Effects of supplementing Mojosari ducks diet with fish oil or fish oil in combination with tomato powder on hatching egg quality during storage

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Abstract

This study investigated the effects of supplementing Mojosari ducks diets with fish oil or fish oil in combination with tomato powder on hatching egg quality during storage. Eighty four Mojosari ducks (consisted of 72 female and 12 male ducks) were randomly allotted into 12 flocks (each flock consisted of 6 female and 1 male ducks) and fed 1 of 3 diets: Control (diet containing 2% soybean oil), FO (diet containing 2% fish oil), or FOTP (diet containing 2% fish oil + 1% tomato powder). One hundred and eight hatching eggs (36 hatching eggs per treatment) were randomly collected at the end of 7th weeks of dietary treatments. Hatching eggs were then stored for 14 days under room temperature (24-25^{o}C) and egg quality analysis was done at 0, 7, and 14 days of storage. Data were analyzed using two-way ANOVA. Means with significant result were further analyzed using Duncan Multiple Range Test. Result showed that there were no effect ($p>0.05$) of either dietary treatments or storage periods on the weight of whole egg and its components (yolk, albumen, and shell), shell thickness, and shell surface area. Supplementation of fish oil (FO) or fish oil in combination with tomato powder (FOTP) had higher ($p<0.05$) egg specific gravity compared to control. Egg stored for 7 and 14 days had lower ($p<0.05$) egg specific gravity, Haugh unit, albumen index, and yolk index compared to fresh egg. It could be concluded that dietary fish oil and tomato powder had no effect on whole egg weight and its component, internal egg quality and external egg quality, except for egg specific gravity of Mojosari ducks. Storage under room temperature for 7 and 14 days could decrease internal egg quality of Mojosari ducks.

Keywords: *carotenoid, Haugh unit, lycopene, omega-3 PUFA, omega-6 PUFA*

Introduction

Egg storage is a common practice in hatcheries. Storage of hatching egg is aimed to obtain sufficient numbers of egg to fulfill maximum capacity of an incubator. However, the increase of storage period may alter egg quality, which then may also decrease hatchability. In a study conducted by Samli et al (2005) duration of storage could decrease some egg quality such as shell weight, specific gravity, Haugh unit, and yolk index. Moreover, Khan et al (2014) reported that duration of storage not only decrease yolk weight, albumen index, yolk index, and Haugh unit, but also increase embryonic mortality and decrease hatchability.

In the current poultry industry, omega-6 PUFA are supplied in high or even in the excess quantities

as a result of common dietary grain or dietary oil used in feed formulation. In contrast, omega-3 PUFA are still supplied in the low quantities. Previously, it was reported that dietary supplementation with fish oil which contains n-3 fatty acids could improve calcium uptake in rats (Haag et al 2003). Improvement of calcium uptake may had beneficial effect to support eggshell formation, which was very important aspect in poultry. In another study, Saleh (2013) found that supplementation of fish oil could increase the relative weight of shell and shell thickness. Those findings indicate that fish oil supplementation could improve of calcium uptake and then may improve eggshell quality. The improvement of eggshell quality may provide possibilities to maintain egg quality during storage.

However, it should be noted that fish oil is highly susceptible to oxidation. Consequently, fish oil supplementation should be combined with dietary antioxidant. Tomato is one of the fruits which have a great potency as natural antioxidant. Tomato contains carotenoid, mainly lycopene, which has high potent of antioxidant (Guil-Guerrero and Rebolloso-Fuentes, 2009). Beside providing antioxidant activity, tomato powder also had beneficial effect on egg quality. Previously, it was reported that lycopene (main bioactive compound found in tomato) supplementation could increase eggshell weight (Grigorova and Petkova, 2014). This finding indicated that combination of fish oil and tomato powder may improve eggshell quality, which then could maintain egg quality during storage. Therefore, this study investigated the effects of supplementing Mojosari ducks diets with fish oil or fish oil in combination with tomato powder on hatching egg quality during storage.

Materials and methods

Birds and dietary treatments

Eighty four Mojosari ducks (72 ducks and 12 drakes), aged at 40 weeks old, were randomly distributed into 12 cages (each cage consisted of 6 ducks and 1 drake). They were housed in open-sided cage with 12 hours of daylight (05.00 am - 05.00 pm). The ducks were then fed 1 of 3 diets, either Control (diet containing 2% soybean oil), FO (diet containing 2% fish oil), or FOTP (diet containing 2% fish oil + 1% tomato powder). Dietary treatments was given for 7 weeks. Ingredient and nutrient content of dietary treatments were shown in Table 1.

Table 1. Ingredient and nutrient content of diets

Ingredient	Control	FO	FOTP
		g/kg of diet	
Yellow corn	480	480	480
Soybean meal	200	200	200
Rice bran	132	132	132

Meat bone meal	80	80	80
Soybean oil	20	0	0
Fish oil	0	20	20
Tomato powder	0	0	10
Tapioca flour	10	10	0
Grit	50	50	50
Vitamin-mineral mix	28	28	28
Calculated nutrient content[1]			
Energy, kcal ME/kg	2,862	2,862	2,862
		g/kg of diet	
Crude protein	194	194	194
Fat	48.9	48.9	49
Ca	32.5	32.5	32.5
P	5.0	5.0	5.0
Lysine	10.6	10.6	10.6
Methionine	5.4	5.4	5.4

Notes: [1] based on Table of Nutrient Content of Feedstuff (Leeson and Summers, 2005)

Egg quality during storage

One hundred and eight hatching eggs (36 hatching eggs per treatment) were randomly collected at the last weeks of dietary treatments. Hatching eggs were then stored for 14 days under room temperature (24-25^{o}C). Egg quality analysis was done at 0, 7, and 14 days of storage. Whole egg weight was weighted using electrical balance. The eggs were then broken to measure the weight of shell, albumen and yolk. Shell thickness was presented as the mean of triplicate measurement from upper, middle, and lower part of the shell. Eggshell area was calculated using formula 4.835 x egg weight$^{0.662}$ (Kokoszy?ski et al 2007). Specific gravity was measured using gradual saline solution from 1.075 to 1.100 in increments of 0.005. Yolk index was calculated by using formula yolk index = (yolk height / yolk diameter) (Yimenu et al 2017). [W1] Albumen index was calculated by using formula albumen index = (thick albumen height / thick albumen diameter) (Yimenu et al 2017). Haugh unit (HU) was calculated using formula HU = 100 log (H + 7.57 - 1.7W$^{0.37}$), H was the albumen height and W was the egg weight (Yimenu et al 2017).

Data analysis

Data of the weight of whole egg and its component, external egg quality, and internal egg quality were analyzed using two-way ANOVA based on a completely randomized design. The first factor was dietary treatments (Control, FO and FOTP), while the second factor was storage period (0, 7 and 14 days). Means with significant result were further analyzed by LSD Duncan.

Results and discussions

Effect of treatment on the weight of whole egg and its component

Effect of dietary treatment and duration of storage on the weight of whole egg, yolk, albumen, and shell were presented in Table 2. Dietary treatments and duration of storage did not have any effect (p>0.05) on the weight of whole egg, yolk, albumen and shell of Mojosari duck. In line with this finding, Ortega (2007) also reported that fish oil supplementation in broiler breeder diet at the level of 1.75% had no effect whole egg, yolk, albumen and shell weight. No effect of duration of storage in this study was also in accordance with Pappas et al (2005), who reported that duration of storage did not have any effect on the weight of whole egg and its component. Similarly, Scott and Silversides (2000) also found that duration of storage had no effect on egg weight.

Table 2. Effects of supplementing Mojosari ducks diets with fish oil or fish oil and tomato powder on whole egg weight
and its components during storage up to 14 days

Treatments	Whole egg (g)			Yolk (g)			Albumen (g)			Shell	
	0	7	14	0	7	14	0	7	14	0	7

Control	64.8	64.1	63.9	21.5	21	20.9	36.5	36.3	36.4	6.88	6.8
FO	64.4	63.9	60.4	21.4	20.7	18.9	36.5	36.8	35.2	6.54	6.4
FOTP	65.4	64.2	62.5	22.3	20.8	19.1	36.1	37	37	7	6.3
SEM		1.89			1.03			1.97			0.26
Source of variation					***p* -value**						
Diet		0.647			0.636			0.952			0.26
Storage		0.241			0.086			0.933			0.24
Diet x storage		0.906			0.764			0.966			0.85

Effect of treatment on external egg quality

Effect of dietary treatment and duration of storage on shell thickness, eggshell area and egg specific gravity were presented in Table 3. Dietary treatments and duration of storage had no effect (p >0.05) on shell thickness and eggshell area. However, FO and FOTP groups had higher egg specific gravity (p<0.05) compared to control (Table 4.), while egg stored for 14 days has lower (p <0.05) specific gravity, compared to egg stored for 0 and 7 days. (Table 5).

The increase of egg specific gravity in FO and FOTP groups maybe related with the fish oil supplementation. Fish oil had higher saturated fat compared to soybean oil (37.04 % vs 14.83%) (Pita et al 2011). As a consequence, FO and FOTP groups may also had higher saturated fat compared to control group. It was previously demonstrated that the increase of saturated fat in the diet could increase egg specific gravity (Peebles et al 2000, Bozkurt et al (2008).

Table 3. Effects of supplementing Mojosari ducks diets with fish oil or fish oil and tomato powder on
external egg quality during storage up to 14 days

Treatments	Shell thickness (?m)			Eggshell area (cm^2)			Specific gravity (g/cm^3)		
	0	**7**	**14**	**0**	**7**	**14**	**0**	**7**	**14**
Control	261	258	258	76.5	75.9	75.8	1.082	1.081	1.077
FO	276	274	269	76.2	75.8	73	1.089	1.084	1.079
FOTP	272	267	260	77	76	74.7	1.086	1.084	1.079
SEM		7.45			1.49			0.002	
Source of variation					***p* -value**				
Diet		0.103			0.653			0.031	
Storage		0.494			0.247			<0.0001	
Diet x storage		0.978			0.899			0.577	

Table 4. Effects of dietary fish oil or fish oil and tomato powder supplementation on egg specific gravity

Treatments	Specific gravity (g/cm^3)
Control	1.080[a]
FO	1.084[b]
FOTP	1.083[b]
SEM	0.001
p -value	0.031

[ab] *means in the same column followed with different letter are different significantly at p<0.05*

Table 5. Effects of storage periods on egg specific gravity of Mojosari ducks

Storage period (day)	Specific gravity (g/cm^3)
0	1.086[a]
7	1.083[a]
14	1.078[b]
SEM	0.001
p -value	<0.0001

[ab] *means in the same column followed with different letter are different significantly at p<0.05*

In the previous finding, KÃ¼Ã§Ã¼kersan et al (2010) found that dietary fish oil supplementation in laying hens diet had similar shell thickness compared to other dietary oil supplementation (sunflower, soybean and hazelnut oil). In another study, it was also reported that egg specific gravity was decrease with increased of storage duration (Samli et al 2005).

Effect of treatment on internal egg quality

Effect of dietary treatment and duration of storage on Haugh unit, albumen index, and yolk index were presented in Table 6. Supplementation of fish oil or fish oil in combination with tomato powder did not affect (p>0.05) Haugh unit, albumen index and yolk index . This finding was in accordance with Saleh (2013), who also reported that dietary fish oil supplementation had no effect on Haugh unit, albumen index and yolk index of laying hens. Akdemir et al (2012) also found that there were no effect of tomato powder supplementation on Haugh unit of laying hens. It could be explained that due to the Haugh unit, albumen index and yolk index were indicator of egg freshness, it was logical that dietary treatments had minor role affecting these variables.

Table 6. Effects of supplementing Mojosari ducks diets with fish oil or fish oil and tomato powder on internal egg quality during storage up to 14 days

Treatments	Haugh unit			Albumen index			Yolk index	
	0	7	14	0	7	14	0	7
Control	83.9	67.3	66	0.113	0.088	0.073	0.385	0.375
FO	87.9	76.6	56.6	0.12	0.095	0.068	0.44	0.38
FOTP	88.8	67.4	65.2	0.11	0.083	0.083	0.418	0.378
SEM		4.26			0.007			0.014
Source of variation					***p*-value**			
Diet		0.903			0.845			0.379

Storage	<0.0001	<0.0001	0.001
Diet x storage	0.189	0.382	0.161

Table 7. Effects of storage periods on internal egg quality of Mojosari ducks

Storage period (day)	Haugh unit	Albumen index	Yolk index
0	86.9[a]	0.114[a]	0.414[a]
7	70.4[b]	0.088[b]	0.378[b]
14	62.6[c]	0.074[c]	0.368[b]
SEM	2.46	0.004	0.008
p -value	<0.0001	<0.0001	0.001

[ab] *means in the same column followed with different letter are different significantly at p<0.05*

As can be seen on Table 7, storage for 7 and 14 days could decrease ($p<0.05$) Haugh unit, albumen index and yolk index. Similarly, Pappas et al (2005) also reported that storage for 14 days could decrease Haugh unit of egg of broiler breeder. Similarly, Oleforuh-Okoleh and Eze (2016) also noticed that Haugh unit, albumen index and yolk index was decrease with the increase of storage duration. It could be explained that the decrease of internal egg quality during storage may be related with the evaporation of water from the egg (Khan et al 2014). In addition, carbon dioxide loss from albumen may be also could decrease internal egg quality during storage (Samli et al 2005).

Conclusion

- It could be concluded that dietary fish oil and tomato powder had no effect on whole egg weight and its component, internal egg quality and external egg quality, except for egg specific gravity of Mojosari ducks. Storage under room temperature for 7 and 14 days could decrease internal egg quality of Mojosari ducks.

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Go to top