

## Effects of Glucose Supplementation of Drinking Water on the Performance of Fasting Newly Hatched Chicks

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**Abstract:** The effects of Delaying access to Feed and water (DF) after hatch and glucose supplementation of drinking water on the performance of broiler chickens were investigated in 2 trials. DF for up to 48 h immediately after hatch depressed performance, weight of bursa of fabricius and heart and small intestine length and thickness. However, the DF period did not influence mortality percentage, feed efficiency, composition of eviscerated carcass and body weight percentage of small intestine, heart and lymphoid organs of chickens at 33 days of age when compared with birds fed immediately after hatch. Access to feed and water after hatch increased body weight gain, feed intake and eviscerated carcass weight over the 33 days experimental period. The addition of glucose for up to 10% to drinking water of DF birds in the 1st 72 h did not influence the performance and eviscerated carcass of DF birds.

**Key words:** Hatch chicks, feed deprivation, glucose, performance, intestine, lymphoid organs, carcass

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### INTRODUCTION

The period from hatching of chicks to the initiation of feeding can have critical impacts on its subsequent short and long term performance. Access to feed immediately after hatch is beneficial to initiate the growth of chickens. The delay in feeding of hatchling reduced body weight gain (Vieira and Jr. Moran, 1999; Noy and Sklan, 1999; Noy *et al.*, 2001; Juul-Madsen *et al.*, 2004), weight of crop, proventriculus, small and large intestines, liver and pancreas (Baranyiova, 1972; Moran, 1985; Sell *et al.*, 1991; Murakami *et al.*, 1992; Uni *et al.*, 1998; Noy and Sklan, 1999; Corless and Sell, 1999; Sklan and Noy, 2000), satellite cell activity and DNA synthesis in muscular tissue and breast yield of broilers (Noy and Sklan, 1999; Halevy *et al.*, 2000) and altered immune system (Dibner *et al.*, 1998; Juul-Madsen *et al.*, 2004).

The newly hatched chicks are lacking of glycogen during the post-hatching period and the only way to increase glycogen concentrations is feeding (Rosebrough *et al.*, 1979). During this period, the hatching chicks make the transition from egg nutrients to exogenous feed. Lilburn (1998) suggested that providing some form of oral carbohydrate may have a significant glycogenic effect.

The beneficial effects of post-hatch intubation of different nutrients were investigated by different researchers (Noy and Pinchasov, 1993; Vieira and Jr. Moran, 1999; Bhanja *et al.*, 2010). The need for feeding

supplements for the newly hatched chicks encouraged companies such as Novus International and Dawe's Laboratories to produce such products (Oasis, a hydrated nutrient compound (OASIS™, Novus, St. Louis, MO, USA) and GroGel™ Plus, a gel nutrient packed supplement (Dawe's Laboratories, Milford, KS, USA), respectively. The available products are carbohydrates based. Noy and Sklan (1999) reported that broiler chicks and poults subjected to early post-hatch feed deprivation for 34 and 48 h, respectively after arrival at research facilities had a significant reduction in body weight and breast yield compared to birds given either immediate access to feed and water or Oasis.

However, the idea of providing feed to the newly hatched chicks at the hatchery is not very well received by poultry producers. Producers feel that feeding chicks during the period from hatching to placement of chickens is not essential because the bird can survive on its residual yolk (Esteban *et al.*, 1991).

This study was designed to investigate the effects of Delaying access to Feed and water (DF) for up to 48 h and adding glucose to drinking water in the 1st 72 h on the performance, Small Intestine (SI), lymphoid organs and carcass characteristics of DF broiler chickens.

### MATERIALS AND METHODS

A total of 700 freshly laid eggs with an average weight of 62.0 g produced by a meat-type breeder flock

(Ross, Al-Wady Company, Al-Riyadh, Saudi Arabia) at 34th week of age were used. Eggs were set in a Maino, force-draft incubator (Model II, Maino Enrico, Co., Rome, Italy) and incubated at 99.5°F (37.5°C) and 55% relative humidity. Eggs were transferred to hatching trays on day 19 of incubation. The hatching compartment was set at 98.6°F (37°C) and 65% relative humidity until the end of day 21 of incubation.

Chickens hatched from 480-492 h of incubation (with in a period of 12 h ) were removed and hatching weight was recorded to the nearest 0.1 g. The effects of time of initiation of feeding (Early access to Feed and water (EF) and DF for 24 and 48 h) on Body Weight (BW) and weight of lymphoid organ (Bursa of Fabricius (BOF)), liver and heart and measurements (weight, length, thickness (weight/length) of SI segments (duodenum, jejunum, ileum) of broiler chickens were studied in trial 1. A total of 30 male chickens were selected, individually weighed, tagged with a wing band and randomly distributed into 5 groups of 6 birds each. At the beginning of the experiment (0 h), one group of chickens was randomly selected as a control then killed by cervical dislocation and their organs and SI were harvested to establish the baseline levels of these measurements.

The intestinal segments of duodenum (from the pylorus to distal point of entry of bile duct), jejunum (from entry of the bile ducts to Meckel's diverticulum) and the ileum (from Meckel's diverticulum to the ileocecal junction) were removed and then gently flushed with saline solution to remove intestinal contents. Weight and length of each segment were recorded. The liver, heart and BOF were separated and weighed. Each of the remaining 4 groups of chickens was randomly selected and subjected to one of the 4 treatments used in the experiment. The treatments were EF and DF for 24 or 48 h (EF24, EF48, DF24 or DF48) at which time chickens were weighed then killed and their organs harvested as in the control group.

The effects of adding glucose to drinking water in the 1st 72 h of DF48 birds on the performance (Body Weight Gain (BWG), feed intake and Feed Conversion Ratio (FCR)), mortality percentage, weight of lymphoid organs (thymus and BOF) and liver and heart and SI measurements and carcass composition at 33 days of age were investigated in trial 2.

Also, chicken weight during the 48 h DF period were recorded at 24 and 48 h. A total of 270 birds were selected, weighed and randomly distributed into 5 treatments with 9 replicates of 6 birds each and housed in electrically heated battery brooders. Each replicate had an equal number of both sexes. The treatments were EF (non-supplemented tap water) and 4 treatments for DF48

birds in which tap water supplemented with glucose in the 1st 72 h after starvation. The levels of glucose in drinking water were 0, 2.5, 5 and 10% (DFG0-DFG3, respectively). Glucose supplemented solutions were prepared daily and made available *ad libitum* in 1.3 L plastic drinkers. Water consumption was recorded daily during the 72 h of glucose supplementation. Birds were offered a commercial starter diet (21% protein and 3100 Metabolizable Energy (ME) kcal kg<sup>-1</sup>, Arasco, Riyadh, Saudi Arabia) to 21 days followed by a commercial finisher diet (19% protein and 3200 ME kcal kg<sup>-1</sup>, Arasco, Riyadh, Saudi Arabia) until the termination of the experiment at 33 days of age. Feed and fresh water were available *ad libitum*.

A total of four birds were randomly selected at 7, 21 and 33 days of age from each of the five treatments. Birds were weighed then killed by cervical dislocation and their organs and SI were harvested and measurements were taken.

At the end of the experiment, 5 birds from each sex representing the mean body weight were sacrificed after 12 h of feed and water deprivation for the determination of carcass composition and characteristics.

Data were subjected to ANOVA and analyzed using the Statistical Analysis System (SAS, 2002). All per cent data were transformed using arc sine square root percentage transformation before analysis. When significant variance ratios were detected, differences between treatment means were tested using the Least Significant Difference (LSD) procedure.

**RESULTS AND DISCUSSION**

The effects of DF for 24 and 48 h post-hatch on the BW and BW% of liver, heart and BOF and measurements of SI of chickens are shown in Fig. 1-3 and

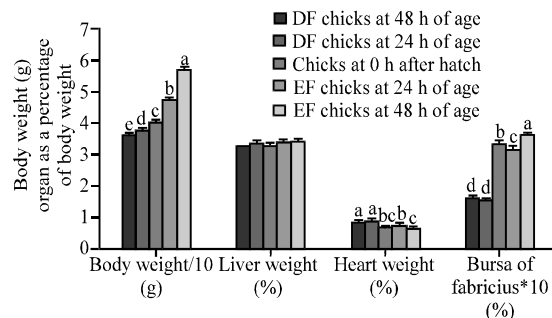


Fig. 1: Body weight and body weight percentage of liver, heart and bursa of fabricius of chickens provided with feed and water (EF) or deprived from feed and water (DF) for up to 48 h after hatch (trial 1); \*Means with different superscripts are significantly different (p<0.05)

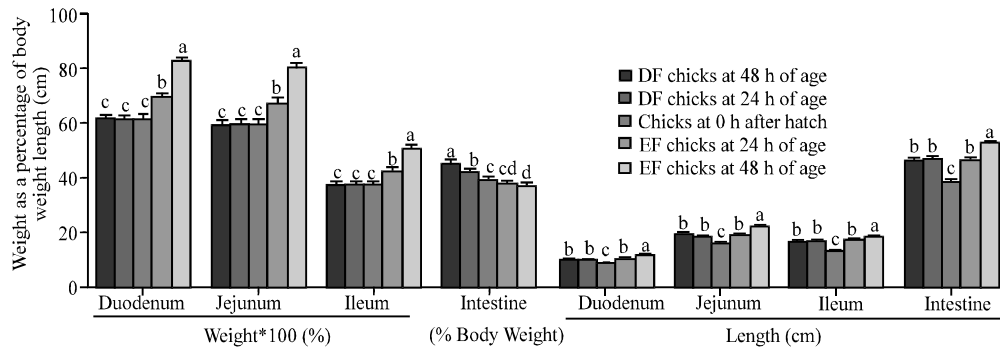


Fig. 2: Body weight and length of small intestinal segments of chickens provided with feed and water (EF) or deprived from feed and water (DF) for up to 48 h after hatch (trial 1); <sup>a-c</sup>Means with different superscripts are significantly different (p<0.05)

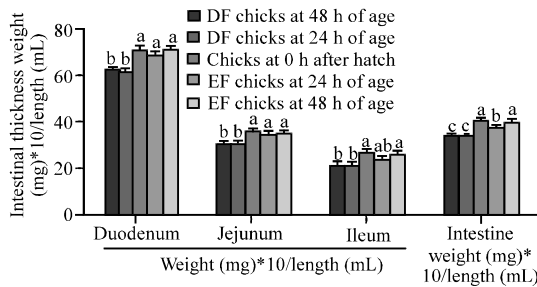


Fig. 3: The thickness of small intestinal segments of chickens provided with feed and water (EF) or deprived from feed and water (DF) for up to 48 h after hatch (trial 1) <sup>a-c</sup>Means with different superscripts are significantly different (p<0.05)

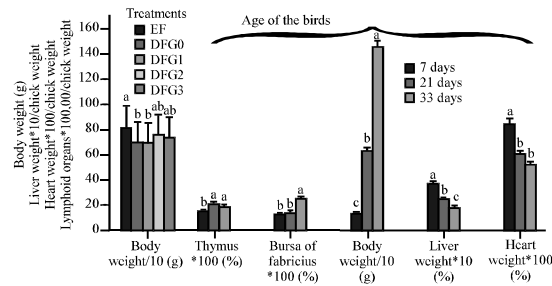


Fig. 4: Effects of adding glucose to drinking water in the 1st 72 h in body weight percentage of lymphoid (thymus and bursa of fabricius) and body (liver and heart) organs between 7 and 33 days of age of broiler chickens Deprived of Feed and water (DF) for 48 h after hatch (trial 2). There was no significant difference among treatments in body weight percentage of lymphoid (thymus and bursa of fabricius) and body (liver and heart) organs; EF = Chicks were allowed access to feed and water after hatch; DFG0-DFG3 = Chicks were deprived of feed and water for 48 h after hatch, then provided with 0, 2.5, 5 and 10% of glucose in tap water for 72 h in treatments DFG0-DFG3, respectively. Means with different superscripts are significantly different (p<0.05)

Table 1: Body weight and mortality percentage of chickens deprived of feed and water for up to 48 h after hatch (trial 2)

Treatments <sup>1</sup>	Body weight (g)			Mortality (%)
	Initial	24 h fasting	48 h fasting	
EF	40.34±0.302	46.84±0.262 <sup>a</sup>	56.35±0.244 <sup>a</sup>	0.00±00.00
DFG0	40.40±0.257	38.62±0.245 <sup>b</sup>	36.89±0.234 <sup>b</sup>	3.17±2.099
DFG1	40.26±0.302	38.48±0.289 <sup>b</sup>	36.75±0.276 <sup>b</sup>	1.59±1.586
DFG2	40.49±0.266	38.71±0.254 <sup>b</sup>	36.97±0.243 <sup>b</sup>	4.76±2.381
DFG3	40.29±0.271	38.55±0.256 <sup>b</sup>	36.88±0.248 <sup>b</sup>	3.17±2.099
SEM <sup>2</sup>	0.279	0.270	0.257	1.72

<sup>1</sup>EF = Chicks were allowed access to feed and water after hatch; DFG0-DFG3 = Chicks were deprived of feed and water for 48 h after hatch then provided with 0, 2.5, 5 and 10% of glucose in tap water for 72 h in treatments DFG0-DFG3, respectively. <sup>2</sup>Standard error of means; <sup>a,b</sup>Means within row followed by different superscripts are significantly different (p<0.05)

Table 1 (trials 1 and 2, respectively). The effects of adding glucose to drinking water of DF birds in the 1st 72 h on the performance, carcass composition and SI measurements and lymphoid organs (BOF and thymus) are shown in Table 2 and 3 and Fig. 4-6, respectively (trial 2). Time of initiation of feeding influenced the performance of chickens during the early 48 h of age. DF birds had significantly (p<0.01) lower BW (Fig. 1 and

Table 1), weight of SI segments (duodenum, jejunum and ileum), thickness of the duodenum and jejunum and BW% of BOF and higher BW% of SI and heart when compared with those of EF birds at 24 and 48 h of age (Fig. 1-3). EF birds at 48 h had significantly (p<0.01) heavier and longer SI as a whole or segments than those of DF and younger EF birds (Fig. 2). Results from this experiment indicated that DF period of 48 h after hatch reduced BW of birds by approximately 8.7% at the time of feeding of 3 days of age. Similar finding was reported by Noy and Sklan (1998).

These results were consistent with other scientists (Vieira and Jr. Moran, 1999; Noy and Sklan, 1999; Noy *et al.*, 2001; Juul-Madsen *et al.*, 2004) who concluded that providing hatchling with an early access to feed in the very early stage of development is important and that 1st 3 days after hatch are critical to the chick's development. Results from trial 2 indicated EF birds had significantly ( $p < 0.01$ ) higher BWG, feed intake and eviscerated carcass weight over the 33 days experimental period when compared with those of the DF treatments (DFG0-DFG3) and ( $p < 0.05$ ) percent of abdominal fat and longer duodenum and ileum and thicker jejunum and intestine than those of DFG0. DFG0 birds had lower BWG and feed intake at 21 and 33 days of age by

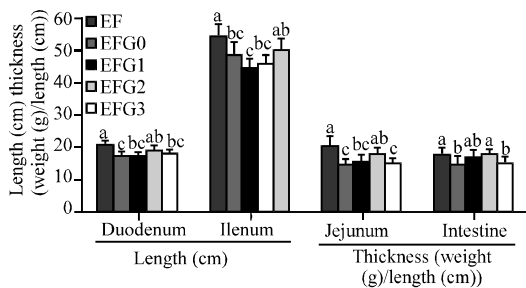


Fig. 5: Effects of adding glucose to drinking water in the 1st 72 h on intestinal segments (duodenum, jejunum and ileum) measurements (weight, length and thickness) between 7 and 33 days of age of broiler chickens Deprived of Feed and water (DF) for 48 h after hatch (trial 2). There was no significant difference among treatments in the weight of intestinal segments, length of jejunum and whole intestine, thickness of duodenum and ileum and body weight percentage of the intestine; EF = Chicks were allowed access to feed and water after hatch; DFG0-DFG3 = Chicks were deprived of feed and water for 48 h after hatch then provided with 0, 2.5, 5 and 10% of glucose in tab water for 72 h in treatments DFG0-DFG3 respectively. <sup>a-c</sup>Means with different superscripts are significantly different ( $p < 0.05$ )

approximately 7.8, 6.6, 9.3 and 9.6%, respectively when compared with those of EF birds. The DF reduced initial performance of chickens and that reduction in BW continued up to the end of experimental period of 33 days without influencing feed efficiency and mortality percentage of birds. The effects of DF on feed intake, feed efficiency and mortality percentage were in agreement with Noy and Pinchasov (1993) who reported that broiler chicks denied access to feed and water for 24 h post-hatch consumed less feed through 40 days of age and Almeida *et al.* (2006) who reported no mortality differences at 21 days in birds housed after 48 h fasting after removal from the hatcher. Similar findings were reported in turkey by Corless and Sell (1999) who reported that a delay access to feed and water decreased feed intake without affecting feed efficiency and mortality percentage (6 vs. 30, 54 h after hatch).

In contrast, Vieira and Jr. Moran (1999) reported that 24 h delay in housing increased total mortality. Results from these experiment indicated that DF for up to 48 h after hatch reduced SI absolute weight and thickness whilst the length of SI was significantly reduced only at 48 h when compared to their EF counterparts (Fig. 2 and 3). These results suggest that feed intake at

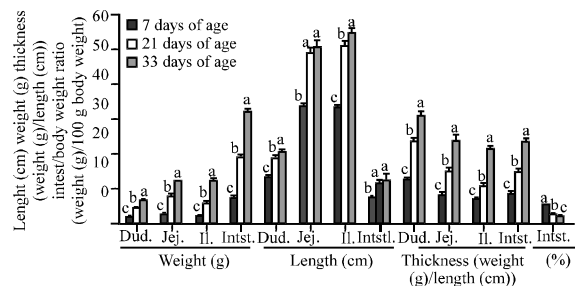


Fig. 6: Measurements of Intestinal (Intst.) segments (Duodenum (Dud.), Jejunum (Jej.) and Ileum (Il.)) between 7 and 33 days of age of broiler chickens Deprived of Feed and water (DF) for 48 h after hatch and drank water supplemented with glucose during the 1st 72 h (trial 2); <sup>a-c</sup>Means with different superscripts are significantly different ( $p < 0.05$ )

Table 2: Effects of adding glucose to drinking water in the 1st 72 h of broiler chickens deprived of feed and water for 48 h after hatch on body weight gain, feed intake and feed conversion ratio during a 33 days experimental period (trial 2)

Treatments <sup>1</sup>	Age (days)			Age (days)			Age (days)			Mortality (%)
	1-21	22-33	1-33	1-21	22-33	1-33	1-21	22-33	1-33	
	BWG <sup>2</sup> (g)	Feed intake (g)	FCR <sup>3</sup>	BWG <sup>2</sup> (g)	Feed intake (g)	FCR <sup>3</sup>	BWG <sup>2</sup> (g)	Feed intake (g)	FCR <sup>3</sup>	
EF	694.5 <sup>a</sup>	984.8 <sup>a</sup>	1.43	906.6 <sup>a</sup>	1674.6 <sup>a</sup>	1.88	1601.1 <sup>a</sup>	2659.4 <sup>a</sup>	1.68	1.59
DFG0	644.3 <sup>b</sup>	923.8 <sup>b</sup>	1.45	821.0 <sup>b</sup>	1501.6 <sup>b</sup>	1.89	1465.3 <sup>b</sup>	2425.4 <sup>bc</sup>	1.68	6.35
DFG1	634.4 <sup>b</sup>	903.0 <sup>bc</sup>	1.44	814.4 <sup>b</sup>	1507.2 <sup>b</sup>	1.90	1448.8 <sup>b</sup>	2410.6 <sup>c</sup>	1.69	3.17
DFG2	632.4 <sup>b</sup>	913.5 <sup>b</sup>	1.45	855.2 <sup>ab</sup>	1594.8 <sup>bc</sup>	1.89	1487.7 <sup>b</sup>	2508.3 <sup>b</sup>	1.70	4.76
DFG3	622.5 <sup>b</sup>	886.1 <sup>c</sup>	1.44	840.1 <sup>b</sup>	1570.1 <sup>bc</sup>	1.91	1462.6 <sup>b</sup>	2456.2 <sup>bc</sup>	1.70	4.76
SEM4	10.0	7.6	0.02	19.9	29.2	0.05	25.9	33.8	0.03	2.29

EF = Chicks were allowed access to feed and water after hatch; DFG0-DFG3 = Chicks were deprived of feed and water for 48 h after hatch then provided with 0, 2.5, 5 and 10% of glucose in tab water for 72 h in treatments DFG0-DFG3, respectively; BWG = Body Weight Gain (g); FCR = Feed Conversion Ratio (Feed intake (g)/weight gain (g)); SEM=Standard error of means; <sup>a-c</sup>Means within row followed by different superscripts are significantly different ( $p < 0.05$ )

Table 3: Effect of adding glucose to drinking water in the 1st 72 h of sexed broiler chickens deprived of feed and water for 48 h after hatch on carcass characteristics at 33 days of age (trial 2)

Treatment <sup>1</sup>	Body composition									
	Live body weight (g kg <sup>-1</sup> )				Eviscerated carcass (g kg <sup>-1</sup> )					
	Live body weight (g)	Eviscerated carcass (g)	Abdominal fat	Neck	Eviscerated carcass	Thigh	Drums	Wings	Breast	Back
EF	1598.0 <sup>a</sup>	1137.9 <sup>a</sup>	14.4 <sup>a</sup>	34.6	713.7	149.0	137.6	103.2	295.0	248.9
DFG0	1452.7 <sup>b</sup>	1039.1 <sup>b</sup>	8.9 <sup>b</sup>	33.2	715.2	147.7	137.5	102.9	288.3	266.6
DFG1	1436.1 <sup>b</sup>	1035.3 <sup>b</sup>	9.8 <sup>ab</sup>	33.2	720.3	137.9	142.9	100.2	297.6	266.9
DFG2	1469.6 <sup>b</sup>	1052.5 <sup>b</sup>	10.8 <sup>ab</sup>	36.5	716.2	147.2	134.2	103.2	306.8	248.5
DFG3	1467.7 <sup>b</sup>	1048.6 <sup>b</sup>	10.2 <sup>ab</sup>	32.1	714.3	150.0	137.3	100.4	295.7	257.3
SEM <sup>2</sup>	38.9	27.9	1.7	1.6	5.3	6.4	4.0	5.0	8.2	7.1
<b>Sex</b>										
Male	1548.6 <sup>**</sup>	1106.2 <sup>**</sup>	11.4	33.9	714.7	148.8	138.5	102.5	295.5	254.3
Female	1421.1	1019.9	10.3	34.0	717.2	143.9	137.3	101.6	297.9	260.9
SEM <sup>2</sup>	24.6	17.7	1.1	1.0	3.3	4.0	2.5	3.0	5.2	4.5

<sup>1</sup>EF = Chicks were allowed access to feed and water after hatch; DFG0-DFG3 = Chicks were deprived of feed and water for 48 h after hatch then provided with 0, 2.5, 5 and 10% of glucose in tap water for 72 h in treatments DFG0-DFG3, respectively. <sup>2</sup>Standard error of mean. <sup>\*\*</sup>Significant difference (p<0.01); <sup>a,b</sup>Means within column followed by different superscripts are significantly different (p<0.05)

early age stimulates the development and growth of SI. Early research showed that lack of feed intake to the newly hatched chicks depresses the development of SI (Baranyiova and Holman, 1976; Uni *et al.*, 1998) by reducing digestive and absorptive area (Dibner *et al.*, 1998).

However, there was no difference in the length and BW% of SI of birds among treatments. It appears that birds were able to overcome the retardation in the growth of SI during the 48 h DF period with age and the addition of glucose to drinking water of DF birds in the 1st 72 h after starvation did not influence the growth of SI (Fig. 5) and BWG, FCR, body proportion of abdominal fat and eviscerated carcass of birds (DFG0 vs. DFG1-DFG3, Table 2 and 3). The finding that DF of 48 h after hatch reduced BW% of BOF is supported by Dibner *et al.* (1998) who reported a lower BOF weight of fasted broiler chicks 48 after hatch when compared with those fed at hatch and Bhanja *et al.* (2010) who reported a reduction in BOF weight following a DF period of 24 h of hatching chicks. Similarly, turkey poults had lower weights of immune organs when birds were restricted to maintenance level of feed intake (El-Hadri *et al.*, 1998).

The effects of DF on hatching chicks suggested that the survival of DF birds was related to their ability to use their body reserves to supply the nutritional requirement for survival and that resulted in reduction of BW and SI weight. The body, heart and SI of EF birds grew positively when compared with those of DF birds. BW% of the heart and SI were increased and BOF was decreased by the 48 h DF period. Whilst BW% of liver was not influenced by DF period of 48 h.

Lilja and Olsson (1987) suggested that the organogenesis of poultry embryos selected for rapid growth at post-hatching stage is characterized by the preferential growth of supply organs (heart, liver,

intestines) over demand organs (heart, muscles). It seems that EF immediately after hatch favored the expression of characteristic of fast-growing birds. The addition of glucose to drinking water of DF birds increased the daily energy intake of chickens by approximately 0, 9, 18.6 and 35 kJ for DFG0-DFG3, respectively in the 1st 72 h but did not influence water consumption. It seems that drinking the glucose-water solutions for only 72 h was not sufficient to recover the loss in BW and body organs during the DF period. Age of the bird influenced BW of chickens, weight of lymphoid organs and measurements of the SI (Fig. 4 and 6). Male birds had significantly (p<0.01) higher live BWG and eviscerated carcass weight than female birds (Table 3). Sex did not influence composition of the body or carcass.

## CONCLUSION

It was observed that DF for up to 48 h immediately after hatch depressed performance, weight of BOF and heart and SI length and thickness at the end of the DF period and that did not influence mortality percentage, FCR and composition of eviscerated carcass and BW% of SI, heart and lymphoid organs at 33 days of age when compared with EF birds. EF Birds had greater BWG, feed intake and eviscerated carcass weight over the 33 days experimental period. The addition of glucose for up to 10% to drinking water in the 1st 72 h did not influence performance and eviscerated carcass of DF birds.

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