ab}$ | 77.39$^{ab}$ | 80.67$^{a}$ | 1.68 | 0.018 |
| CF% | 24.25$^{b}$ | 37.21$^{a}$ | 36.99$^{a}$ | 32.98$^{a}$ | 2.05 | 0.060 |
| EE% | 74.10 | 78.73 | 73.41 | 78.46 | 1.63 | 0.098 |
| NFE% | 72.31 | 74.08 | 73.81 | 74.99 | 1.68 | 0.732 |

a,b and c means in the same rows for each treatment having different letter(s) are significantly different ($p<0.05$), DM= dry matter, OM= organic matter, CP= crud protein, CF= crude fiber, EE=ether extract , NFE=nitrogen free extract, Con.= control, Enz.= enzymes mixture and MOS=mannan oligosaccharides

***Chemical analysis of meat:***

The chemical composition of breast and thigh meats as affected by feed additives is presented in Table 7. Dry matter, fat, and ash of breast meat not affected significantly with supplements. Breast Crud protein had high significant (P<0.05) differences among treated groups and control group. The greatest (P<0.05) crud protein of breast meat was related to Enz. + MOS group (79.73%) followed by (76.76%) for MOS group compared to Enz. Group or control group. Dry matter, crude protein and fat of thigh meat content had no significant variances with insignificant increase for fat thigh content compared to the supplemented groups. Ash percentage of thigh meat was increased significantly with adding the mixture (group four).

**Table 7. Effect of different additives on chemical composition of Sasso broiler chicks**

| Parameter | Treatments | | | | Statistics | |
|---|---|---|---|---|---|---|
| | Con. | Enz. | MOS | Enz. + MOS | SEM | P-value |
| **Breast meat** | | | | | | |
| **Most. %** | 73.40 | 73.60 | 73.16 | 72.800 | 0.84 | 0.916 |
| **DM%** | 26.60 | 26.40 | 26.50 | 27.20 | 0.85 | 0.908 |
| **CP%** | 73.40[c] | 73.33[c] | 76.76[b] | 79.73[a] | 0.74 | 0.0008 |
| **Fat%** | 4.60 | 4.03 | 4.13 | 3.81 | 0.35 | 0.591 |
| **Ash%** | 3.86 | 4.16 | 4.56 | 5.00 | 0.42 | 0.326 |
| **Thigh meat** | | | | | | |
| **Most. %** | 75.50 | 74.83 | 75.55 | 75.06 | 0.273 | 0.259 |
| **DM%** | 24.50 | 25.16 | 24.44 | 24.93 | 0.273 | 0.259 |
| **CP%** | 64.66 | 64.78 | 65.76 | 67.80 | 1.13 | 0.271 |
| **Fat%** | 6.26[a] | 5.17[ab] | 4.66[b] | 5.53[ab] | 0.398 | 0.104 |
| **Ash%** | 4.43[b] | 5.10[ab] | 5.93[a] | 6.02[a] | 0.288 | 0.013 |

a,,b and c means in the same rows for each treatment having different letter(s) are significantly different (p<0.05), Moist. = moisture DM= dry matter, CP= crud protein, Con.= control, Enz. = enzymes mixture and MOS=mannan oligosaccharides

***Blood parameters:***

The hematological and biochemical blood constituents, digestive enzymes and total antioxidants of Sasso broilers are shown in Table 8. Effect of Enz., MOS or Enz.+ MOS was insignificant on values of total counts of white blood cells and red blood cells, albumin, globulin, albumin: globulin ratio, total lipids, glucose, uric acid, alkaline phosphatase, T3, T4, and protease. Sasso broilers fed basal diet with Enz. Had high significant values of hematocrit (Hct%), lipase and amylase. While, birds fed Enz. + MOS diet significantly (P<0.05) recorded the highest value for hemoglobin (Hb%), total protein (TP), and total antioxidants capacity (TAC), those broilers in the same group had insignificant increase of albumin (Alb.) and protease enzyme values. Broiler chicks fed diet with MOS recorded insignificantly increase of red blood cells count.

**Table 8. Effect of different additives on hematological and biochemical blood parameters and digestive enzymes of Sasso broiler chicks**

| Parameter | Treatments | | | | Statistics | |
|---|---|---|---|---|---|---|
| | Con. | Enz. | MOS | Enz.+ MOS | SEM | P-value |
| **WBC×$10^3$** | 24.16 | 26.73 | 25.73 | 26.17 | 0.75 | 0.1710 |
| **RBC×$10^6$** | 4.03 | 4.53 | 5.73 | 4.50 | 0.74 | 0.189 |
| **Hct%** | 35.70[b] | 42.80[a] | 37.50[b] | 37.93[b] | 1.20 | 0.016 |
| **Hb%** | 11.90[b] | 12.63[b] | 12.50[b] | 14.27[a] | 0.40 | 0.017 |
| **TP(g\dl)** | 4.17[c] | 4.57[bc] | 5.13[ab] | 5.63[a] | 0.28 | 0.024 |
| **Alb. (g\dl)** | 1.34[b] | 1.50[ab] | 1.48[ab] | 1.99[a] | 0.17 | 0.122 |
| **Glob. (g\dl)** | 2.72 | 3.03 | 3.44 | 2.74 | 0.47 | 0.517 |
| **Alb\Glob** | 0.50 | 0.52 | 0.43 | 0.70 | 0.11 | 0.365 |
| **TL(mg\dl)** | 563.87 | 570.48 | 580.41 | 540.93 | 44.46 | 0.741 |
| **Glu(mg\dl)** | 209.70 | 269.30 | 240.00 | 253.40 | 20.50 | 0.281 |
| **UR(mg\dl)** | 3.86 | 4.23 | 4.30 | 4.87 | 0.60 | 0.711 |
| **ALP (U\L)** | 71.66 | 83.33 | 68.04 | 76.70 | 15.96 | 0.9156 |
| **T3 (ng\ml)** | 2.58 | 3.55 | 2.970 | 3.33 | 0.44 | 0.4799 |
| **T4(ng\ml)** | 13.93 | 14.65 | 16.00 | 14.66 | 1.11 | 0.6315 |
| **Lipase (U\L)** | 30.00[b] | 48.77[a] | 36.00[ab] | 39.53[ab] | 4.45 | 0.0391 |
| **Amylase(U\L)** | 52.33[b] | 89.00[a] | 53.34[b] | 53.00[b] | 5.92 | 0.005 |
| **Protease(U\L)** | 51.00 | 67.00 | 61.33 | 70.45 | 8.62 | 0.455 |
| **TAC (Mmol\L)** | 0.96[b] | 1.10[b] | 1.21[b] | 1.72[a] | 0.09 | 0.002 |

a,,b and c means in the same rows for each treatment having different letter(s) are significantly different (p<0.05), WBC= white blood cells , RBC= red blood cells, Hct=hematocrit , Hb= hemoglobin , TP= total protein, Alb =albumin , Glob= globulin, Alb\Glob=albumin; globulin ratio , TL= total lipids, Glu= glucose, UR=uric acid, ALP= alkaline phosphatase, TAC= total anti-oxidant capacity, Con.= control, Enz.= enzymes mixture and MOS=mannan oligo-saccharides.

## DISCUSSION

***Productive performance :***

***Growth measurements:***

In the present study, the performance traits were improved in the treatment groups compared to the control. Higher live body weight and weight gain in broiler of group 3 and group 4 may be due to MOS feeding which increases the beneficial bacteria such as *Bifidobacteria* and *Lactobacilli* in the gut of broiler (Baurhoo *et al*., 2007), Improvement in microbial population in the gut causes improvement in nutrient absorption and decrease in nutrients loss (Sultan *et al*., 2015) , in addition to provide the energy for intestinal epithelial cells via short chain fatty acids production which relate to the health of gut lining (Ferket *et al.*, 2005), or may be due to feeding (Enz. + MOS) caused alteration the chicken intestine PH in addition to increase digestive enzymes like protease, amylase, and lipase which enhance nutrient digestion, absorption and utilization of essential minerals and amino acids in the gastrointestinal tract by providing a larger surface area for efficient nutrients absorption (Xu *et al*.,2003; Yang *et al.,* 2009: Santoso *et al*., 2001; Karimi *et al*., 2010 and Ghazalah *et al*., 2011). The present study concluded that significant enhancement of FCR values for all treated groups (Enz., MOS or Enz. + MOS) compared to control group, this result is in agreement with the findings of Dizaji *et al*. (2013), Fernandes *et al*. (2014) and Akoy (2015). Also, Luo *et al*. (2009), Plessis, (2014) and Alqhtani *et al*. (2022) indicated that FCR improved by enzymatic supplementations alone or with other feed additives supplementation compared to control group (at 21-day, 35 day and at 42 day of age). The high enhancement in FCR for feed additives groups (MOS or MOS+ Enz.) may be attributed to stimulated growth of the beneficial microflora in the gastrointestinal tract (GIT) induced by dietary supplementation of MOS or MOS+ Enzyme (Cinar *et al*., 2009), or could be attributed to the growth promoting ability via the prevention and treatment of subclinical infections (Ao *et al*., 2011a, 2011b and Toghyani *et al*., 2011). The current results in disagreement with Salehimanesh *et al*. (2016) who suggested that, the dietary supplementation of MOS and B-glucan did not affect body weight and gain of broiler and (Mahmoud *et al*., 2020) who indicated that the addition of MOS with B-glucan had no significant effect on duck body weight and gain. Also, Kamel and Mohamed (2016) and Garipoglu *et al*. (2006) showed that the lowest value of final body weight and weight gain at six weeks of age found for checks fed basal diet with enzyme supplementation compared to control or other feed additives. Likewise, Rabie and Abo El-Maaty (2015) clarified that final live BW and BW gain of growing Japanese quails fed diet supplemented with Bio-Feed® Pro enzyme were significantly depressed. The obtained results showed that no significant differences in feed intake among all groups. In contrast, Abd-El Hamed *et al*., (2017) found thatthe highest total feed intake value was found for group treated with enzyme, while the lowest value was found for group treated with MOS. Also, Tufail *et al*. (2019) found significantly higher feed intake was recorded for group MOS-100g\kg feed during week 4th and 5th compared to control or other level of MOS.

***Carcass and intestinal parameters:***

In connection with carcass characteristics and gastrointestinal tract lengths, there were insignificant effects of different feed additives on dressed, liver, gizzard, heart and abdominal fat or lengths of intestinal tract (duodenum, jejunum, ileum, colon and cecum) in Tables 3 and 4, respectively. The present results in conformity with Algedawy *et al*. (2011) who concluded that weights of the gizzard, heart and liver showed no significant ($p < 0.05$) differences between the feed additive (Natuzyme or Biogen) supplemented groups and the control group. However, as current study, relative weight of the spleen was significantly greater ($p<0.05$) inBiogen® supplemented birds than in Natuzyme® supplemented birds and the control group. Enhancement in spleen group 4 (Enz+ MOS) may be indicating higher immune competence for these feed additives for broilers. Also, Abdel-Fattah and Fararh, (2009) demonstrated a slight improvement in dressing percentage in birds fed diets supplemented with MOS compared to control birds in the line of current study. Similarly, there was no significant difference in the relative weights of carcass organs for broiler chicks fed on *Lactobacillus spp* (Awad *et al*., 2009 and Zamanzad-Ghavidel *et al*., 2011), or those fed *on Saccharomyces cerevisiae* (Celik *et al*., 2007), compared to the control group. Likely,Abdel-Hafeez *et al*. (2017) and Rehman *et al*. (2020) reported that, prebiotic appeared to have insignificant influence on all carcass parameters of broilers. Sojoudi *et al*. (2012) demonstrated that broiler fed prebiotic at different levels showed no significant difference between treatments in inner organs weights except spleen weight, it has been significantly increased. However, the relative weight of liver and gizzard have been significantly increased by feeding prebiotic (Abdel-Hafeez *et al*. 2017). Biswas *et al*. (2021) included that better ($p < 0.05$) thigh and breast weights (% of live weight) were recorded in (0.2% MOS) group followed by (0.1% MOS) group as compared to control. Similar result has been recorded by Toghyani *et al.* (2011).

In this study, the improvement in breast weight or percentage for group 4 may be attributed to that prebiotic has a positive effect on muscle weight including improvement of calcium, phosphorus and magnesium absorption (Cummings and Macfarlane, 2002). The present findings of intestinal parts size are in contradiction with the findings of Asif, *et al*. (2022) who showed that MOS had significantly (P<0.05) affected the length of intestinal sections; duodenum, jejunum and ilium. Similar results were found by Padihari *et al*. (2014) and Castillo *et al*. (2008) they observed that addition of MOS to basal diet at a level of 0.5g/kg significantly increased the duodenum length and no effect on jejunum length as compared control group (Dimitroglou *et al*., 2010; Padihari *et al*., 2014 and Chand *et al*., 2019).

***Mortality, production index and economical return:***

The current findings about mortality, production index, economic efficiency and relative economic (Table 5) concluded that the best economical measurements were of the share of group four followed by group three then group two compared to un-supplemented control group. This improvement could be due to improving BW and FCR. These results are similar to those reported by Jahan *et al*. (2006), Attia *et al*. (2014b), Mostafa *et al*. (2015) and El- Kelawy *et al*. (2017) who indicated that production index and economic efficiency increased with supplementing multienzyme and or other additives (as Bio-Mos) to the diets compared with control diets. Unlike, Kamel and Mohamed (2016) found that the lowest value of total revenue was found for the enzyme group compared to other groups.

***Digestibility of nutrients:***

Effect of different feed additives on digestibility coefficients of DM, OM, CP, CF, EE and NFE are presented in Table 7. The improvement in CP digestibility for group 4 in the current study may be mediated to improvement in blood serum TP and protease activity values (Table 8). The digestibility of basal diet is limited to about 70- 80% for broilers, which is mainly owing to the existence of insoluble non-starch polysaccharides (NSPs) in cell walls of corn and SBM (Ward, 2021), causing inhibition of nutrient digestion specialty crude fiber, these substances affect the growth performance of broiler chickens and are indigestible in poultry due to the absence of adequate endogenous activity of enzymes (Shang *et al*., 2018). Therefore, from the current results, it has been concluded that supplementing exogenous enzymes targeting these indigestible compounds to improving the digestive enzymes to the cell-wall-encapsulated nutrients and better coefficient digestibility of starch (as CF%) in group 2. El-Kelawy *et al*. (2017) showed that *chicks* treated with enzymes addition followed by chicks treated with (enzyme + probiotic) had significantly greater digestibility of crude fiber than untreated chicks (control). Many previous studies investigated that adding different types of commercial enzyme preparations with or without (prebiotic or probiotic) to broiler diets to achieve a positive impact on the digestibility of CP and crude fiber compared to those fed the control diets (Sherif, 2009a; Sherif, 2009b; Wang *et al.,* 2005 and Amerah *et al*.,2017). While, exogenous enzyme supplementation had no significant effect on values of digestibility coefficient of EE, CF, CP, and NFE (Shalash *et al*., 2009 and Sharifi *et al*. (2012)).

***Chemical analysis of meat:***

Concerning to chemical composition of meat, the previous data showed significant increase and decrease of protein and fat of breast and thigh meats respectively for additive groups compared to control group. Semi-similarly, Ibrahim *et al*. (2021) reported that a significant reduction (P<0.05) in fat content of broiler breast and thigh meat of the prebiotics and other feed additives treated groups compared to untreated group (Ooi and Liong , 2010 : Weitkunat *et al*., 2015; Ilham *et al*., 2019; Okrathok and Khempaka ,2020; and Biswas *et al*., 2021).While, there was a significant increase (P<0.05) in protein content of broiler breast meat of treated groups which has been reported by (Ibrahim *et al*., 2021). The reduction in breast or thigh meat fat content may be related to the absorption process of bile acids and cholesterol from digestive tracts depending on level of soluble fiber in the ration of MOS (Ilham *et al*., 2019).

***Blood parameters:***

Results obtained (Table 8) revealed that significant differences in Hct, TP, Alb., Hb, lipase, amylase and TAC values between supplemental groups and control. In the line of our study, Ismail *et al*. (2011) revealed that Hubbard broiler chicks fed either feed additives or Natuzyme® supplemented diets achieved significantly higher total protein and albumin levels which may be attributed to the favorable environment in the intestinal tract created by the feeding of these additives, in addition it might have helped to digest and absorb more nitrogen (Mohan *et al*., 1995 and Panda *et al*., 2006). Hemoglobin values increased in treated groups (four and three) than control group, this result may be due to addition of these additives might have stimulated iron absorption and activity of the hematopoietic organs and causes erythropoiesis, also high environmental temperature may have influenced the hematological parameters (Hasan *et al*., 2015).

Value of RBCs ranged from (4.03 x 106 /µl) to (5.73 x106 /µl) for all groups. There were no significant differences among treatments with simple increase to MOS group. This result semi-agreed with Sosan *et al*. (2010) they concluded that there was a significant increase in erythrocyte count due to prebiotic supplementation, while disagreed with Abeer and Soltan (2015) who found that value of RBCs decreased by prebiotic supplementation. Also, Chuka (2014) concluded that value of RBCs was lower in enzyme group compared with the control, while disagree with Rahman *et al*. (2013) they reported that value of RBCs increased by enzyme supplementation. The benefit effects of enzymes supplementation preparation that have additional benefit effects with MOS supplementation, these benefits when applied to diet, in addition to the protease component of the enzyme's combination may have a positive effect on trypsin inhibitor (Cowieson and Ravindran, 2008) and causes a greater activity of digestive protease in blood serum. The significant increase in TAC values for supplemented groups in comparison to control may be related to that supplementation. Improved quality and number of useful gut microfloramay have caused release of some bioactive substances that could potentially prevent oxidative damage with an increase in the activity of antioxidant response system (Tan *et al*., 2010). On the other hand, Sohail *et al*. (2011) demonstrated that Supplementation of the MOS with or without probiotic to heat stressed broiler chicks caused a decrease in ($P<0.05$) total antioxidant activity and concentrations compared to control.

## CONCLUSION

The results of the this study supported the notion that the mixture of (frazyme + mannanoligosahharides) could have more potential value than the commercial enzyme (Frazyme®) or mannanoligosaccharide (Y- MOS) alone as an alternative dietary additive to improve productive performance of broilers. Therefore, it had positive effect on total return, net return, survival, and relative economic efficiency.

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## تأثير إضافة الإنزيمات التجارية مع أو بدون سكريات المنان أوليجو على الدلالات الإنتاجية، الغذائية والتمثيلية لبدارى التسمين

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أجريت هذه التجربة لاستخدام بعض الاضافات الغذائية كمنشطات للنمو لكتاكيت الساسو وتقييم تأثيرها على الأداء الإنتاجى، معاملات هضم العناصر الغذائية، استجابات الدم وكذلك بعض مقاييس الذبيحة والقناة الهضمية والعائد الاقتصادى، تم استخدام ١٢٠ كتكوت ساسو غير مجنس عمر يوم بمتوسط وزن (40.65±0.65جم) تم توزيعها عشوائيا وتقسيمهم لأربع مجموعات (كل مجموعة ٣٠ كتكوت١٠/ كتاكيت فى كل مكررة× ٣ مكررات). المجموعة الاولى تم اعتبارها مجموعة (المقارنة الكنترول). المجموعات الثانية والثالثة والرابعة تم اعطائها عليقة الكنترول المضاف اليها: ١ جم من خليط الانزيمات التجارية (فرازيم١/ كجم عليقة، ٢,٥ جم من سكر المنان) موس/كجم عليقة ٠,١جم من فرازيم مع ٢,٥ جم من الموس/كجم عليقة على التوالى. تمت التربية لمدة ٥٨ يوم وتم أخذ القياسات الخاصة بالتجربة. أوضحت النتائج المتحصل عليها:

١. من حيث الأداء الإنتاجى :أعطت المجموعة الرابعة (نزيمات+ موس) أفضل قيم معنوية من وزن الجسم الحي، الزيادة فى الوزن، ومعامل التحويل الغذائي بينما لم توجد اى اختلافات معنوية فى معدل استهلاك العليقة مقارنة بباقى المجموعات.
٢. سجلت معاملات هضم البروتين الخام والالياف الخام اعلى قيم معنوية لكل من المجموعة الرابعة والثانية على التوالى.
٣. من حيث مواصفات الذبيحة :تبين أن أكبر محصول لأوزان الصدر والطحال كان من نصيب المجموعة الرابعة، بينما لم تظهر اختلافات معنوية لأوزان كل من الفخذ، الكبد، القونصة، القلب، دهون البطن او نسبة التصافى بين المجموعات الاربعة.
٤. قياسات أطوال أجزاء القناة الهضمية :لم تظهر الاضافات الغذائية المختلفة للعليقة الكنترول اى فروق معنوية بين جميع المجموعات.
٥. قياسات الدم :سجلت المجموعة الثانية (مجموعة الانزيمات) زيادة معنوية فى كل من قيم الهيماتوكريت، وانزيمات الليبيز والاميليز الهاضمة . بينما سجلت المجوعة الرابعة (الخليط) زيادة معنوية فى قيم البروتين الكلى، الالبيومين، الهيموجلوبين وكذلك نشاط مضادات الاكسدة الكلية.
٦. التركيب الكيميائي للحم :اعلى محتوى معنوى للبروتين فى لحم الصدر تم تسجيله للمجموعة الرابعة .بينما أعلى محتوى للدهن فى لحم الفخذ سجل لمجموعة الكنترول، وسجلت قيمة الرماد فى لحم الفخذ أيضاً زيادة معنوية لطيور المجموعة الرابعة.
٧. أفضل قيم لمقاييس الكفاءة الاقتصادية تم تسجيلها للمجموعة الرابعة، يليها المجموعة الثالثة ثم المجموعة الثانية وذلك مقارنة بمجموعة الكنترول.

من خلال النتائج السابقة يمكن القول أن: هذه الدراسة توصى بإستخدام كل من الإضافات السابقة كمنشطات للنمو دون أى تأثير سلبي على بدارى التسمين حيث اثبتت الدراسة أن إستخدام (خليط الإنزيمات التجارية مع الموس) أفضل تأثيراً على الأداء الإنتاجى، والكفاءة الإقتصادية من إستخدام كل مادة على حدة لبدارى تسمين الدجاج الساسو.