Journal of Animal Feed Science and Technology 5 (2017) 45-53
DOI: http://dx.doi.org/10.21088/jafst.2321.1628.5217.2

Effect of feeding seabuckthorn cake (hippophae l.) on egg production and egg quality in poultry birds

V.K. Sharma*, Rana Divya, Wadhwa Daisy***, Hasanuzzaman Md.******

*Professor & Head **Phd Scholar ***Associate Professor, Dept. of Animal Nutrition, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya (CSK HPKV), College of Veterinary and Animal Sciences (COVAS), Palampur, Dist. Kangra, Himachal Pradesh 176062, India. ****Professor, Animal Nutrition, Bangladesh Agriculture University, Chittagoan, Bangladesh.

Keywords:

Seabuckthorn (SBT) Cake
Poultry Birds
Layers
Egg Production
Egg Quality Traits
Feed Conversion Ratio.

Abstract

Nutritionally balanced feeding is the most important for economic production of poultry. So, minimization of feed cost would be a great achievement for poultry farmers if the unconventional feed resources are introduced as the replacer of protein source, Nutritionally, SBT cake is very rich in proteins, fat, amino acids, vitamins and minerals. Very little systematic and scientific work has been conducted to study the effects of feeding SBT cake to the poultry. Hence, the present study was envisaged to see the effect of replacement of CP of conventional feed of layers with the protein of SBT to observe the effect on quality traits of eggs and egg production. An experiment was conducted to study the effect of SBT cake on layers. The trial was conducted in 360 BV-300 layer chicks, where conventional rations in control (S_0) group replaced with 10, 20, 30, 40 and 50 per cent of CP by SBT cake CP in treatment groups S_{10}, S_{20}, $S_{30,}$ S_{40} and S_{50} respectively. The egg production percent, egg mass of layers were higher in S_{20} group, where 20 per cent CP of conventional concentrate was replaced with the CP of the SBT cake. FCR in respect of egg mass of the layer was found better in S_{20} treatment group. It was noticed that, as the level of SBT cake increased beyond 20 per cent. The quality traits of eggs were not affected by replacement of SBT cake at any of the levels. It was revealed that replacement of CP of conventional layer feed with SBT cake CP up-to 20 per cent level was economic for layer production. Looking at the results of present investigations, it is concluded from this study that 20 per cent CP of the traditional concentrate ration can be replaced with the CP of SBT cake in layer birds for a viable and cost effective egg production.

Introduction

The economy of agricultural based country mostly on its agricultural supported sectors such as livestock, poultry and fisheries production which are the integral parts of farming system of the country. Poultry plays a significant role in economy by providing nutritional security, employment generation and complementary income. Commercialization and organization has changed the face of Indian poultry sector which is witnessing huge growth continuously. Scientific production and management has made considerable progress to make the poultry farming as fastest growing industry. India stands at fourth largest producer of eggs (47 billion of eggs) and fifth largest producer of broilers (2.3 million metric tons of meat) having more than 1.5 billion birds spread over more than 150,000 farms (Panda and Reddy, 2009). But a key factor behind India's poultry industry is the sufficient availability of cheap feed ingredients and non conventional feed resources (NCFR) for rapid expansion of commercial poultry.

The seabuckthorn (SBT) is one of the newer NCFR. The SBT fruit pressed residues cake is very rich in fats, proteins, vitamins and minerals, which can be used in the production of quality animal feeds. The

Corresponding Author: V.K. Sharma, Professor & Head, Dept of Animal Nutrition, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya (CSK HPKV), College of Veterinary and Animal Sciences (COVAS), Palampur, Dist. Kangra, Himachal Pradesh 176062, India
E-mail: vkcovas@gmail.com

Received on 08.07.2017, **Accepted on** 01.09.2017

industrial wastes of this plant are available as byproducts and can be used successfully for the formulations of various types of feeds, feed supplements and additives for the poultry and animal production. The cakes of SBT are very nutritious and can be fed to the animals after value addition (Sharma *et al.*, 2009).

As a replacement of major protein and energy source, the inclusion of SBT cake and its industrial by products which is exploited as the unconventional but potential ingredient (Singh, 2006), can be of economic relief for the poultry through minimization of feed cost. Nutritionally, cake is very rich in proteins, fat, amino acids, vitamins and minerals (Stalazs and Savenkos, 2011).

Seabuckthorn fruit contains high quality of pulp and seed oils, which have high contents of peculiar types of fatty acids like Linolenic and Palmitolic acids (Singh *et al.*, 2003) and other phyto-nutrients, which have many medicinal properties like protection from cardiovascular diseases and cancer (Yang and Kallio, 2006).

However, scientific validations of these properties of Indian forms of SBT are yet to be exploited for development of useful feed preparations. There is a need for the development of variety of food products, veterinary and neutraceutical products, which will add value to SBT and increase its demand in the market.

Keeping in view the usefulness of SBT cake, it will be of great importance to evaluate its nutrient utilization in poultry for egg production. Feeding SBT cake can meet some amount of the nutrient availability to the layers for egg production hence, the present study was envisaged to evaluate the effect of replacement of crude protein of conventional feed of layers with crude protein of Seabuckthorn cake (*Hippophae L.*) on various the quality traits of eggs and the feed conversion ratio in layers.

Material and Methods

1. Experimental Design

The present study was carried out in the metabolic stall of the Department of Animal Nutrition, Dr. G.C. Negi, College of Veterinary and Animal Sciences (COVAS) from March 2010 to July 2011.

Under this experiment for evaluating the replacement of Seabuckthorn (SBT) cake CP in the traditional ration of poultry for egg production and study the egg quality traits 360 one day-old layer chicks were procured from the hatchery of M/S Venketshawara Hatcheries Pvt. Ltd., Nalagrah, HP near Chandigarh.

These chicks were divided into 6 groups having 4 replications, each consisting of 15 chicks. The crude protein (CP) content of the traditional ration control, (S_0) was replaced with SBT cake CP at 10, 20, 30, 40 and 50 per cent at different phases production in layers according to the BIS (1992) standard (Table-1). The whole period of experiment was conducted keeping in view the following phases as per BIS, 1992 standards.

Table 1: Experimental Lay out

Treatment No.	Treatment Detail	Abbreviation used	Supplementation level: Chick Phase (Starter ration, 0-8 wks)	Growing Chick Phase (Grower ration, 8-20 wks)	Laying Chick Phase (Layer ration, 20-32 wk)
1	Control	S_0	Basal ration	Basal ration	Basal ration
2	10 per cent CP of Control feed replaced with CP of SBT cake	S_{10}	7.9 kg of SBT cake	6.9 kg of SBT cake	6.5 kg of SBT cake
3	20 per cent CP of Control feed replaced with CP of SBT cake	S_{20}	15.8 kg of SBT cake	13.8 kg of SBT cake	13 kg of SBT cake
4	30 per cent CP of Control feed replaced with CP of SBT cake	S_{30}	23.7 kg of SBT cake	20.7 kg of SBT cake	19.5 kg of SBT cake
5	40 per cent CP of Control feed replaced with CP of SBT cake	S_{40}	31.6 kg of SBT cake	27.6 kg of SBT cake	26.0 kg of SBT cake
6	50 per cent CP of Control feed replaced with CP of SBT cake	S_{50}	39.5 kg of SBT cake	34.5 kg of SBT cake	32.5 kg of SBT cake

SBT= Seabuckthorn

i. Chick Phase (Day old chicks to 8 weeks of age
ii. Growing Chick Phase (8 weeks to 20 weeks of age)
iii. Laying Chick Phase (20 weeks to 32 weeks of age of layer onwards)

Table 2: Physical and chemical composition of chick ration of layers (%DMB)

	Physical Composition Treatment Groups						Chemical Composition Treatment Groups					
Particulates	**Control (S_0)**	**S_{10}**	**S_{20}**	**S_{30}**	**S_{40}**	**S_{50}**	**Particulates**	**Control (S_0)**	**S_{10}**	**S_{20}**	**S_{30}**	**S_{40}**	**S_{50}**
Maize	45.00	42.50	43.00	40.00	38.00	33.00	DM	95.02	95.10	95.40	95.00	95.30	95.03
Molasses	06.00	06.00	05.00	05.00	04.00	04.00	CP	20.68	20.80	20.44	20.36	20.38	20.50
Soya Flakes	23.00	21.00	16.65	13.50	10.50	07.75	CF	03.77	03.56	03.46	03.27	03.09	02.53
Fishmeal	05.00	05.50	05.00	05.00	05.15	04.00	EE	03.40	03.80	04.40	04.80	05.30	03.70
GNC	11.50	09.00	08.50	07.00	05.00	05.00	NFE	60.01	56.39	53.67	50.09	46.78	42.65
DORB	06.50	05.00	03.00	02.65	03.00	04.00	TA	05.66	05.92	05.95	06.27	06.55	06.99
Salt	00.525	00.525	00.50	00.50	00.50	00.50	AIA	03.59	03.93	04.38	04.85	05.24	05.87
Premix*	00.25	00.25	00.25	00.25	00.25	00.25	Ca	00.98	01.03	01.04	01.10	00.98	00.98
Lime Powder	01.225	01.325	01.30	01.40	01.00	01.00	P	00.55	00.73	00.91	01.08	01.26	01.44
DCP	01.00	01.00	01.00	01.00	01.00	01.00	Meth	00.77	00.79	00.78	00.86	00.97	01.19
SBT cake	00.00	07.90	15.80	23.70	31.60	39.50	Na	00.25	00.29	00.31	00.35	00.35	00.42
Total	100.00	100.00	100.00	100.00	100.00	100.00	ME	2878	2860	2858	2832	2818	2784

Merivite AB_2D_3K: 25g (Vitamin A –82.500 IU, Vitamin B_2 – 52 mg, Vitamin D_3 – 12000 IU, Vitamin K – 10 mg, PO_4 – 395 mg/g)
Nicomix BE: 25g (Vitamin B_1 – 4 mg, Vitamin B_{12} – 40 micro g, Calcium Pentothenate – 40 mg, Vitamin E – 40 mg/g)
Trace Minerals: 50g (Ferric oxide – 2 g, Copper Sulphate – 2 g, Ferrus Sulphate – 10 g, Zinc Sulphate – 0.6 g, Di-Calcium Phosphate – 53.65 g, Manganese Sulphate – 5.5 g, Potassium Iodide – 2.5 g, Sodium Thiosulphate – 0.75 g, Zinc Oxide – 1 g)
Choline Chloride: 100g
Veldot: 25g (Coccidiostat), and
E-care: 25g (Vitamin E)

Table 3: Physical and chemical composition of grower ration of layers (%DMB)

	Physical composition Treatment groups						Chemical composition Treatment groups					
Particulates	**Control (S_0)**	**S_{10}**	**S_{20}**	**S_{30}**	**S_{40}**	**S_{50}**	**Particulates**	**Control (S_0)**	**S_{10}**	**S_{20}**	**S_{30}**	**S_{40}**	**S_{50}**
Maize	50.00	46.15	43.00	39.35	36.85	33.85	**DM**	95.20	95.30	95.33	95.00	95.05	95.09
Molasses	04.55	06.00	06.00	06.00	06.00	06.00	**CP**	18.20	18.50	18.50	18.60	18.40	18.50
Soya Flakes	17.00	15.00	11.75	09.00	06.00	05.00	**CF**	03.40	03.30	03.20	03.10	02.90	02.70
Fishmeal	05.00	05.00	04.50	04.00	03.50	03.00	**EE**	03.20	03.60	04.00	04.50	04.90	05.20
GNC	09.00	08.00	08.00	08.00	07.00	05.00	**NFE**	61.00	59.00	56.00	52.00	50.00	47.00
DORB	10.00	10.00	10.00	10.00	10.00	09.60	**TA**	05.30	05.80	06.10	06.50	06.70	07.00
Salt	00.40	00.40	00.40	00.40	00.30	00.30	**AIA**	03.30	03.90	04.40	04.90	05.30	05.60
Premix*	00.25	00.25	00.25	00.25	00.25	00.25	**Ca**	01.60	01.20	01.20	01.10	01.10	01.10
Limestone	01.50	00.00	00.00	00.00	00.00	00.00	**P**	00.50	00.70	00.80	00.90	01.00	01.10
Lime Powder	01.30	01.30	01.30	01.30	01.40	01.50	**Lys**	00.50	00.80	01.10	01.40	01.80	02.00
DCP	01.00	01.00	01.00	01.00	01.10	01.00	**Meth**	00.90	00.90	01.00	01.10	01.20	1.30
SBT cake	00.00	06.90	13.80	20.70	27.60	34.50	Na	00.20	00.23	00.20	00.20	00.30	00.30
Total	100.00	100.00	100.00	100.00	100.00	100.00	**ME**	2800	2830	2810	2790	2770	2750

Merivite AB_2D_3K: 25g (Vitamin A–82.500 IU, Vitamin B_2 – 52 mg, Vitamin D_3–12000 IU, Vitamin K–10 mg, PO_4– 395 mg/g)
Nicomix BE: 25g (Vitamin B_1 – 4 mg, Vitamin B_{12} – 40 micro g, Calcium Pentothenate – 40 mg, Vitamin E – 40 mg/g)
Trace Minerals: 50g (Ferric oxide– 2g, Copper Sulphate– 2g, Ferrus Sulphate– 10 g, Zinc Sulphate– 0.6g, Di-Calcium Phosphate – 53.65 g, Manganese Sulphate – 5.5 g, Potassium Iodide – 2.5g, Sodium Thiosulphate – 0.75 g, Zinc Oxide–1g)
Choline Chloride: 100g
Veldot: 25g (Coccidiostat), and
E-care: 25g (Vitamin E)

2. *Diet Formulation*

The physical and chemical composition of different experimental rations as per BIS (1992) standard on dry matter basis as per different phases of studies has been given in Tables 2, 3 and 4. Standard methods as reported in AOAC (2005) were followed for determination of proximate composition of ingredients as well as feed samples. The

Table 4: Physical and chemical composition of finisher ration of layers (%DMB)

	Physical composition Treatment groups							Chemical composition Treatment groups					
Particulates	**Control (S_0)**	**S_{10}**	**S_{20}**	**S_{30}**	**S_{40}**	**S_{50}**	**Particulates**	**Control (S_0)**	**S_{10}**	**S_{20}**	**S_{30}**	**S_{40}**	**S_{50}**
Maize	48.23	44.01	41.51	41.00	37.23	34.23	**DM**	95.00	95.08	95.11	95.06	95.02	95.08
Molasses	01.00	02.00	02.00	02.00	02.00	02.00	**CP**	17.80	17.60	17.60	17.70	17.50	17.80
Soya Flakes	20.00	16.00	12.00	10.00	06.00	05.50	**CF**	03.60	03.50	03.40	03.20	03.20	03.10
Fishmeal	05.00	05.00	05.00	04.50	04.00	03.00	**EE**	03.50	03.90	04.20	04.70	05.30	05.50
GNC	05.00	05.00	05.00	04.50	04.00	03.00	**NFE**	57.00	55.00	52.00	50.00	48.00	45.00
DORB	04.50	05.22	05.22	05.23	06.00	07.00	**TA**	04.80	05.30	05.70	05.80	06.30	06.60
Salt	07.00	07.00	07.50	05.50	08.00	06.50	**AIA**	02.70	03.30	03.80	04.20	04.80	05.20
Premix*	00.27	00.27	00.27	00.27	00.27	00.27	**Ca**	03.30	03.70	03.90	03.90	03.80	03.90
Limestone	03.00	03.00	03.00	03.00	02.50	02.00	**P**	00.80	01.00	01.00	01.10	01.20	01.40
Lime Powder	03.00	03.00	03.00	02.50	02.00	02.00	**Lys**	00.80	01.10	01.30	01. 50	01.70	2.00
DCP	03.00	03.00	02.50	02.00	02.00	02.00	**Meth**	00.80	00.90	01.00	01.00	01.20	01.30
SBT cake	00.00	06.50	13.00	19.50	26.00	32.50	Na	00.04	00.07	00.10	00.13	00.16	00.19
Total	100.00	100.00	100.00	100.00	100.00	100.00	**ME**	2600	2600	2600	2620	2620	2610

***Merivite AB_2D_3K:** 25g (Vitamin A– 82.500 IU, Vitamin B_2– 52 mg, Vitamin D_3– 12000 IU, Vitamin K–10 mg, PO_4 – 395 mg/g)
Nicomix BE: 25g (Vitamin B_1 – 4 mg, Vitamin B_{12} – 40 micro g, Calcium Pentothenate – 40 mg, Vitamin E – 40 mg/g)
Trace Minerals: 50g (Ferric oxide– 2g, Copper Sulphate – 2 g, Ferrus Sulphate – 10 g, Zinc Sulphate – 0.6 g, Di-Calcium Phosphate – 53.65 g, Manganese Sulphate – 5.5 g, Potassium Iodide – 2.5 g, Sodium Thiosulphate – 0.75 g, Zinc Oxide – 1 g)
Choline Chloride: 100g
Veldot: 25g (Coccidiostat), and
E-care: 25g (Vitamin E)

metabolizable energy (ME) contents of different test diets used under different experiments were calculated as per the equation proposed by Lodhi *et al*. (1976).

3. *Experimental animals and management*

After procuring the BV-300 strain of layer chicks from Venketshawara Hatcheries Ltd., Nalagarh near Chandigarh, the chicks were kept only on water for first 24 hours and then test feed was offered from the second day onward. They were wing banded, weighed and divided into six treatments and 4 replications containing 15 chicks per replication randomly having same average body weights. The chicks were kept in 24 compartments in the battery brooder which were thermostatically controlled. The standard management practices were followed for rearing the chicks in battery brooders up to 4 weeks of age (Starter phase) and thereafter they were shifted to Californian type cages during Grower and Finisher phase. Clean drinking water and the experimental feeds were always available to the chicks during the entire course of study.

Chick mash was fed to the poultry birds from its arrival until the average body weight of the birds reaches 500 to 600 gms. This was a feed-to-weight program rather than feed-to-age program as per the recommendations of the BV-300 strain chick supplier. In grower stage, grower feed was fed till flock reaches an average body weight of 1000 to 1100 gms. The layer feed was offered to the laying birds during the egg production.

The poultry house was kept well decorated with light, temperature, and humidity was controlled. Enough natural light was also provided. The total duration of lighting was provided up-to 16 hours a day to the birds after taking into consideration of the available natural light. Later, at laying period the artificial light was increased by half an hour every week till it reached 15 hours per day, inclusive of natural light.

4. *Dry Matter Intake (DMI)*

The birds were offered feed twice daily as per the individual requirement and the refusal at the following day were taken and weighed. After deducting the total refusal from the feed offered to the layer, the DMI was calculated with the following equation:

DMI = (DM offered- DM refused)/ day

5. *Body Weight Gain (BWG)*

The weights of chicks were recorded at different interval and the body weight was calculated by the following equation:

BWG = Initial body weight – Final body weight

6. *Hen Housed Egg Production*

The per cent of eggs produced in a particular period of time in respect of the total number of layer chicks reared was calculated by the following equation:

HHEP = (Total No's of eggs produced/ Initial Nos. of chicken kept in the experiment) X 100

7. *Hen Day Egg Production*

Hen day egg production is the per cent of eggs produced daily on the basis of the total layer chicks available in the experiment on a particular day and it was calculated by the following formula:

HDEP = (Total egg production/Total number layer chicks available on a particular day) X 100

8. *Quality Traits/ Parameters of Eggs*

The external and internal quality of eggs were determined at 28th week and 32nd week of age of the poultry layer. The parameters observed during this period were as in Table 9 and 10.

After measuring weight the eggs were broken gently by using a scalpel and its contents were taken on the flat glass plate. The maximum height of yolk and thick albumen were measured from at least 3 places of each broken egg with tripoid micrometer (Froning and Fank, 1958). Individual Haugh unit (Haugh, 1937) score was calculated with the egg weight and albumen height (Doyon *et al.*, 1986) by using the following equation:

$$HU = 100 \log (H - 1.7W^{0.37} + 7.6)$$

Where

HU = Haugh unit

H = Observed height of the albumen in mm

W = Weight of egg (g)

Subsequently, yolk was separated from albumen and weighed. The yolk width and yolk height were also measured and the yolk index was estimated from ratio of yolk height to yolk width.

$$\text{Yolk index} = \frac{\text{Height of egg yolk}}{\text{Width of egg yolk}} \times 100$$

Shell weight was measured after removal of remaining albumen with water and subsequent drying for six hours. Albumen weight was calculated by subtracting the weights of yolk and shell from the weight of whole egg. Shell thickness was measured with a micrometer screw gauge according to Chowdhury (1987). Shell Surface Area (SSA) was determined from the equation according to Paganelli *et al.* (1974) as follows:

$$A = (4.835 \times W^{0.662})$$

Where

A = Shell Surface Area

W = Egg weight (g).

9. *Feed Conversion Ratio (FCR)*

The Feed conversion rate or feed conversion ratio or the feed conversion efficiency is a measure of poultry's efficiency in converting feed mass into body mass under standard condition. FCR is the mass of the feed eaten divided by the body mass gain in a specified period of time. It was calculated by using the following equation:

FCR = Mass of feed consumed / Body mass gain

According to Jafari *et al.* (2006), the Feed efficiency was calculated by following equation:

Feed efficiency = Feed consumed in g / Egg mass production in g

10. *Cost Benefit Ratio*

To compare financial returns in the flocks it is essential to calculate the cost-benefit ratio and it was calculated using the following records: Income from sale of eggs and culled birds, Cost of chicks ,Cost of feed, Cost of labour and other variable costs. From this information, by determining the return on capital, the net profit as a percentage of capital invested was calculated. To do this the gross profit was calculated by taking into consideration the total income and cost of production. Then, from gross profit, all the overhead expenses were deducted to arrive at net profit.

11. *Statistical Analysis*

The data obtained from the experiments was analyzed as per the standard methods of statistical analysis (Snedecor and Cochran, 1967) using Software GraphPad InStat™ 1990-1994, by applying One Way Analysis of Variance. The differences between the treatment means were tested by applying Duncan's (1955) multiple range test (DMRT).

Results and Discussion

Egg Production of Layers

The egg laying was started at 18th week of age onwards of the layers. The average fort-nightly egg production has been given in Table 7. The overall average percent egg production was significantly highest (P<0.01) in S_{20} group (77.22±1.63) and minimum in S_{50} (54.77±3.70) group. The statistical comparison of the result of average per cent of egg production revealed the positive effect of SBT cake CP up-to 20 per cent level of inclusion followed by S_{10} and S_0 groups. The production of S_{30} to S_{50} was found lower. It may be due the fact that the inclusion of CP of SBT more than 20 per cent cannot be used for poultry layer and more then SBT cake was having higher percentage of phosphorous leads to imbalance of nutrient availability and lowered the egg production. The result corroborated with the findings of Monira *et al*. (2003) and lower than that of Khan *et al*. (2004).

Table 5: Fortnightly Egg Production from 20th to 31st weeks of age (%)

Duration	Treatment groups						Significant level
	S_0	S_{10}	S_{20}	S_{30}	S_{40}	S_{50}	
1st Fortnight (20-21 week)	55.71^a±2.63	58.79^a±3.07	60.22^a±4.05	42.67^b±3.27	48.37^{ab}±3.03	42.11^b±1.75	*
2nd Fortnight (22-23 week)	75.83^a±1.50	77.79^a±1.37	81.38^a±1.68	68.31^b±1.78	65.22^{bc}±1.82	60.39^c±1.95	*
3rd Fortnight (24-25 week)	85.33^a±2.00	75.56^b±1.24	77.89^{ab}±1.39	66.00^{cd}±1.95	68.67^{bc}±2.89	58.70^d±2.24	*
4th Fortnight (26-27 week)	78.07^a±1.65	82.56^a±1.68	83.11^a±1.24	70.22^b±2.64	70.74^b±2.05	47.19^c±0.42	*
5th Fortnight (28-29 week)	81.21^a±1.99	81.78^a±1.29	81.19^a±1.32	78.19^a±2.37	74.20^a±2.23	61.62^b±2.37	*
6th Fortnight (30-31 week)	71.53^{ab}±2.20	73.52^a±1.69	79.50^a±1.78	71.65^{ab}±2.29	63.70^{bc}±2.74	58.58^c±2.46	*
Overall	74.61^a±4.24	75.00^a±3.54	77.22^a±3.48	66.17^{ab}±4.99	65.15^{ab}±3.69	54.77^b±3.30	*

Values bearing different superscripts in a same row within the same week differ significantly (*P<0.05, **P<0.01, ***P<0.001); NS =Non significant

Table 6: Economics of layer production from 20th to 31st weeks of age

Attributes	Treatment groups					
	S_0	S_{10}	S_{20}	S_{30}	S_{40}	S_{50}
Body weight	1250.30	1252.40	1259.70	1203.40	1183.10	1160.80
Meat Cost @Rs.70	87.52	87.67	88.18	84.24	82.82	81.26
Avg. Egg production (%)	74.61	75.00	77.22	66.17	65.15	54.77
Egg Cost @Rs. 3	188.03	189.00	194.58	166.76	164.18	138.01
Total Income (Rs./bird)	275.55	276.67	282.76	250.99	247.00	219.26
Dry Matter Intake (g/b/d)	80.24	80.84	80.45	116.68	124.55	86.58
Feed Intake (g/b/d)	84.46	85.09	84.68	122.82	131.11	91.14
Total Feed consumption (kg)	07.09	07.15	07.11	10.32	11.01	07.66
Feed Cost (Rs/kg)	15.00	15.4	15.78	16.18	16.56	16.96
Total Feed Cost (Rs.)	106.42	110.08	112.25	166.93	182.37	129.84
Profit (Rs./bird)	169.12	166.59	170.51	84.07	64.62	89.43
Egg mass g/hen/day	32.58	37.46	37.16	35.18	29.27	27.43
FCR (Feed/egg mass)	02.59	02.27	02.28	03.49	04.48	03.32

• *Egg Mass Production*

The fortnightly egg mass production (g/hen) of the layers has been depicted in table 7. The overall egg mass production found significantly (P<0.05) higher in S_{20} group followed by S_0, S_{10}, S_{30}, S_{40} and S_{50} treatment groups chronologically. The mean egg mass production (g/hen) in the S_{20} group showed significantly (P<0.05) best performance. It was due to the increased in per cent of egg production of the same (S_{20}) treatment group. The refindings to per cent of production as well as egg mass production were lower than that of results depicted by *de* Witt *et al*. (2009) and Jafari (2006). However, the findings of the current study were in close agreement with the findings of Gupta (2003) and Bhatt (1993).

Cost Benefit Ratio of Layer Production at 31st Week of Age

The cost benefit ratio of the layer production was calculated and value regarding it has been presented in Table 8. The largest profit was obtained in S_{20} group followed by S_0, S_{10}, S_{50}, S_{30} and S_{40} treatment groups respectively. It indicated that the birds belonging to S_{20} group was more profitable as compared to other treatment groups.

Quality Traits/ Parameters of Egg

The external and internal quality of egg was studied twice during the experiment at 28th and 32nd week of age of layer. The value regarding the quality traits of egg have been presented in Table 9 and 10.

A. *External Quality Traits*

• *Egg Weight:* The egg weight (g) was found non-significant among all treatments and highest in S_{10} and S_{20} treatment groups. These values were similar with the findings of Khan *et al.* (2004) and Yang *et al.* (2009) but lower than that of Monira *et al.* (2003).

• *Egg Length:* The average values of egg length at these ages were found to be non-significant among all the treatment groups at all the ages and no specific trend of this variation was observed. This result was closely related to the findings of Hasanuzzaman *et al.* (2011), Yang *et al.* (2009), Jafari *et al.* (2006), Khan *et al.* (2004) and Monira *et al.* (2003).

Table 7: External egg quality traits of layers egg

Traits	Age of Layers	Treatment groups						Significant level
		S_0	S_{10}	S_{20}	S_{30}	S_{40}	S_{50}	
Egg production (%)	28th week	81.21ᵃ±1.99	81.78ᵃ±1.29	81.19ᵃ±1.32	78.19ᵃ±2.37	74.20ᵃ±2.23	61.62ᵇ±2.37	*
	32th week	71.53ᵃᵇ±2.20	73.52ᵃ±1.69	79.50ᵃ±1.78	71.65ᵃᵇ±2.29	63.70ᵇᶜ±2.74	58.58ᶜ±2.46	*
	Average	76.37	77.67	80.35	74.92	68.95	60.1	--
External Egg Quality Traits								
Egg weight (g)	28th week	53.09±0.98	53.70±1.04	53.44±0.82	51.58±1.28	53.10±0.64	53.43±0.53	NS
	32th week	52.08±1.05	52.00±0.46	52.24±1.17	51.42±0.93	51.53±0.93	50.49±1.47	NS
	Average	52.59±0.69	52.85±0.62	52.84±0.70	51.50±0.73	52.32±0.60	51.96±0.91	NS
Egg length (cm)	28th week	5.46±0.02	5.50±0.07	5.48±0.03	5.47±0.04	5.47±0.02	5.47±0.06	NS
	32th week	5.45±0.02	5.38±0.02	5.40±0.06	5.34±0.04	5.39±0.05	5.34±0.04	NS
	Average	5.45±0.01	5.44±0.04	5.44±0.03	5.40±0.04	5.43±0.03	5.41±0.04	NS
Egg width (cm)	28th week	4.16±0.04	4.22±0.03	4.19±0.04	4.12±0.03	4.17±0.03	4.20±0.02	NS
	32th week	4.16±0.03	4.14±0.02	4.16±0.04	4.15±0.03	4.10±0.02	4.12±0.04	NS
	Average	4.16±0.02	4.18±0.02	4.18±0.03	4.13±0.02	4.13±0.02	4.16±0.03	NS
Shape index	28th week	76.37±0.58	76.95±0.64	77.02±0.85	77.69±0.47	76.13±0.44	77.01±0.34	NS
	32th week	76.30±0.57	76.73±1.30	76.47±1.01	75.31±0.18	76.24±0.46	76.87±1.16	NS
	Average	76.33±0.38	76.84±0.67	76.75±0.62	76.50±0.51	76.18±0.29	76.94±0.56	NS

Each figure is a mean± SEM value of 20 eggs; Mean bearing different parenthesis in the same row differ significantly; *= (P<0.05); **= (P<0.01); NS= Non-significant

• *Egg Width:* The average values of egg length at these ages was found to be non-significant among all the treatment groups at all the ages and highest in S_{10} and S_{20} treatment groups. This result was corroborated closely with the findings of Hasanuzzaman *et al.* (2011), Yang *et al.* (2009), Jafari *et al.* (2006), Khan *et al.* (2004) and Monira *et al.* (2003).

• *Shape Index:* The average values of shape index at these ages were found to be non- significant highest in T_{20},T_{30} and T_{40} treatment groups as compared to T_{10} (Control group) at all the ages and no specific trend of this variation was observed. This result was closely related to the findings of Hasanuzzaman *et al.* (2011), Yang *et al.* (2009), Jafari *et al.* (2006), Khan *et al.* (2004) and Monira *et al.* (2003).

B. *Internal Quality Traits*

The internal quality traits of egg like Haugh unit, albumin height, albumin length and shell weight at 28th and 32nd week of age were also calculated and presented in table 10.

a. Haugh Unit: The values of Haugh unit at 28th week of age ranged from 77.68±2.73 (S_{10}) to 84.08±1.40 (S_{50}) and found to be significant (P<0.05) being highest in S_{50} and lowest in S_{10} treatment groups. The values of Haugh unit of egg at 32nd week of age was found non-significant. The average mean of Haugh unit was also found to be non-significant among all the treatment groups and no specific trend was observed. This Haugh unit value was higher in S_{50} and lower in S_{10} groups. This might be due to the higher calcium and protein contents of SBT cake which increased the Haugh unit value. The comparable Haugh units were also observed by Rajkumar *et al.* (2010), Parmar *et al.* (2006), Dudusola (2010), Khan *et al.* (2004) and Monira *et al.* (2003) but results were different from the findings of Yang *et al.* (2009) and Jafari *et al.* (2006).

b. Yolk Weight: The yolk weight (g) of egg at 28th and 32nd weeks of age were found to be non-significant among all the treatment groups and no specific trend of this variation was observed. The average mean value during this period was found non-significant among the different treatments group. Higher yolk weight was reported in nacked neck of Andaman by Chatterjee *et al.* (2007), hill fowl from backyards poultry by Singh *et al.* (2009) and Yakubu *et al.* (2008) while Islam *et al.* (2001) and Zhang *et al.* (2005) observed no change in yolk weight in nacked neck birds. The comparative lower proportion of the yolk indicates the lower fat percentage as it is the sole source of fat in the egg.

c. Yolk Height: The yolk height (cm) at 32nd week of age ranged from 1.83±0.07 to 2.11±0.08 cm found to be significant (P<0.05) being highest in S_{50} and lowest in S_0 treatment groups respectively. The average value of yolk height during this period was found to be non-significant among all the treatment groups and no specific trend of this variation was observed. These values of yolk height were higher as compared to the findings of Fayeye *et al.* (2005).

d. Yolk Width: The average value of yolk width during this period was found to be non-significant among all the treatment groups at 28th week of age and no specific trend of this variation was found. However these values were significantally higher in S_{10} group and lowest in S_{50} treatment group. The overall value of yolk width was higher than the findings of Fayeye *et al.* (2005).

e. Yolk Index: The average values of shape index was non-significant among all the treatment groups at all the stages of age and no specific trend of this variation was observed. The values yolk height was similar in study as that of findings of Fayeye *et al.* (2005), Dudusola (2010), but higher than that of Dudusola (2009) and Khan *et al.* (2004).

f. Albumin Weight: The average values of albumin weight at these ages found to be non-significant among all the treatment groups at all the ages and no specific trend of this variation was observed. The values albumin weight was similar with the findings of Khan *et al.* (2004), Fayeye *et al.* (2005), and Dudusola (2010), but lower than that of Yang *et al.* (2009).

g. Albumin Height: The albumin height of egg at 28th week of age ranged from 5.83±0.23 to 6.75±0.25 mm found to be significant ($P<0.05$) being highest in S_0 and lowest in S_{50} groups. The average value of albumin height at 32 week of age was, found to be non-significant among all the treatment groups and decreasing trend with increase in SBT cake was found. This albumin height was observed similar with the findings of Dudusola (2010) but was higher than the findings of Khan *et al.* (2004) and Monira *et al.* (2003).

h. Albumin Length: The average value of albumin length at 28th week of age was found to be significantly higher in S_{10} group as compared to all other groups. This albumin length was observed similar with the findings of Dudusola (2010) but was

Table 8: Internal quality traits of egg at different treatments

Traits	Age of Layers	Treatments						Significant level
		S_0	S_{10}	S_{20}	S_{30}	S_{40}	S_{50}	
Haugh Unit	28th week	78.04^{ab}±1.48	77.68^{a}±2.73	81.45^{ab}±0.39	83.24^{ab}±0.87	83.57^{ab}±1.22	84.08^{b}±1.40	*
	32th week	89.90±2.82	95.78±0.56	94.67±1.27	92.27±1.60	93.26±1.02	92.20±1.86	NS
	Average	83.97±2.68	86.73±3.66	88.06±2.57	87.75±1.90	88.41±1.97	88.14±1.88	NS
Yolk weight (g)	28th week	15.05±0.25	15.62±0.64	14.69±0.33	14.08±0.32	15.28±0.49	14.62±0.21	NS
	32th week	14.33±0.52	13.91±0.25	14.35±0.34	13.73±0.29	13.97±0.21	14.11±0.32	NS
	Average	14.69±0.30	14.76±0.45	14.52±0.23	13.94±0.21	14.62±0.35	14.36±0.20	NS
Yolk height (cm)	28th week	1.93±0.13	2.20±0.03	2.15±0.07	2.02±0.07	2.07±0.05	2.01±0.14	NS
	32th week	1.83^{a}±0.07	1.82^{a}±0.12	1.98^{ab}±0.03	2.04^{ab}±0.03	2.08^{ab}±0.05	2.11^{b}±0.08	*
	Average	1.88±0.07	2.01±0.09	2.07±0.05	2.03±0.04	2.07±0.03	2.06±0.05	NS
Yolk width (cm)	28th week	3.91±0.02	3.85±0.05	3.85±0.02	3.87±0.03	3.96±0.04	3.95±0.05	NS
	32th week	3.91^{a}±0.03	3.92^{a}±0.03	3.84^{ab}±0.03	3.86^{ab}±0.03	3.86^{ab}±0.01	3.78^{b}±0.02	*
	Average	3.91±0.02	3.88±0.03	3.85±0.02	3.87±0.02	3.91±0.03	3.87±0.04	NS
Yolk Index	28th week	0.50±0.03	0.56±0.01	0.56±0.02	0.53±0.02	0.54±0.02	0.53±0.02	NS
	32th week	0.47±0.02	0.47±0.03	0.51±0.01	0.53±0.01	0.52±0.02	0.54±0.02	NS
	Average	0.48±0.02	0.52±0.02	0.54±0.01	0.53±0.01	0.53±0.01	0.53±0.01	NS
Albumin weight (g)	28th week	23.20±0.78	24.58±0.97	23.62±1.14	23.28±0.31	24.46±0.53	24.91±0.45	NS
	32th week	21.38±0.75	22.81±0.43	21.81±1.35	23.97±0.60	23.73±1.38	21.07±0.94	NS
	Average	22.29±0.61	23.69±0.59	22.71±0.88	23.63±0.34	24.09±0.70	22.99±0.87	NS
Albumin height (mm)	28th week	5.83^{a}±0.23	5.84^{a}±0.38	6.34^{ab}±0.09	6.52^{ab}±0.10	6.65^{ab}±0.17	6.75^{b}±0.25	*
	32th week	7.71±0.52	8.81±0.11	8.60±0.29	8.09±0.29	8.28±0.21	8.03±0.28	NS
	Average	6.77±0.44	7.32±0.59	7.47±0.45	7.30±0.33	7.46±0.33	7.39±0.30	NS
Albumin Length (cm)	28th week	8.83^{ab}±0.31	9.01^{a}±0.33	8.58^{ab}±0.08	8.26^{ab}±0.12	8.25^{ab}±0.06	8.05^{b}±0.20	*
	32th week	7.91±0.16	7.56±0.06	7.66±0.10	8.04±0.09	7.89±0.13	8.03±0.18	NS
	Average	8.37±0.34	8.28±0.31	8.12±0.18	8.15±0.08	8.07±0.09	8.04±0.12	NS
Albumin width (cm)	28th week	6.57±0.06	6.59±0.13	6.54±0.04	6.37±0.08	6.44±0.08	6.32±0.19	NS
	32th week	6.22±0.10	5.99±0.91	6.04±0.10	6.11±0.12	6.07±0.08	5.99±0.07	NS
	Average	6.39±0.08	6.29±0.13	6.29±0.11	6.24±0.08	6.26±0.11	6.15±0.11	NS
Shell weight (g)	28th week	6.38^{ab}±0.16	6.43^{ab}±0.17	6.24^{a}±0.12	6.35^{ab}±0.21	6.79^{b}±0.11	6.92^{ab}±0.17	*
	32th week	7.02±0.19	6.97±0.09	7.07±0.11	6.51±0.18	6.98±0.15	6.55±0.22	NS
	Average	6.70±0.17	6.70±0.14	6.66±0.17	6.43±0.13	6.88±0.09	6.74±0.15	NS
Shell thickness (mm)	28th week	0.41±0.01	0.40±0.02	0.42±0.01	0.39±0.01	0.40±0.02	0.43±0.02	NS
	32th week	0.40±0.02	0.41±0.02	0.42±0.02	0.42±0.01	0.42±0.01	0.41±0.01	NS
	Average	0.40±0.01	0.40±0.01	0.42±0.01	0.40±0.01	0.41±0.01	0.42±0.01	NS
Shell Surface Area (cm^2)	28th week	66.19±0.58	66.10±0.72	66.29±0.85	65.61±0.89	65.72±0.63	64.81±1.03	NS
	32th week	67.01±0.81	67.53±0.74	67.30±0.90	65.75±0.74	67.03±0.82	67.30±0.89	NS
	Average	66.60±0.51	66.82±0.52	66.80±0.61	65.68±0.64	66.37±0.52	66.05±0.76	NS

Each figure is a mean± SEM value of 20 eggs; Mean bearing different parenthesis in the same row differ significantly (*= ($P<0.05$); NS=Non-significant.

higher than the findings of Khan *et al.* (2004) and Monira *et al.* (2003).The average value at 32 weeks of age found to be non-significant .

i. Albumin Width: The average values of albumin width at all the ages were found significant among all the treatment groups and no specific trend was observed. The value was in consistence with the findings of Raji *et al.* (2009), ACIAR (1998), Scott and Silversides (2000) and Samli *et al.* (2005).

j. Shell Weight: The shell weight of egg at 28th week of age ranged from 6.24±0.12 to 6.92±0.17 g found to be significantly ($P<0.05$) highest in S_{50} and lowest in S_{20} groups. The average value of shell weight during 32 week of age was found to be non-significant among all the treatment groups and no specific trend of this variation was found. The shell weight was found similar as stated by Fayeye *et al.* (2005), Jafari *et al.* (2006), Yang *et al.* (2009) and Dudusola (2010), but higher than the findings of Anderson *et al.* (2004) in current study.

k. Shell Thickness: The average values of shell thickness at all the ages were found to be non-significant among all the treatment groups and no specific trend was observed. The shell thickness was found similar as stated by Khan *et al.* (2004). The values were found lower than the findings of Fayeye *et al.* (2005) and Anderson *et al.* (2004) but higher than that of Monira *et al.* (2003) and Jafari *et al.* (2006) in current study.

l. Shell Surface Area: The average values of shell surface area at 28th and 32 week of age were found to be non-significant among all the treatment groups and no specific trend of this variation was observed. The shell surface area was found similar as stated by Jafari *et al.* (2006) but lower than the findings of Yang *et al.* (2009) and Dudusola (2010) in current study.

Conclusions

- The egg production, egg mass of layers were higher in S_{20} group where 20 per cent CP of conventional concentrate was replaced with the CP of the SBT cake.
- FCR in respect of growth performance as well as egg mass of the layers was found better in S_{10} treatment group followed by S_{20} treatment group.
- The quality traits of eggs were not appreciably affected by replacement of SBT cake at any level.
- Replacement of CP of conventional layer feed with SBT cake CP upto 20 per cent level was economic for layer production.

References

1. AOAC. Official Methods of Analysis. 16th edition, Association of Official Analytical Chemists., Washington, DC, USA, 2005.
2. BIS. Poultry Feed Specification. IS: 1374 (4th revision). Bureau of Indian standards., Manak Bhavan, 9 Bahadur Zafar Marg, New Delhi-110002, India. 1992.
3. Chowdhury, SD., Effects of feeding steolathyrogens to laying fowl (Gallus domesticus) with particular to egg shell and membrane quality. PhD Thesis, 1987; University of London, UK.
4. Duncan, DB., Multiple range and F tests. Biometrics; 1955;11:1-42.
5. Doyon, G., Bernier-Cardou, M., Hamilton, RMG., Eastaigns, F. and Ramdald, CT. Egg quality. 2. Albumen quality of egg from five commercial strains of White Leghorn hens during one year of lay., Poultry Science., 1986;65:63-66.
6. Froning, GW. and Fank, EM. Seasonal variation in quality of egg laid by caged layers and their sisters on the floor. Poultry Science., 1958;37:215-223.
7. Haugh, RR. The Haugh unit for measuring egg quality. U.S. Egg and Poultry Magazine., 1937;43: 522-555.
8. Jafari, M., Pirmohammadi, R. and Bampidis, V. The Use of Dried Tomato Pulp in Diets of Laying Hens., International Journal of Poultry Science., 2006;5(7): 618-622.
9. Lodhi, GN., Singh, D. and Ichponani, JS. Variation in nutrient content of feeding stuff rich in protein and reassessment of the chemical methods of metabolisable energy estimation. Journal of Agricultural Sciences 1976;86:293-303.
10. Panda, AK. and Reddy, MR. Boosting the chick's immune system through early nutrition. Poultry international 2009;46(7):22-26.
11. Paganelli, CV., Olszowka, A. and Arora, A. The Avian Egg: Surface Area, Volume, and Density. The Condor 1974;76:319-325.
12. Sharma, VK. and Shashwati, KA. Seabuckthorn leaves as a protein replacer for the poultry broiler production. In: 13th Biennial Animal Nutrition Conference. 2009.p.225.
13. Singh. B., Chandan, BK. and Gupta, DK. Phytotherapy Research. 2003;17: 31-536.
14. Singh, V. Seabuckthorn (Hippophae L.) A multipurpose wonder plant. Vol. II: Biochemistry and Pharmacology. 2006; Daya publishing House, Delhi 110 035.
15. Stalazs, A. and Savenkovs, N. Gelechia hippophaella (Schrank, 1802). In: Abstract proceedings of the 5th International Seabuckthorn Association Conference, September 3-8, 2011, Xining, Qinghai, China. p 11.

16. Yang, B. and Kallio, H. Lipophilic Components of Seabuckthorn (Hippophoe rhamnoides L.) Seeds and Berries. In: Seabuckthorn (Hippophoe L.) –A Multipurpose Wonder Plant, Vol. II. Biochemistry and Pharmacology (Singh V, Ed.-in-Chief). Daya Publishing House, New Delhi, 2006.p.600.