

## Egg Production and Quality in Zinc Propionate-molted Hens with Reference to Certain Blood and Tissue Chemical Parameters

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**Abstract:** The study aimed to evaluate the effects of 1 % zinc propionate as a molting agent on egg production and quality, certain biochemical blood parameters, hepatic and renal residues of zinc in laying hens. Sixty laying hens of 64 weeks old were divided into two equal groups; control non molted group, that fed a layer ration without additives and molted group, that fed a layer ration with 1% zinc propionate for 9 days to induce molting. Egg production was monitored for hens of both groups 8 weeks premolt and postmolt. Blood samples were collected at 3,5,7 and 9 days of molting period. Tissue samples of liver and kidneys were taken at the end of molting period for determination of zinc residues. Results revealed that egg production or egg quality during postmolt period did not affected significantly. Activities of serum Alkaline phosphatase (ALP), Lactic dehydrogenase (LDH) and glutamic oxalacetic transferase (SGOT) were significantly increased, while that of serum glutamic pyruvic transferase (SGPT) was significantly decreased at days 3 and 5 of molting process. Blood levels of glucose and cholesterol were significantly elevated, while that of albumin was significantly decreased at the same time intervals. Serum total protein level was maintained unchanged allover the molting time. Zinc residues in liver and kidney tissues were significantly elevated in molted hens. In conclusion, molting induction by using a high level of zinc propionate (1%) was associated with a higher liver and kidney residues of zinc. There were a higher levels of certain blood metabolites that could be act as a metabolic pools avoiding body weight loss and ovarian regression usually accompanying different molting procedures. Maintenance of egg production level and quality during postmolt period considered also a practical benefits.

**Key words:** Egg Production and Quality • Molting • Zinc Propionate • Zinc Residues

### INTRODUCTION

Molting in layers means shedding and replacement of feathers [1]. Different methods of induced molting have been used in laying hens. It was found that to maintain a higher level of egg production during post molt period, the weight loss might be ranged between 25-35% [2]. The feed withdrawal technique is the most commonly used in laying hens as it is simple and practicable that can be used together with light and/or water restriction [3,4].

The increasing public awareness of the animal stress associated with feed withdrawal has led researchers to investigate alternative molting processes. Mineral induced molting programs were also adopted. The use of higher levels of either aluminium salt [5] or dietary zinc [6] have been successfully practiced. However, supplementing low levels of dietary zinc combined with

reduced calcium levels in the diet have induced molting successfully in laying hens [7]. Also, the use of low sodium diet was found to be an effective procedure for molt induction [8].

It was observed that molt induction by feeding hens a diet containing high levels of zinc oxide or zinc acetate resulted in stoppage of egg production within 5 days [9] and was associated by an earlier stoppage of ovulation than fasting do [10]. In several studies, it has been also reported that the effectiveness of zinc to induce follicular atresia and paused egg laying is probably due to the cation's ability to depress feed intake [11].

Propionic acid has been used as a feed fungistat, but high concentrations may reduce chicks feed intake by decreasing palatability [12,13]. Previously reported methods of dietary zinc for induction of molt were restricted to zinc acetate and oxide. Hence, the aim of the

present study was to investigate the effects of zinc propionate, a recent molting salt form of zinc, on egg production and quality, certain biochemical blood parameters, hepatic and renal residues of zinc in laying hens.

## MATERIAL AND METHODS

Sixty, Hi-Sex hens of 64 weeks old, were used. The birds were active, housed in caged laying metal batteries and provided access *ad libitum* to a complete layer ration (Table 1) and water via nipple drinkers for 8 weeks prior to molting. During the 8 weeks acclimation period, egg production was monitored to insure that all hens were healthy and in active production. Birds were maintained under an artificial lighting program of 16 L:8 D.

**Molting Procedure:** After acclimation, hens were divided into 2 equal groups as follow: (A) Control-non molted group (30 birds), where the hens fed on layer ration without additives. (B) Molted group (30 birds), where the hens fed on layer ration to which 1% zinc propionate was added. All hens provided their respective diets and water *ad libitum*. Hens were placed on an artificial lighting program of 8L:16 D for one week prior to molting procedure. At the end of molting trial (day 9), respective diet immediately replaced by complete layer ration and subjected to an artificial program of 16L:8D to stimulate egg production. Daily egg production was monitored for 8 weeks (postmolt). Molting diet was replaced by a control layer ration in both groups.

**Blood Samples and Analysis:** At days 3,5,7 and 9 of molting, blood samples were collected from all birds via wing veins, allowed to clot at room temperature, centrifuged at 3000 r.p.m / 20 min. Sera were collected and stored at -20°C for analysis. The biochemical serum analysis were quantitated using a commercial available kits; Alkaline Phosphatase (ALP), Alanine aminotransferase (ALT), Aspartate aminotransferase (AST), Lactate dehydrogenase (LDH), Total protein (TP), Albumin (Alb), Glucose (Glu) and Total Cholesterol (T.Chol.).

**Zinc Residues of Liver and Kidney Tissues:** At the end of molting period (9 days), 10 birds from each group were slaughtered, samples of liver and kidney were taken and stored frozen until zinc determination. Approximately, 0.2 gm (frozen) of each liver or kidney samples was dried at 75°C for 3 days and subsequently predigested in nitric

Table 1: Percentage composition of layer ration

INGREDIENTS	PERCENTAGE (%)
Maize	44.5
Palm kernel cake	9.0
Corn bran	8.0
Wheat bran	10.5
Ground nut cake	7.0
Soya bean meal	9.5
Fishmeal	2.0
Bone meal	3.0
Oyster	5.7
Salt	0.25
Layer premix	0.25
Methionine	0.15
Lysine	0.15

acid for 3 days. The predigested sample was further digested for 2 hours at 100°C using an oven [14]. Atomic absorption spectrophotometry (4000 Atomic absorption, Perkin-Elmer, Norwalk, CT) was used to determine zinc concentrations in the liver or kidney tissue samples.

**Egg Production and Quality Parameters:** Egg production and quality were monitored and compared after molting. Egg weight, egg circumference, egg length and width, albumin height and shell thickness were measured [9]. Daily egg production was monitored 8 weeks before molting and 8 weeks after molting.

**Statistical Analysis:** Data were analyzed using (T) test and "ANOVA" to analyze the differences among groups using general linear model procedure (SAS). Level of significance used in all results was ( $p < 0.05$ ).

## RESULTS

**Egg Production and Quality:** Daily egg production % in non molted control and molted group on a weekly basis during pre and post molt is shown in figure (1). A significant increase in egg production was recorded in non molted group at the first and second weeks after molting period ( $P < 0.05$ ). However, no significant changes were recorded among molted and non molted groups from 3-8 weeks after the molting period. The egg production in zinc propionate-fed hens and control one from 3-8 weeks post molt (Figure 2) was 70.31 and 71.04%, respectively. The molted group reached more than 50% egg production from 3<sup>rd</sup> week to the end of the trail. In zinc propionate-fed group, 0% egg production was shown in the first week post molt (Figure 1). At the second week post molt,

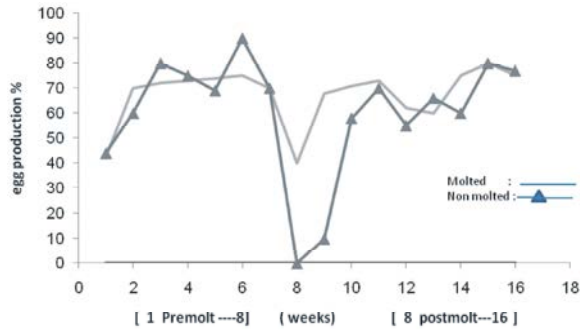


Fig. 1: Daily egg production % of molted and non-molted hens on weekly basis during premolt and postmolt.

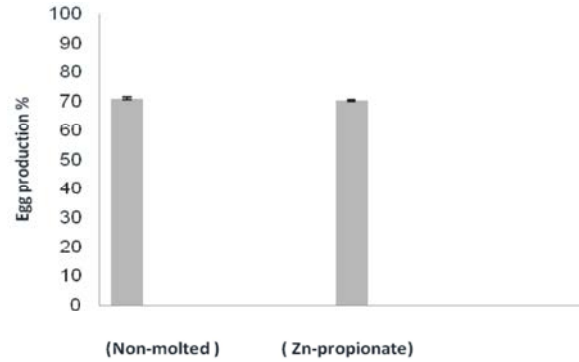


Fig. 2: Egg production % post molting by Zn-propionate (3-8 weeks post molt)

Table 2: Effect of molting and non-molting diet on egg quality parameters of layer during postmolt period

Groups	Parameters				
	Albumin height (mm)	Weight (g)	Width (cm)	Length (cm)	Circumference (cm)
Non-molted (Control)	7.57±0.62	69.77±1.04	5.92±0.16	5.90±0.12	15.50±0.09
Molted	6.90±0.32	70.14±0.88	5.75±0.18	6.10±0.13	16.43±0.05

-Values are means±SE., level of significance at  $p < 0.05$ , Number of birds: 30 / group.

Table 3: Serum biochemical parameters of non-molted and Zn-propionate-induced molted layers during molting period (9 days)

Parameters	Molted hens					LSD
	Non-molted (Control)	3 <sup>rd</sup> day	5 <sup>th</sup> day	7 <sup>th</sup> day	9 <sup>th</sup> day	
ALP-IU/L	308.00±48	535.00±42	406.00±40	348.00±35	311.00±32	15.00
LDH-IU/L	311.00±25	522.00±24	388.00±28	322.00±24	312.00±20	18.50
ALT-IU/L	6.90±0.4	5.60±0.3	4.89±0.3	5.80±0.4	6.11±0.5	0.95
AST-IU/L	112.00±4.0	155.00±4.0	143.00±0.4	138.00±0.4	136.00±0.3	4.80
Glucose-mg/dl	212.00±2.5	244.00±3.0	227.00±2.90	239.00±3.0	231.00±2.90	2.80
Cholesterol-mg/dl	111.00±9.0	180.00±8.0	166.00±11.0	126.00±9.50	134.00±8.5	5.00
T.proteins-g/dl	4.70±0.12	5.18±0.15	5.96±0.17	4.77±0.18	4.82±0.15	1.01
Albumin-g/dl	2.55±0.0	2.05±0.01	2.01±0.01	2.40±0.02	2.80±0.01	0.18

-Values are means±SE., level of significance at  $p < 0.05$ , Number of birds: 30 / group.

-(ALP): Alkaline Phosphatase, (LDH):Lactic dehydrogenase,(ALT): Alanine aminotransferase, (AST): Aspartate aminotransferase.

all molted hens initiated egg production. The egg production by hens fed zinc propionate 1 % was stopped by the fourth day of molting procedure. Regarding egg quality, no significant differences ( $P < 0.05$ ) were recorded among molted and non molted control hens in albumin height, egg weight, width, length and circumference during post molt period (Table 2).

**Biochemical Parameters:** Table (3) showed that ALP,LDH,and AST activities were significantly increased during third and fifth days of molting period as compared with control. However, the activities of ALT was

significantly decreased. Serum levels of glucose and cholesterol were significantly elevated while albumin concentration was significantly decreased in molted hens during the same molting time intervals by the days 7 and 9 of the molting period, compared with control. Level of total proteins did not change all over the molting period.

**Zinc Residues in Kidney and Liver Tissues:** Table (4) showed that hens fed 1% zinc propionate had a higher zn residues in kidney (402.04±42.00 ppm) and liver tissues (296.20±15.26) as compared with control group (88.20±12.60 and 112.80±19.10 ppm), respectively.

Table 4: Effect of Zn-propionate induced molting on Zn residues of kidney and liver in laying hens

Groups	Organs	
	Kidney (ppm)	Liver (ppm)
Non-molted / Control	88.20 ± 12.60 <sup>a</sup>	112.80 ± 19.10 <sup>a</sup>
Molted / Zn-propionate	402.04 ± 42.00 <sup>b</sup>	296.20 ± 15.26 <sup>b</sup>

-Means within a column with different superscripts are significantly different at  $p < 0.05$ , Number of birds: 10 / group.

## DICUSSION

**Egg Production and Quality:** In the present study, the control hens had a higher level of egg production than molted hens. However, there were no differences in egg production among molted and non molted control hens from the week 3 to the end of 8 week after the molting period (Fig.2). Egg production in molted and control hens from week 3 to the end of 8 weeks after molting was 70.31% and 71.04 %, respectivel. This finding may be due to the age of the layers which is an important molting inducing factor [10]. Additionally, it was reported that hens molted by salts supplementation exposed to less stressful conditions and reduce less weight therefore, resulting in satisfactory level of egg production [9].

However, data analysis showed that molted hens had 0% egg production in the 1<sup>st</sup> week postmolt and initiated egg production from the 2<sup>nd</sup> week postmolt. Such findings are in line with Johnson and Brake [15] who found that 1% zn as oxide or acetate resulted in reduction of egg production from 60% to 0% within 6 days. The results may suggest that zinc has a direct effect on reproductive organs distinct from that of fasting and a combination effect of the suppression of feed intake resulting in regressive organs and direct suppressive effect on the reproductive organs independent of anorexia [16].

The measured egg quality parameters were not significantly different among molted and nonmolted hens. Generally, North and Bell [17] were reported that egg size is larger during the second cycle than the first. Also, The shell quality and interior egg quality are better during the first cycle than the second one. Medvedev *et al.* [18] found that egg size was increased significantly after molting induction with a higher percentages of graded large. Shell weight of eggs was also improved after molting [19].

**Serum Biochemical Parameters:** Serum ALP was significantly elevated in molted hens during early time of molting. Evidence was reviewed by Salem *et al.* [20] that

hens often show daily fluctuations in ALP due to great individual variations. Other source of ALP variation include differences in time of ovulation or oviposition among hens [1]. However, Brake *et al.* [21] attributed the elevated activity of ALP in molted hens to the accelerated thyroid activity observed during feather regeneration. Salem *et al.* [20] found that plasma ALP activity has been noted to increased after thyroxine injection. In addition, osteoclastic, osteoblastic and intestinal sources of ALP have been suggested in laying hens.

Webster [22] was reported that LDH arises from somatic tissues, mainly the liver and cardiac muscles in chickens. The early increased LDH activity found in molted hens may indicate that the level of glycolysis was greater in certain tissues that associated with molting and metabolic rate.

Serum ALT activity was decreased, while AST activity was elevated in early molted hens. The liver is one source of these serum enzymes, the elevated AST activity may reflects an elevated rate of gluconeogenesis that run parallel to the higher glucose level noted in molted hens. Elevated glucose level has been previously reported in molting hens [1]. Many authors attributed the increased transaminase activity to the corticosteroid stimulation in the liver, so it seems that higher ALT activity may be associated with higher adrenal corticosterone output, whereas lower adrenal output may be associated with lower ALT but higher AST activity [23]. In addition, authors reported that during early molting gluconeogenesis in the liver may increase circulating glucose for use in lipid synthesis, proliferation of feather follicle cells and for fueling increased metabolic rate [22]. A clear temporal relationship between plasma corticosteroid peak and the glucose peaks was recorded in molted hens [23]. In the current study the early elevated glucose level may be lagged behind the corticosterone peaks.

Cholesterol is a precursor of steroid hormones and is used in yolk formation. Dietary levels of cholesterol, age, liver synthesis, and steroid hormones influence cholesterol level [22]. The lower level in control non molted hens compared to the early molted is probably attributed to cholesterol utilization in yolk formation and an increased steroid hormones synthesis by the control hens.

In spite of the results reported [1], total protein was not depressed in the molted hens and no significant differences was recorded in its levels among molted and non molted control hens. Obtained results could be attributed to the different methods used in molt induction.

They were used water deprivation in molting induction with the subsequent shrinkage of plasma volume and increased hematocrite value. In addition, the depressed albumin in early molted hens, in comparison to the control, may be attributed to the lack of egg production [24]. Also, it is possible that the albumin depression in molted hens was associated with feather keratin synthesis.

**Zinc Residues in Kidney and Liver Tissues:** Data analysis revealed a significant increase in zinc residues in the kidney and liver tissues in molted hens in comparison with control. The results agree with that of Park *et al.* [11] who found that feeding layers with 1 or 2% zinc as oxide resulted in 4-folds and 10-folds increase in the residues of zinc in the kidney and liver, respectively. They attributed such results to the reduction of feed intake. Other researchers suggested that kidney, liver and pancreas tissues have a buffering action with respect to the zinc released during the reduction of lean body mass, thus preventing excessive losses of zinc [16].

### CONCLUSION

In conclusion, induction of molting in layers by 1 % zinc propionate did not change egg production, either quantity or quality, maintained a higher level of some metabolites as glucose, cholesterol and total proteins, acting as metabolic pools helping to reduce body weight loss and ovarian regression that usually associated with molting process and supporting new regeneration of feather follicles. Also, higher zinc retention was associated with better performance. So, zinc propionate 1% as an alternative molting agent is a comparable tool for induction of molting in layers.

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