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The Effect of Duckweed Supplementation on Egg Production and Egg Quality of White Leghorn Layers

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ABSTRACT

Chicken production plays an important role in the economy of Eritrea. In Eritrea duckweed (DW) is not yet utilized as poultry feed due to lack of knowledge on its use and nutritional value. Therefore a feeding trial was carried out to examine *the effect of duckweed supplementation on egg production of white leghorn*. The control diet consists of locally available commercial layer ration. A total of 120 White leghorn layers (60 weeks of age) were randomly assigned to four treatments. Each treatment contained three replicates of ten birds each. Each treatment contained sun dried DW (CP 15.05, CF 25.7%) at 0, 5, 15 and 25% by weight. The experiment was continued for a period of eight weeks after 10 days of adaptation. Increasing levels of DW in the ration showed no significant effect on egg production, body weight, feed intake, egg weight, shell weight, shell thickness and shape index. However egg yolk color ($P< 0.001$) and feed conversion ratio (FCR) ($P<0.05$) showed significant differences. The mean egg production of the birds was 330 eggs (57.60%) for the control diet (0% DW). 336.7 (58.90%) for 5% DW and 15% DW and 227 (48.20%) for 25% DW level. So DW can serve as a viable alternative protein supplement to layers ration in Eritrea up to 15%.

INTRODUCTION:

The rearing of chicken is popular in rural areas of most resource-poor countries including Eritrea as a means of providing supplementary food, extra income and employment to family members and also to capitalize on harvest wastes and inferior grains produced on farms. The majority of the poultry in Eritrea are raised under back yard system where they can obtain their feed from near the household area.

Protein rich feed resources are generally in short supply and are usually the most costly components of diets and the same is the major constraint for commercial animal production and poultry production in developing countries like Eritrea.

Cereal grains and protein meals are required for human consumption on priority and those are too expensive as well and as such those cannot be spared for poultry. Currently available commercial layer feeds are inadequate. On account of low quality most of them need protein supplementation for optimum production. Thus, it is necessary to explore some new sources of nutrients which are not being presently utilized for human beings.

For sustainable intensification of animal production, the use of duckweed is of great importance mainly for three reasons: the global demand for grains being higher than the global grain production, stiff competition between man and livestock for the existing food and feed resources, and the need for feeds that are adapted to harsh environmental conditions due to the ongoing climate change (FAO, 2012).

Sundried duckweed (DW) can be incorporated as a major source of protein in poultry industries of developing countries (Leng *et al.,* 1995) and can reduce cost of poultry production because of its availability at reasonable price. DW is the fastest growing flowering plant and it has world-wide distribution on minimum agronomic practices. It can grow in fresh, brackish and waste waters. DW production yields up to 183metric tones dry matter per hectare per year (Leng *et al.,* 1995). Nutritionally DW grown under ideal conditions can replace soybean and fishmeal in feeds of chickens, goats, pigs, ducks and fish (Hillman and Culley 1978; Culley *et al.,* 1981; Edwards, 1990; Landesman *et al.,* 2002) and has high crude protein (CP) content ranging from 35 to 37.3% (Thuy and Oggle, 2004; Khang and Ogle, 2004 and Akter *et al.,* 2011). DW has a better array of essential amino acids which resemble animal proteins more than most plant proteins (Hillman and Culley, 1978). DW has a balanced amino acid content especially the limiting amino acids lysine (7.5%) and methionine (2.65%) (Rusoff *et al.,* 1980).

In Eritrea two genera belonging to *Lemna* and *Wolffia* have been identified. They are found in the highlands and mid altitude areas. Since duckweed is adapted to different climatic conditions it could have a big role in minimizing the problem of shortage of protein supplements. However, in Eritrea duckweed is not yet utilized as an animal feed due to lack of knowledge on its uses and nutritional value. As a result a trial was conducted to examine the potential of duckweed as a protein supplement and to compare the effect of different levels of duckweed supplementation on daily egg production and egg quality of White Leghorn layers.

MATERIALS AND METHODS:

Study site or location:The experiment was carried out at Adal Poultry Farm P.L.C. found in Anseba zone along the Anseba River. It is located at about 3km north east of Keren. It is 93Km towards west from the capital city of Eritrea, Asmara. The temperature of this area ranges from 17.7°C to 34.8°C. Its altitude is 1280 meters above sea level. Adal Poultry Farm was established in 2001. It is a private farm having an area of three hectares and a housing capacity of about 18,000 hens.***Plant source and processes:*** Fresh DW was harvested from the duckweed ponds at Hamelmalo Agricultural College (HAC) and Shifshifit Dam found in Keren. After harvest, the duckweed was dried by spreading on clean cement floor on plastic sheets and exposing to direct sunshine. Foreign matter was then picked by hand. The remaining foreign particles were separated using different sized sieves, followed by grinding. It was then mixed at the rate of 0, 5, 15 and 25% of the layer ration by weight. The feed samples were subjected to proximate analysis according to (AOAC, 1995).***Experimental design:*** A total of 120 single comb White Leghorn layers (60 weeks of age), in their first year laying cycle, were selected and randomly assigned into four treatments with 30 chickens each in three replicates. Each group was housed in separate pen. The birds were fed as a group in each pen. Formulated feeds and drinking water were supplied *ad lib*. The birds received identical care and management.

Measurements (parameters measured): Records were kept of body weight, feed intake, feed conversion ratio, egg weight, shell weight, shell thickness, shape index, yolk color and daily egg production for each experimental unit during the experimental period of eight weeks. The experimental period was preceded by ten days of adaptation period.Feed refusal was recorded once a week. Record of weekly feed intake was kept separately for each experimental unit. Weekly feed intake per experimental unit was used to compute feed intake per bird per day using the following formula:*Feed intake/bird/day = (weekly feed consumption by a replicate/No of birds in a replicate)/7*Feed conversion ratio was calculated on the basis of gram of feed required to produce a gram of egg by using the following formula: FCR (g feed/g egg) = [weekly feed consumption per replicate (g) / weekly No of egg produced per replicate multiplied by average egg weight of the replicate (g)]Mean egg production was calculated by = Total eggs laid by (REP1 +REP2 +REP3)/*3* ***Statistical analysis:*** The trial was designed according to a completely randomized design (CRD). The data was analyzed using GENSTAT release 9.2 (2007).

RESULTS AND DISCUSSION

Chemical Composition: In the study, the protein content of duckweed was low, associated with its high fiber content (Table 1). The lower CP content of duckweed and high fiber content could be due to the poor nutrient content of the fresh water where it grew and stage of growth of the duckweed during harvesting. Similarly, Ansal *et al.* (2010) reported that when duckweeds are grown on water body poor in nutrients, their protein content is low. Mbagwu and Adeniji (1988) and Skillicorn *et al.,* (1993) also showed that fiber and ash content were higher and protein content was lower in duckweed colonies that grew slowly. As compared with the data reported by Thuy and Ogle (2004) and Akter *et al.,* (2011) the duckweed used for this study had lower crude protein content (15.05%) and higher fiber content (25.7%). Similarly, Mbagwu and Adeniji (1988) and Skillicorn *et al.,* (1993) found that the concentration of nutrients in dry matter of a wild colony of duckweed growing on nutrient-poor water was 15 to 25% protein and 15 to 30% fiber. Lower CP content (7 to 20%) of duckweed was also observed when duckweed was collected from natural waters (Tan, 1970). Lower CP content (7 to 20%) of duckweed was also observed when duckweed was collected from natural waters (Tan, 1970). The ether extract and ash content was found to be lower as compared with the previous reports of Thuy and Ogle (2004). This could be due to the poor nutrient content of the water and aging of the duckweed without being harvested; as plants get older, generally CP and ether extract decrease while fiber and mineral contents increase.

Table (1) Chemical composition of sundried DW and DW supplemented rations

Nutrients	DW	Experimental diets			
		Control	DW5%	DW15%	DW25%
DM	89.50	91.33	91.24	91.06	90.87
CP	15.05	16.24	16.18	16.06	15.94
CF	25.70	7.10	8.03	9.89	11.75
EE	4.20	3.60	3.63	3.69	3.75
Ash	14.01	11.66	11.78	12.01	12.25

Effect of Duckweed on Egg Production: The performance of layers supplemented with duckweed at different dietary levels showed a positive effect on both egg production and quality parameters. Egg production, feed intake and body weight change were found to be non-significant for all treatments. During the entire experimental period no mortality and loss of body weight occurred in all the treatments. This indicated that all birds were reared under sound management (health, housing and feeding) practices.There were no significant differences in feed conversion ratio among the control, 5% DW and15% DW supplements. However, a significant difference was found at 25% DW. This result showed that duckweed can be included in layers ration up to 15% by weight.Even though it was statistically non-significant there was some variation in egg production of the control, DW5%, DW15%, DW25% diets. The chemical composition of DW was considerably lower than that of control diet particularly in CP%. However, layers fed the diets having 5% and 15% DW produced more eggs than the birds fed the control diet. This could be due to the reason that Duckweed has a better array of essential amino acids which resemble animal proteins more than most plant proteins (Hillman and Culley, 1978). Duckweed has a balanced amino acid content especially the limiting amino acids lysine (7.5%) and methionine (2.65%) (Rusoff *et al.,* 1980).

Table (2) Effect of Duckweed on Egg Production

Parameters	Levels of duckweed				Lsd	± S.E.
	DW 0 %	DW 5 %	DW 15 %	DW 25 %		
Mean egg production	300	336.7	336.7	277	NS*	15.801
Feed intake (g/bird/day)	115.72	116.23	112.49	114.43	NS*	1.95
FCR (g feed/g egg)	3.65[a]	3.45[a]	3.33[a]	4.41[b]	6.34*	1.95
Body weight change (g)	199	51	8	42	NS	50.7

NS = non-significant, * = P>0.05 values with different superscripts show significant differences

The birds supplemented with 25% duckweed laid a lower number of eggs as compared with the other levels. This could be due to the increase in fiber content of the layer ration along with the increase in the amount of duckweed. From the experiment it is clear that supplying duckweed at 5% to 15% of layer diet had positive effect on egg production. In situations where duckweed could be available cheaply and other protein supplements are expensive it is recommended to include duckweed up to 25% of the ration. The slight drop in egg production could be compensated by the cheaper cost of duckweed. It should also be noted that the duckweed used in the study was among the poor quality duckweeds grown in a water body poor in nutrients. If duckweed was grown under ideal conditions, its nutritional value would be expected to increase, i.e., protein content would increase and fiber content would decrease. ***Effect of Duckweed supplement on Egg Quality:*** As shown in Table (3) there was no statistically significant difference (P > 0.05) in the average feed intake, egg weight, shell weight, shell thickness and shape index. The average shell thickness was found to be within the recommended range of shell thickness as the range of shell thickness is from 0.30 mm to 0. 4 mm (Saxena and Ketelaars, 1993 and Meindera, 1990). The optimum shape index is 74% (Saxena and Ketelaars, 1993 and Meindera, 1990). The shape index in this study was close to the optimum shape index as can be seen in Table 3. This result agreed with the reports of Slipper *et al.,* (1999) that duckweed had no significant effect on shell thickness.

Table (3) Average values of egg quality parameters

Parameters	Levels of duckweed				Lsd	± S.E.
	DW 0 %	DW 5 %	DW 15 %	DW 25%		
Feed intake (g/bird/day)	115.72	116.23	112.49	114.43	NS*	1.95
Average shell weight (g)	6.028	6.101	5.710	5.936	NS*	0.144
Average shell thickness (mm)	0.3893	0.4000	0.3767	0.3920	NS*	0.011
Average egg weight (g)	57.67	58.90	58.41	58.20	NS*	0.903
Average yolk color (RYCF)	3.003^{a}	5.087^{b}	6.837^{c}	8.710^{d}	0.5019**	0.154
Average shape index (%)	74.4	73.9	74.6	68.1	NS*	2.940

NS = non-signifiant, * = P>0.05, ** = P<0.001. The value for yolk color with different superscripts differ significantly

The average egg weight of chickens is 58g (Singh, 1990). In this study both egg weight and shell thickness were found to be close to the optimum. The near optimum shell thickness found in duckweed supplemented layers could be due to the rich supply of minerals in duckweed as Duckweed has a mineral absorbing character. It can be concluded that duckweed can be a part of the layer ration up to 15% without any negative effect on shell thickness, shell weight and shape index. ***Effect of Duckweed Supplementation on Egg Yolk Color:*** The pigmentation and appearance of the yolk is of major importance in determining its quality (Singh and Panda, 1996). The color of the yolk is influenced by nutritional factors. Yolk color showed highly significant (P< 0.001) difference between the different treatments.

Figure 1: Effect of increasing levels of duckweed supplementation on egg yolk color

The photo shows from left to right (Contol, 5% DW, 15% DW, 25% DW) diets potential for enhancing market value, thereby profit. This is because consumers prefer brightly-colored yolks (Hasin *et al.,* 2006).

CONCLUSIONS:

The duckweed used in the study was particularly affected by the low nutrient content in which it grew. Therefore, it had a relatively low crude protein and a high fiber contents. Increasing levels of DW in the ration showed no significant difference on egg production, body weight, feed intake, egg weight, shell weight, shell thickness and shape index (P>0.05). However, egg yolk color (P< 0.001) and FCR (P<0.05) showed significant differences. So duckweed collected from low nutrient containing water bodies can be served as a viable alternative protein supple ment in layer rations up to 15% by weight.

The highly significant improvement in yolk color with increasing levels of duckweed in the diet was due to the xanthophyll pigments found in duckweed (Akter *et al.*, 2011 and Khang and Ogle 2004). Egg yolks from the group supplemented with 25% duckweed had the deepest yellow color while those in the control had the palest yellow color. The effect of duckweed on egg yolk color increased linearly with increasing the inclusion level of duckweed in the layer ration. This result agreed with the results reported by Thuy and Ogle (2004) and Slipper *et al.,* (1999), that duckweed improves yolk color intensity. Xanthophylls improve the aesthetic value of egg yolk as they impart yellow color to the egg yolk. It can be concluded that duckweed has

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