COMPARATIVE PERFORMANCE OF NEW HAMPSHIRE AND INDIGENOUS NAKED NECK HENS IN CAGES

By

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THESIS

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Department of Poultry Science

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2000

DECLARATION

I hereby declare that the thesis entitled **"COMPARATIVE PERFORMANCE OF NEW HAMPSHIRE AND INDIGENOUS NAKED NECK HENS IN CAGES"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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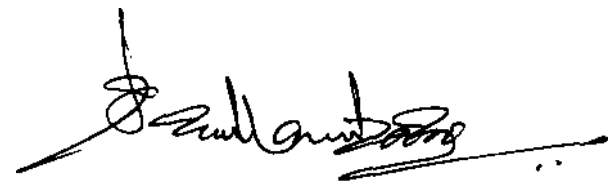
Certified that the thesis, entitled **"COMPARATIVE PERFORMANCE OF NEW HAMPSHIRE AND INDIGENOUS NAKED NECK HENS IN CAGES"** is a record of research work done independently by Jayasree, K.S., under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.



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To
My beloved friend
and guide

CONTENTS

Chapter	Title	Page No.
1	INTRODUCTION	1
2	REVIEW OF LITERATURE	4
3	MATERIALS AND METHODS	14
4	RESULTS	23
5	DISCUSSION	59
6	SUMMARY	72
	REFERENCES	76
	ABSTRACT	

LIST OF TABLES

Table No.	Title	Page No.
1	Per cent composition of feed ingredients in the layer mash fed to the experimental birds.	15
2	Per cent chemical composition of the nutrients in the layer mash on dry matter basis.	16
3	Mean daily meteorological observations during the experimental period from January to June 1999 for Mannuthy region.	24
4	Mean body weight (g) at 20 and 40 weeks of age in New Hampshire (NH) and Naked Neck (NN) hens in cages.	26
5	Age at first egg in the flock and ages at 10 and 50 per cent production (days) in New Hampshire and Naked Neck hens in cages.	28
6	Week-wise mean Hen-Housed number and per cent in New Hampshire and Naked Neck hens in cages from 25 to 40 weeks of age.	29
7	Week-wise mean Hen-Day number and per cent in New Hampshire and Naked Neck hens in cages from 25 to 40 weeks of age.	34
8	Period-wise mean Hen-Housed number and per cent production in New Hampshire and Naked Neck hens in cages from 25 to 40 weeks of age.	38
9	Period-wise mean Hen-Day number and per cent in New Hampshire and Naked Neck hens in cages from 25 to 40 weeks of age.	40
10	Mean daily feed consumption (g) in New Hampshire and Naked Neck hens in cages from 21 to 40 weeks of age.	41
11	Mean feed conversion ratio per dozen eggs in New Hampshire and Naked Neck hens in cages from 25 to 40 weeks of age.	45

12	Mean egg weight (g) in New Hampshire and Naked Neck hens in cages at four weeks intervals during 25 to 40 weeks of age.	47
13	Mean egg mass (kg) per day in New Hampshire and Naked Neck hens in cages at four weeks intervals from 25 to 40 weeks of age.	50
14	Overall mean values of egg quality traits at 40 weeks of age in eggs from New Hampshire and Naked Neck hens in cages.	52
15	Per cent livability in New Hampshire and Naked Neck hens in cages from 21 to 40 weeks of age.	55
16	Economics of egg production over feed cost from 25 to 40 weeks of age in New Hampshire and Naked Neck hens in cages.	56
17	Summary of performance in New Hampshire and Naked Neck hens in cages from 20 to 40 weeks of age.	58

LIST OF FIGURES

Figure No.	Title	Page No.
1	Week-wise mean Hen-Housed (HH) egg number from 23 to 40 weeks of age in New Hampshire and Naked Neck birds.	32
2	Week-wise mean per cent Hen-Housed (HH) production from 23 to 40 weeks of age in New Hampshire and Naked Neck birds.	33
3	Week-wise mean Hen-Day (HD) egg number from 23 to 40 weeks of age in New Hampshire and Naked Neck birds	35
4	Week-wise mean per cent Hen-Day (HD) production from 23 to 40 weeks in New Hampshire and Naked Neck birds.	36
5	Mean daily feed consumption (g) in New Hampshire and Naked Neck birds at different periods.	43
6	Mean feed conversion ratio per dozen eggs in New Hampshire and Naked Neck birds at different periods.	46
7	Mean egg weight (g) in New Hampshire and Naked Neck hens at different ages.	49

Introduction

INTRODUCTION

The poultry industry in India is transformed itself into a dynamic agri-based enterprise from an age-old backyard avocation utilising breeds and varieties under modern housing systems with newer technologies for efficient production. The intensive system accounted for about 70 per cent of total poultry meat and egg production in our country. Indigenous desi fowls although poor in growth and productivity, continued in the mainstream of backyard poultry keeping. India ranked fifth in the world in egg production in the year 1998. The GDP value of egg output was Rs.2190 crores during the year 1993.

Among the states, Andhra Pradesh ranked first in the country while Kerala occupied 12th position in egg production. The estimated annual egg production in our state was 2150 million in the year 1997-98. In Kerala, 52.61 per cent chicken were desi type and only 47.39 per cent were improved varieties (Anon, 1996). The poultry population in Kerala according to 1996 Livestock census was 26.95 million, out of which chicken population was 25.65 million, ducks 1.19 million and other poultry were only 0.11 million (Anon, 1998).

Poultry farming has been identified as one of the subsidiary occupations of the rural poor ensuring economic benefits and employment opportunities. Although backyard system of rearing has been largely replaced by scientific intensive systems, the traditional system has definite role in developing nations particularly in rural areas.

Indigenous breeds and varieties of chicken are well adapted to harsh conditions and they can withstand stressful environment in a better way. Exotic breeds which are high producers are not suited for back-yard conditions. High mortality and adverse environmental conditions work as counter force in rearing exotic birds in rural areas. Therefore desi chickensare being reared in the rural parts of India. In Kerala also by and large native desi birds or its crosses are preferred in villages.

Among the desi birds, Naked Neck fowls are having better egg production potential under tropical climate. The Naked Neck gene has long been known in the domestic fowls as a genetic mutant affecting feather restriction thereby assisting to resist acute heat stress measured in terms of livability. These fowls are distributed in subtropical, tropical and equatorial zones with hot humid climate.

New Hampshire, an exotic breed is a popular general purpose fowl for egg and meat production. This breed was developed from Rhode Island Red by consistent selection procedures for early maturity, larger eggs, quick feathering, strength and vigour. This breed is one among the exotic breeds that could be made use for evolving cross-breds for rearing in the back-yard, after appropriate evaluation.

Studies on housing systems indicate that raising of chickens in cages is beneficial under various agro-climatic conditions with due care for alleviating stress in summer and cold situations.

Considering the above aspects, the present study was undertaken to compare and evaluate the present status of production traits in New Hampshire and Indigenous Naked Neck hens in cages during summer season.

REVIEW OF LITERATURE

History

New Hampshire, an exotic breed ; popular general purpose fowl for egg and meat production was developed from Rhode Island Red by the continual selection procedures for early maturity, larger eggs, quick feathering, strength and vigour and this breed was admitted to the standard of perfection in the year 1935 (Anon, 1974).

The history of the Naked Neck fowl runs into a distant and obscure past and are supposed to have originated in western Hungary but reached their highest state of perfection in Germany. They were also bred in other countries and the desire for smooth skinned dressed fowl are the commendable and favourable features (Anon, 1974).

The Naked Neck type has long been known in the domestic fowl and Davenport (1914) demonstrated that this trait is caused by a dominant gene, called Na. The homozygous (NaNa) birds can be distinguished by sight from heterozygous (Nana) that the later shows a tuft of several dozen feathers on the front of the neck which is absent or reduced to a few units in the homozygous (Crawford, 1976).

Meteorological profile

Somanathan (1980) reported that the highest mean maximum and minimum temperature was 32.35 and 25.27°C respectively during May and the months of February to April was hot and dry season in Mannuthy region since the ambient temperature was above 32°C.

North and Bell (1990) observed that as the ambient temperature increased, the feed intake, bird weight, egg production, egg weight, egg shell quality, shell thickness and interior egg quality decreased.

Body weight

Bordas *et al.* (1982) reported that Naked Neck (NaNa) birds had significantly lower body weight at 39 weeks of age compared to normal neck birds.

Monnet *et al.* (1982) observed that body weight at 18th week were heavier for Naked Neck birds reared at 31°C, the differences decreased with age were not significant from 27 weeks.

Fundora and Valdivie (1989) opined that mean body weight of the Naked Neck birds at 18 weeks of age was 1169 g in comparison with other breeds.

Above 25°C, particularly beyond 30°C, the Naked Neck (NaNa) gene resulted in increased growth rate in chicken (Merat *et al.*, 1991).

Fathi *et al.* (1993) related that body weight at 30 weeks of age did not differ significantly among males of the homozygous Naked Neck, (NaNa) heterozygous Naked Neck (Nana) and normal neck (nana) genotype. The birds of the Naked Neck phenotypes having genotypes NaNa and Nana had higher dressing percentage than New Hampshire (nana) birds.

At 18 weeks of age Naked Neck bird attained an average body weight of 822.5 g (Ibe, 1993).

Akhtar and Bulbul (1994) reported that Naked Neck desi fowls attained a body weight of 1140 g at sexual maturity.

Abdellatif and Horst (1994) observed that Naked Neck fowls had a significantly higher weight gain upto 16 weeks of age than other normal neck types.

Yahav *et al.* (1998) reported that the Naked Neck birds gained more weight at high ambient temperature.

Age at Sexual maturity

Aggarwal *et al.* (1971) reported that the age at first egg for Black Bengal, Aseel and Desi females were 120, 230 and 223 days respectively.

Smit and Lee (1977) found no differences in sexual maturity between homozygous Naked Neck and heterozygous Naked Neck.

The age at first egg in heterozygous Naked Neck birds averaged 146.2 days and in normal necked hens it was 141.0 days in a study conducted by Bordas and Merat (1992).

Bordas *et al.* (1993) explained that genotype significantly affected age at first egg when homozygous or heterozygous Naked Neck and normal necked hens kept in cages at a temperature of 21°C or 31°C from 18 weeks of age.

Abdellatif and Horst (1994) concluded that the Naked Neck birds matured earlier than the dwarf types. Akhtar and Bulbul (1994) stated that the age at sexual maturity was 202 days in Naked Neck desi fowls.

Bhatti and Sahota (1996) mentioned that Fayoumi fowls attained sexual maturity at 145 days of age as against 202.67 days in desi fowls.

Egg production

Horst *et al.* (1986) compared birds with and without the Naked Neck (Na) gene and found that heterozygous (Nana) had significantly higher egg number.

An increase in egg production was reported by Merat *et al.* (1991) in fowls with Naked Neck gene, which reduced feathering by 30-40 per cent.

Bordas *et al.* (1993) reported that hens hetrozygous (Nana) or homozygous (NaNa) for Naked Neck kept in cages at a temperature of 31°C had a significantly higher egg production from 18 week of age.

According to Asiedu and Weever (1993), the mean egg production per hen during the pullet year was 59.5 for Creole birds.

Bhatti and Sahota (1996) noticed that desi fowls laid fewer eggs than other breeds.

Szczerbinska (1996) stated that average annual egg production per hen was 192 in New Hampshire birds.

Feed consumption

Merat *et al.* (1974) opined that Naked Neck phenotype consumed significantly more feed than those normal sized and with normal plumage housed at 18-20°C.

Bordas *et al.* (1982) stated that NaNa birds consumed about 400 g more feed during the period of 28 days. The heterozygous (Nana) birds were intermediate but were closer to the nana birds. In the group exposed to constant ambient temperature of 31°C, the feed consumption in homozygous (NaNa) birds (3636 g) was significantly higher than normal necked (na na) birds (3298 g) and the heterozygous (Nana) registered intermediate values closer to Naked Neck (NaNa) than normal (na na).

The ratio of water to feed intake was significantly lower in Naked Neck hens than normal hens (Monnet *et al.*, 1982).

Rauen *et al.* (1986) reported that feed consumption was non-significantly higher in Naked Neck (NaNa and Nana) fowls than normally feathered birds especially in cooler season.

Yahav *et al.* (1998) opined that the Naked Neck birds consumed more feed at low ambient temperature.

Feed conversion ratio

Rauen *et al.* (1986) stated that at higher temperature (heat stress) the feed conversion was improved in Naked Neck birds.

Merat *et al.* (1991) concluded that the Naked Neck gene reduced feed efficiency at low and moderate ambient temperature below 20°C, but above 30°C, it improved feed efficiency.

Mathur and Horst (1990) opined that Na gene had favourable effect on feed conversion.

Eberhart and Washburn (1993) explained that at 32°C broiler population of Naked Neck birds had better feed conversion ratio than the normally feathered ones.

Fathi *et al.* (1993) opined that the feed conversion did not differ significantly among fowls of the homozygous naked neck (NaNa), heterozygous Naked Neck (Nana) and normal neck (nana) genotypes in all seasons.

Egg weight

Chand *et al.* (1972) reported that the average egg weight of Naked Neck hen was 41.19 g.

Merat (1981) found that egg weight at 10 months of age was significantly higher for Nana than nana in normal sized birds (55.36 V54.56 g).

Fraga *et al.* (1985) noted that the Naked Neck birds produced significantly heavier eggs (55.6 to 57.3 g) than Non-Naked Neck genotypes that registered egg weights between 53.2 and 53.98 g.

Horst *et al.* (1986) observed that the Naked Neck gene (Na) when introduced to laying fowls resulted in higher egg weight.

The Naked Neck gene reduced feathering by 30-40 per cent and increased egg weight in hot climate (Merat *et al.*, 1991).

Bordas and Merat (1992) observed that the egg weight during heat stress averaged 49.2 g and 46.6 g in Naked Neck (Nana) and normal neck (nana) birds and the difference was statistically significant ($P>0.01$).

Yeasmin *et al.* (1992) stated that egg weight was lower for indigenous birds (38.4 g) and for other breeds it was ranged between 59.3 and 59.6 g.

Szczerbinska (1996) reported that mean egg weight in New Hampshire bird when housed in cage was 60.4 g.

Egg mass

Horst *et al.* (1986) reported briefly that at high ambient temperature the Naked Neck gene is associated with a 7.4 per cent gain in total egg mass during the first three months of production.

Egg quality traits

Chand *et al.* (1972) reported that the average yolk weight of Naked Neck hen egg was 13.36 g.

An increase in shell thickness during the period of lay was marked at higher ambient temperature of 28-34°C in comparison with 20°C in the normal Naked Neck hens than dwarf hens (Merat *et al.*, 1974).

Ezzeldin and El-Labban (1989) reported that shell percentage, shell thickness, yolk weight, yolk index, albumin index and Haugh units were lower in New Hampshire birds in comparison to other breeds.

Yeasmin *et al.* (1992) found higher shell thickness, lower shape index, albumin index, yolk index and Haugh unit for indigenous fowls in comparison to other breeds.

Zulkifli *et al.* (1992) observed the Naked Neck gene increased shell weight and breaking strength of eggs at 60 weeks of age.

Szczerbinska (1996) explained shell thickness 0.34 mm and egg shell percentage 8.6 for New Hampshire birds at the ages of 26 and 62 weeks, when housed in cages.

Delgado *et al.* (1998) found that the shell weight percentage of Naked Neck hens was 9.28 VS 9.00 for normal hens.

Kovacs *et al.* (1998) reported higher (P>0.05) yolk weight in New Hampshire hens.

Padhi *et al.* (1988) explained that the Naked Neck eggs had higher yolk percentage and lower albumen percentage.

Egg cholesterol

Hall and McKay (1992) studied that the New Hampshire showed higher egg cholesterol than their crossbreds.

Maurice *et al.* (1995) reported that the egg yolk cholesterol of New Hampshire was 15.2 mg/g yolk and there is also a positive correlation of yolk cholesterol and yolk weight.

Kovacs *et al.* (1998) compared and observed that yolk cholesterol were similar in New Hampshire and Transylvanian Naked Neck white eggs.

Livability

Rauen *et al.* (1986) reported that the Naked Neck gene significantly reduced mortality of birds.

Bordas and Merat (1992) observed that the mortality rate was 10.5 and 18.2 per cent for Naked Neck (Nana) and normal hens (nana) during heat stress.

Szczerbinska (1996) found the mortality rate was nine per cent for New Hampshire birds when housed in cages.

Materials and Methods

MATERIALS AND METHODS

An experiment was conducted at the Kerala Agricultural University Poultry Farm, Mannuthy to compare and evaluate the production performance of New Hampshire and Indigenous Naked Neck layers reared in cages. The chicks required for the study were hatched at the University Poultry Farm, Mannuthy. They were reared on litter floor under standard managemental conditions until 18 weeks of age and thereafter in cages. The objective of the present study was to evaluate and compare the production performance of New Hampshire and Indigenous Naked Neck hens from 20 to 40 weeks of age under cage system of rearing.

Sixty (60) pullets each of New Hampshire and Indigenous Naked Neck at the age of 18 weeks were housed in identical cages in four replicates each at the rate of 15 birds per replicate and three birds per cage at random in a well ventilated house with a floor space of 454 cm^2 per bird. The body weights were recorded individually at the age of 20 weeks. Standard managemental practices for layers in cages were followed throughout the experiment.

The production performance was tested for 5 periods of 28 days each from 20 to 40 weeks of age. The layer mash as per BIS (1993) was fed *ad libitum*. The ingredient composition of the feed is presented in Table 1. The proximate composition of the ration was estimated according to the procedure

described in AOAC (1990). The per cent chemical composition of nutrients in the layer mash on dry matter basis is presented in Table 2

Table 1. Per cent composition of feed ingredients in the layer mash fed to the experimental birds

Sl.No.	Ingredient	Per cent
1.	Yellow maize	45.00
2.	Groundnut cake	16.00
3.	Gingelly oil cake	5.00
4.	Dried unsalted fish	5.00
5.	Rice polish	23.00
6.	Shell grit	4.00
7.	Mineral mixture*	1.75
8	Salt	0.25

For every 100 kg feed add: Vitamin premix 10 g. Indomix (AB_2D_3): Vitamin A 40,000 IU., Vitamin B_2 20 mg., Vitamin D_3 5000 IU per gram.

*Mineral mixture: Moisture (max.) 3%, calcium 32%, phosphorus 6%, manganese 0.27%, iodine 0.01%, zinc 0.26%, Fluorine (max.) 0.03%, iron 1000 ppm, copper 100 ppm.

Table 2. Per cent chemical composition of the nutrients in the layer mash on dry matter basis

Nutrients	Per cent
Dry matter	89.99
Moisture	10.01
Crude protein	18.53
Crude fibre	4.91
Ether extract	5.02
Nitrogen free extract	41.38
Total ash	13.70
Acid insoluble ash	6.45
Calcium	2.10
Phosphorus	0.64
Metabolizable energy (Kcal/Kg)	2675.00
(Calculated value)	

The following observations were recorded during the course of the experiment.

1. Body weight at 20 and 40 weeks of age
2. Age at first egg in each replicate (days)
3. Age at 10 and 50 per cent production (days)
4. Weekly egg production on HH and HD basis

5 Period-wise egg production on HH and HD basis

6. Mean daily feed consumption (g)

7. Mean feed conversion ratio

8. Mean egg weight (g)

9. Mean egg mass (kg)

10. Egg quality in terms of per cent shell, albumin and yolk, shape, albumen and yolk indices, Haugh Unit Score

11. Shell thickness

12. Egg yolk cholesterol

13. Livability

14. Economics over feed cost

Body weight

The body weight of birds at 20 and 40 weeks of age were recorded individually to the nearest 10 g accuracy.

Sexual maturity

The age at first egg as well as ages at 10 and 50 per cent production were recorded in each replicate and from these data, the age at sexual maturity in New Hampshire and indigenous Naked Neck birds were determined.

Weekly egg production

Hen-housed (HH) and Hen-day (HD) egg number and their percentages were estimated on weekly basis. The level and duration of peak production were also determined. However the age at which both groups (New Hampshire and Indigenous Naked Neck) commenced laying was used for statistical analysis.

Period-wise egg production

Hen-housed (HH) and Hen-day (HD) egg number and its per cent production were also estimated on period-wise basis. In this case also, the age from which both groups of New Hampshire and Indigenous Naked Neck commenced laying were used for statistical analysis.

Feed consumption

Ad libitum feed was issued in each replicate daily from the feed bins and the balance feed available in the feeders and feed bins at the end of each period were recorded. From this, period-wise mean daily feed consumption per bird per replicate was worked out.

Feed conversion ratio

Feed efficiency was calculated period-wise in each replicate as kilogram of feed consumed to produce dozen eggs. For statistical analysis, feed efficiency values at the end of each period were used from 21 weeks of age.

Egg weight

Three eggs from each replicate during three consecutive days towards the end of 24, 28, 32, 36 and 40 weeks of age were weighed individually to the accuracy of 0.01 g and mean egg weight was arrived at for New Hampshire and Indigenous Naked Neck. Each of these mean values was also considered as the mean egg weight for that particular week and period.

Egg mass

Egg mass was worked out replicate-wise based on the total weight of all eggs laid during the three consecutive days towards the end of 24, 28, 32, 36 and 40 weeks of age. Thus, egg mass for 15 days were recorded altogether in each group and the mean egg mass per day was estimated.

Egg quality

Three eggs in each replicate collected from three consecutive days towards the end of each period were broken to study the egg quality parameters. The weights of shell, albumin and yolk were recorded and expressed as percentage of egg weight. The shape Index, Albumin Index, Yolk Index and Haugh Unit were measured. The shell thickness was measured using the shell thickness gauge.

Egg yolk cholesterol

Egg yolk cholesterol was estimated by the method of Zak (1957) according to the principle and procedure detailed below.

Zak method

Principle

A solution of cholesterol in acetic acid produces a red colour when treated with ferric chloride and sulphuric acid. The colour produced is estimated photometrically.

Procedure

1. Stock ferric chloride solution : Ferric chloride 840 mg was dissolved in a few ml of glacial acetic acid and was diluted to 100 ml with acetic acid.

2. Ferric chloride precipitating reagent : Stock ferric chloride solution was diluted to one in 10 ml with acetic acid.

3. Ferric chloride blank : Stock ferric chloride solution (1.7 ml) was diluted to 20 ml with glacial acetic acid.

4. Cholesterol stock standard : 100 mg Pure dry cholesterol was dissolved in 100 ml glacial acetic acid.

5. Working standard : Cholesterol stock standard (2 ml) was mixed with 1.7 ml of stock ferric chloride solution and diluted to 20 ml with glacial acetic acid.

6. Final standard : Prepared by mixing two ml of the working standard with four ml of the ferric chloride blank solution just before use.

The egg yolk was completely separated from the egg contents, with the yolk membranes intact. Using a filter paper, weight of the yolk was recorded and

the homogenate was prepared in normal saline using the Potter Elvehjem type homogenizer. The final volume of the homogenate was made up to 20 ml.

This homogenate (0.05 ml) was added to six ml of ferric chloride precipitating reagent, mixed and filtered through a dry Whatman No. 42 filter paper and the filtrate was collected in a test tube. Three ml each of the filtrate, final standard (0.1 mg/3 ml) and ferric chloride blank were taken in separate labelled test tubes, two ml of concentrated sulphuric acid was added slowly to each tube and was mixed by gentle shaking. The solutions were cooked, and readings were taken in a spectrophotometer at a wavelength of 500 nm, setting the instrument to zero with the blank solution.

Calculation

$$\text{Total cholesterol (g\%)} = \frac{U}{S} \times \frac{0.1 \times 20}{W \times 0.025}$$

Where

U = reading of unknown

S = reading of standard

0.1 = concentration of standard in mg

W = weight of yolk in g

0.025 = volume of homogenate present in the test solution (0.025 ml/3ml precipitating reagent).

20 = volume of homogenate prepared in ml.

Livability

The week-wise per cent livability was recorded based on the number of birds died in each week.

Economics over feed cost

The economics of egg production over feed cost was calculated taking into account the cost of feed ingredients prevailing at the local market.

The data were subjected to statistical analysis as per methods described by Snedecor and Cochran (1985) in order to draw conclusion.

Results

RESULTS

Meteorological Observations

The meteorological data for each 28-day periods commencing from 15th January to 3rd June 1999 are presented in Table 3. The experimental period from 21 to 40 weeks of age was divided into five periods (I to V) and the mean daily maximum temperature during these periods ranged between 30.05°C (Period I) and 35.45°C (Period II). The highest mean value (35.45°C) recorded during Feb-March in period II was comparable to the maximum temperature of 34.95°C in period III. The age of experimental birds corresponding to periods II and III was from 25 to 32 weeks and the temperature during these two periods was higher than that recorded in other periods. The overall mean value of maximum temperature during the entire period of experiment from 21 to 40 weeks of age was 33.31°C.

The mean daily minimum temperature averaged between 21.95°C and 25.92°C with an overall mean value of 24.12°C. The lowest temperature recorded was in period I and the highest in period IV and the difference between these values was narrow.

The per cent relative humidity (R.H) in the forenoon ranged from 76.75 to 92.25 in periods I to V with an overall mean of 85.20 per cent. The R.H per cent values in the first two periods were statistically non-significant. In the subsequent

Table 3. Mean daily meteorological observations during the experimental period from January to June 1999 at Mannuthy region

Parameters	Experimental periods/age of birds in weeks					Overall mean
	Jan-Feb I/21-24	Feb-Mar II/25-28	Mar-Apr III/29-32	Apr-May IV/33-36	May-June V/37-40	
1. Temperature (°C)						
a. Maximum	b 33.15 ±0.46	a 35.45 ±0.58	a 34.95 ±0.08	b 32.97 ±0.34	c 30.05 ±0.42	33.31 ±0.46
b. Minimum	d 21.95 ±0.86	c 23.42 ±0.48	ab 24.90 ±1.35	a 25.92 ±0.09	bc 24.40 ±0.44	24.12 ±0.36
2. Per cent Relative Humidity						
a. Forenoon	b 76.75 ±2.92	b 78.75 ±4.78	a 89.75 ±0.48	a 88.50 ±0.86	a 92.25 ±1.93	85.20 ±1.78
b. Afternoon	c 38.75 ±2.49	c 34.75 ±1.43	b 54.50 ±0.29	b 59.75 ±0.75	a 75.00 ±3.89	52.55 ±3.46
3. Rainfall (mm)	22.8	--	6.20	478	453.1	529.9
4. Sunshine Hours/day	a 9.30 ±0.51	a 9.30 ±0.80	a 8.02 ±0.22	b 5.62 ±0.74	b 4.87 ±0.81	7.42 ±0.49
5. Wind Speed (km/h)	a 5.80 ±1.39	ab 5.32 ±0.98	c 2.65 ±0.06	gc 3.25 ±0.06	c 2.87 ±0.26	3.98 ±0.43

Means carrying the same superscript within a row did not differ significantly ($P<0.05$)

three periods per cent R.H. values were in a homogenous group and the mean values in this group was significantly higher than those in the initial two periods.

The R.H. per cent in the afternoon ranged from 38.75 to 75.00, in periods I to V with an overall mean of 52.55 per cent. The statistical analysis showed that the R.H. values for the initial two periods were significantly lower than the subsequent periods. The intermediary values recorded in periods III and IV were statistically non-significant. But the relative humidity recorded in period V was significantly higher than the previous periods.

The mean daily sunshine hours during the initial three periods were significantly higher than those values recorded in subsequent periods IV and V. The mean values ranged from 4.87 to 9.3 h/day.

The mean values of daily wind speed ranged between 2.65 to 5.80 Km/h, the highest being in period I and the lowest in period III. The difference between mean values of periods I and III was significant and the values in other periods were intermediary.

Body weight

The mean body weight (BW) recorded at 20 and 40 weeks of age are presented in Table 4. The mean BW at 20 weeks of age was 1675.10 g in New Hampshire (NH) and 1682.30 g in Naked Neck (NN) pullets. The body weight at 40 weeks of age was 2635.45 and 2703.65 g in NH and NN respectively.

Table 4. Mean body weight (g) at 20 and 40 weeks of age in New Hampshire (NH)and Naked Neck (NN) hens in cages

Parameters	Replicates				Overall mean
	1	2	3	4	
Body weight at 20 weeks					
New Hampshire	1684.80 ±64.62	1714.00 ±24.06	1660.80 ±18.85	1640.80 ±58.00	1675.10[a] ±21.98
Naked Neck	1678.80 ±51.79	1687.40 ±51.44	1724.20 ±65.47	1638.80 ±36.32	1682.30[a] ±24.95
Body weight at 40 weeks					
New Hampshire	2668.00 ±111.21	2795.00 ±83.85	2465.00 ±89.68	2613.60 ±51.12	2635.45[b] ±48.09
Naked Neck	2672.60	2762.60 ±119.35	2662.00 ±78.25	2717.40 ±102.26	2703.65[b] ±49.23

The overall means bearing the same superscript between NH and NN did not differ significantly ($P<0.05$)

The body weights showed no significant difference between NH and NN both at 20 and 40 weeks of age.

Age at sexual maturity

The age at first egg in the flock as well as the ages at 10 and 50 per cent production are presented in Table 5. The first egg was laid at 161-days of age in both the flocks, NH and NN. The overall mean age at 10 per cent production was 168.15 days in NH and 170.35 days in NN and the difference between the mean values was non-significant. The 50 per cent level production was attained at 175.50 and 176.55 days in NH and NN, respectively.

Egg production

Weekly hen-housed egg number and per cent

The mean hen-housed egg number (HHN) in NH and NN flocks from 25 to 40 weeks of age are presented in Table 6. The week-wise and overall mean values of HH production were compared between NH and NN in order to decipher the intensity of production in the two groups. The hen-housed egg number and per cent at 23 and 24 weeks of age were very low and hence not included in the statistical analysis.

The week-wise mean HH egg number in New Hampshire ranged between 1.91 and 5.14 with an overall mean of 4.15 eggs/bird/week. Whereas in Naked Neck birds, the weekly mean values were ranged from 1.77 to 5.55 with an overall mean of 4.51 eggs/bird/week (Table 6). Statistical analysis of the data revealed

Table 5. Age at first egg in the flock and ages at 10 and 50 per cent production (days) in New Hampshire and Naked Neck hens in cages

Parameters	Replicates				Overall mean
	1	2	3	4	
Age at first egg					
New Hampshire	166	165	166	161	164.50 ± 1.01 [a]
Naked Neck	163	166	169	161	164.71 ± 1.01 [a]
Age at 10 per cent production					
New Hampshire	167.00 ±0.44	168.60 ±1.47	170.20 ±1.32	166.80 ±2.50	168.15 ±1.36 [a]
Naked Neck	166.80 ±1.46	171.00 ±1.92	177.40 ±2.54	166.20 ±1.71	170.35 ±1.36 [a]
Age at 50 per cent production					
New Hampshire	173.80 ±1.74	176.80 ±1.26	175.00 ±3.07	176.40 ±4.95	175.50 ±1.48 [a]
Naked Neck	175.00 ±2.97	179.00 ±1.26	179.00 ±2.54	172.80 ±1.35	176.55 ±1.17 [a]

The overall means carrying the same superscript between NH and NN did not differ significantly ($P<0.05$)

Table 6. Week-wise mean Hen-Housed (HH) number and per cent in New Hampshire and Naked Neck hens in cages from 25 to 40 weeks of age

Period	Age in weeks	HH Number		HH per cent	
		New Hampshire	Naked Neck	New Hampshire	Naked Neck
I	23	0.01	0.01	0.23	0.23
	24	0.38	0.38	5.47	5.47
II	25	1.91 ^{b}	1.77 ^{f}	27.28 ^{a}	25.28 ^{a}
		± 0.29	± 0.22	± 4.20	± 3.24
	26	3.26 ^{e}	2.77 ^{r}	46.57 ^{a}	39.57 ^{a}
		± 0.27	± 0.29	± 3.97	± 4.27
	27	3.74 ^{efg}	3.70 ^{d}	53.42 ^{a}	52.85 ^{a}
		± 0.22	± 0.26	± 3.20	± 3.75
	28	4.35 ^{bcde}	4.62 ^{bc}	62.14 ^{a}	66.00 ^{a}
		± 0.20	± 0.16	± 2.96	± 4.22
III	29	3.94 ^{cdef}	4.27 ^{cd}	56.28 ^{a}	61.00 ^{a}
		± 0.23	± 0.29	± 3.35	± 4.22
	30	4.43 ^{bcd}	4.91 ^{abc}	63.58 ^{a}	70.14 ^{a}
		± 0.18	± 0.25	± 2.28	± 3.60
	31	5.14 ^{a}	5.55 ^{a}	73.42 ^{a}	79.28 ^{a}
		± 0.20	± 0.17	± 2.68	± 2.44
	32	4.30 ^{bcde}	5.05 ^{ab}	61.42 ^{a}	72.14 ^{a}
		± 0.26	± 0.19	± 2.28	± 2.82
IV	33	3.65 ^{fg}	4.66 ^{bc}	52.14 ^{b}	66.57 ^{a}
		± 0.22	± 0.27	± 3.26	± 3.85
	34	3.90 ^{def}	4.93 ^{ab}	55.71 ^{b}	70.42 ^{a}
		± 0.21	± 0.24	± 3.06	± 3.55
	35	4.60 ^{ab}	4.95 ^{ab}	65.71 ^{a}	70.71 ^{a}
		± 0.17	± 0.24	± 3.14	± 3.56
	36	4.62 ^{ab}	5.01 ^{ab}	66.00 ^{a}	71.57 ^{a}
		± 0.18	± 0.24	± 2.66	± 3.37
V	37	4.53 ^{bc}	4.90 ^{aba}	64.71 ^{a}	70.00 ^{a}
		± 0.21	± 0.25	± 3.11	± 3.63
	38	4.79 ^{ab}	4.85 ^{bc}	68.42 ^{a}	69.28 ^{a}
		± 0.19	± 0.23	± 2.82	± 3.56
	39	4.52 ^{ac}	5.00 ^{ab}	64.57 ^{a}	71.42 ^{a}
		± 0.17	± 0.25	± 3.11	± 3.63
	40	4.73 ^{ab}	5.19 ^{ab}	67.57 ^{a}	74.14 ^{a}
		± 0.14	± 0.18	± 2.06	± 2.63
Overall mean	25-40	4.15 ^{a}	4.51 ^{a}	59.28 ^{a}	64.42 ^{a}
		± 0.06	± 0.07	± 0.95	± 1.10

Means carrying the same superscripts within NH and NN under HHN and between NH and NN under HHP did not differ significantly ($P<0.05$)

Overall means carrying the same superscript between NH and NN did not differ significantly ($P<0.05$).

that the overall HH egg production up to 40 weeks of age was similar in New Hampshire and Naked Neck birds ($P<0.05$).

The pattern of egg production in NH and NN showed that the egg production started at the end of 23rd week of age in both flocks. In NH, it gradually increased to 1.91 eggs/bird/week at 25th week and thereafter to 4.35 eggs/bird/week at 28 weeks of age. They recorded week-wise peak production at 31st week of age at the rate of 5.14 eggs/bird/week. It was significantly higher than the previous week egg number. After peak production, a significant reduction was observed in egg number at 32 and 33 weeks to a level of 4.30 and 3.65 eggs, respectively. The egg number during 35 to 40 weeks of age was more than 4.50 in each week.

In Naked Neck birds, the week-wise mean egg production ranged from 1.77 eggs at 25th week to a peak production of 5.55 eggs per bird at 31 weeks of age. The week-wise mean egg number from 30 to 40 weeks was statistically comparable except those mean values recorded at 33 and 38 weeks of age wherein the egg number was 4.66 and 4.85 respectively.

The per cent HH production at 25th week was 27.28 and 25.28 in NH and NN birds respectively. Both the flocks recorded peak production at 31st week of age with a percentage of 73.42 in NH and 79.28 in NN. The week-wise production from 30 weeks of age (except 33 and 38 weeks) were more than 65 per cent in each week in Naked Neck birds. The overall mean weekly hen-housed number was 4.15 eggs in NH and 4.51 egg in NN with a percentages of 59.28 and

64.42. The magnitude of differences in week-wise mean hen-housed number and per cent are depicted in Figures 1 and 2.

Weekly Hen-day egg number and per cent

The data pertaining to the weekly hen-day egg number from 25 to 40 weeks and the respective percentages in New Hampshire and Naked Neck hens are presented in Table 7.

The hen-day egg number and per cent at 23 and 24 weeks of age were very low. Hen-day production in NH increased significantly from 1.91 at 25th week to 4.35 at 28th week with a corresponding percentages of 27.28 and 62.14.

The weekly hen-day number (HDN) and per cent from 25 to 28 weeks in Naked Neck (NN) were the same as that of corresponding hen-housed number and per cent in all weeks upto 28 weeks as there was no mortality during this period. The highest weekly hen-day number recorded was 5.14 in New Hampshire and 5.55 in Naked Neck at 31st week with corresponding percentages of 73.42 and 79.28, respectively.

The weekly hen-day production was significantly higher in Naked Neck birds than that of NH at 33rd and 34th week. The overall mean weekly hen-day egg number was 4.16 in New Hampshire and 4.52 eggs in Naked Neck with a percentage of 59.42 and 64.57 respectively. The magnitude of variations in weekly hen-day number and per cent from 25 to 40 weeks of age are presented graphically in Figures 3 and 4.

Fig.1. WEEK WISE MEAN HEN-HOUSED (HH) EGG NUMBER FROM 23 TO 40 WEEKS OF AGE IN NEW HAMPSHIRE AND NAKED NECK BIRDS

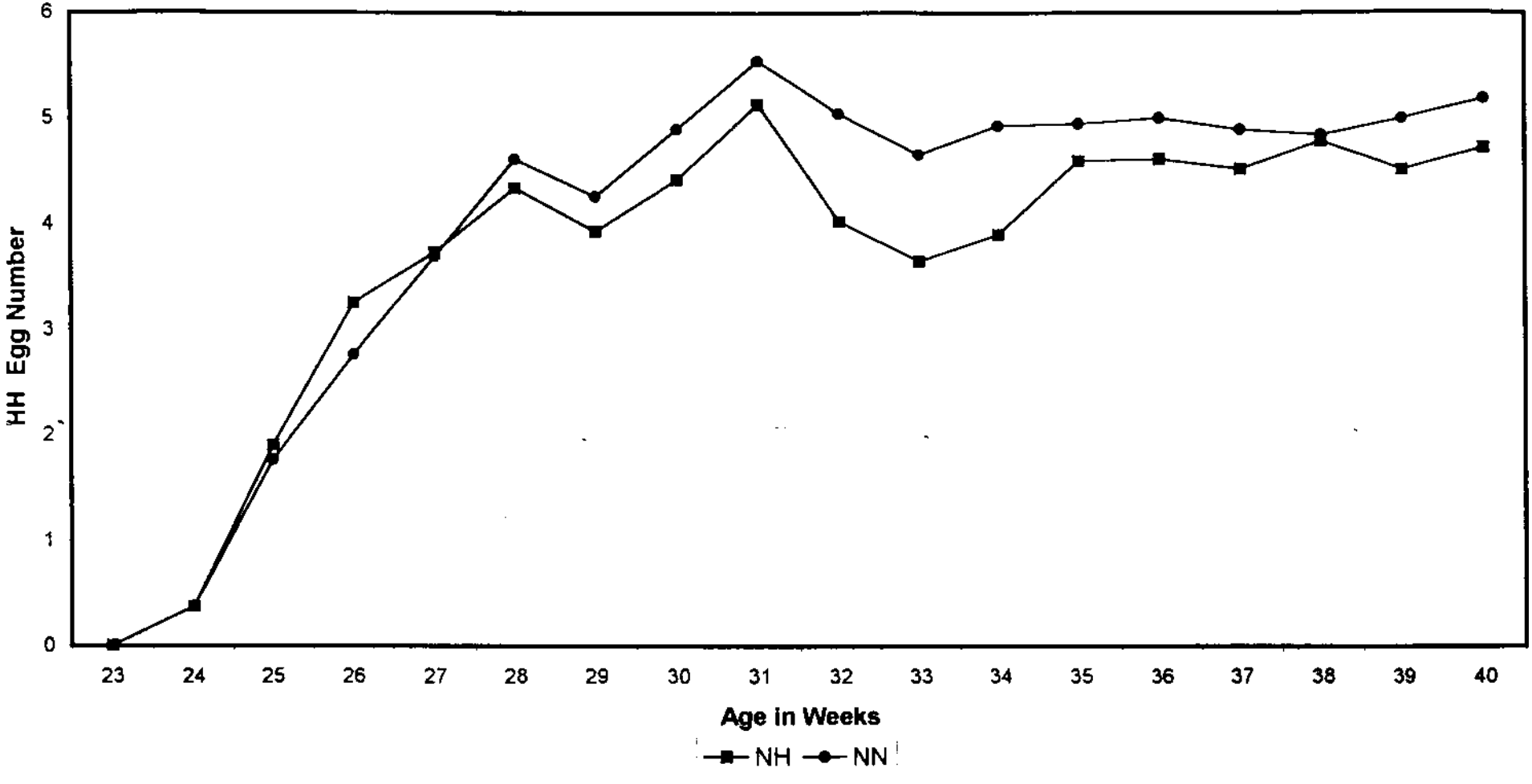


Fig.2. WEEK WISE MEAN PERCENTAGE HEN - HOUSED (HH) PRODUCTION FROM 23 TO 4O WEEKS OF AGE IN NEW HAMPSHIRE AND NAKED NECK BIRDS

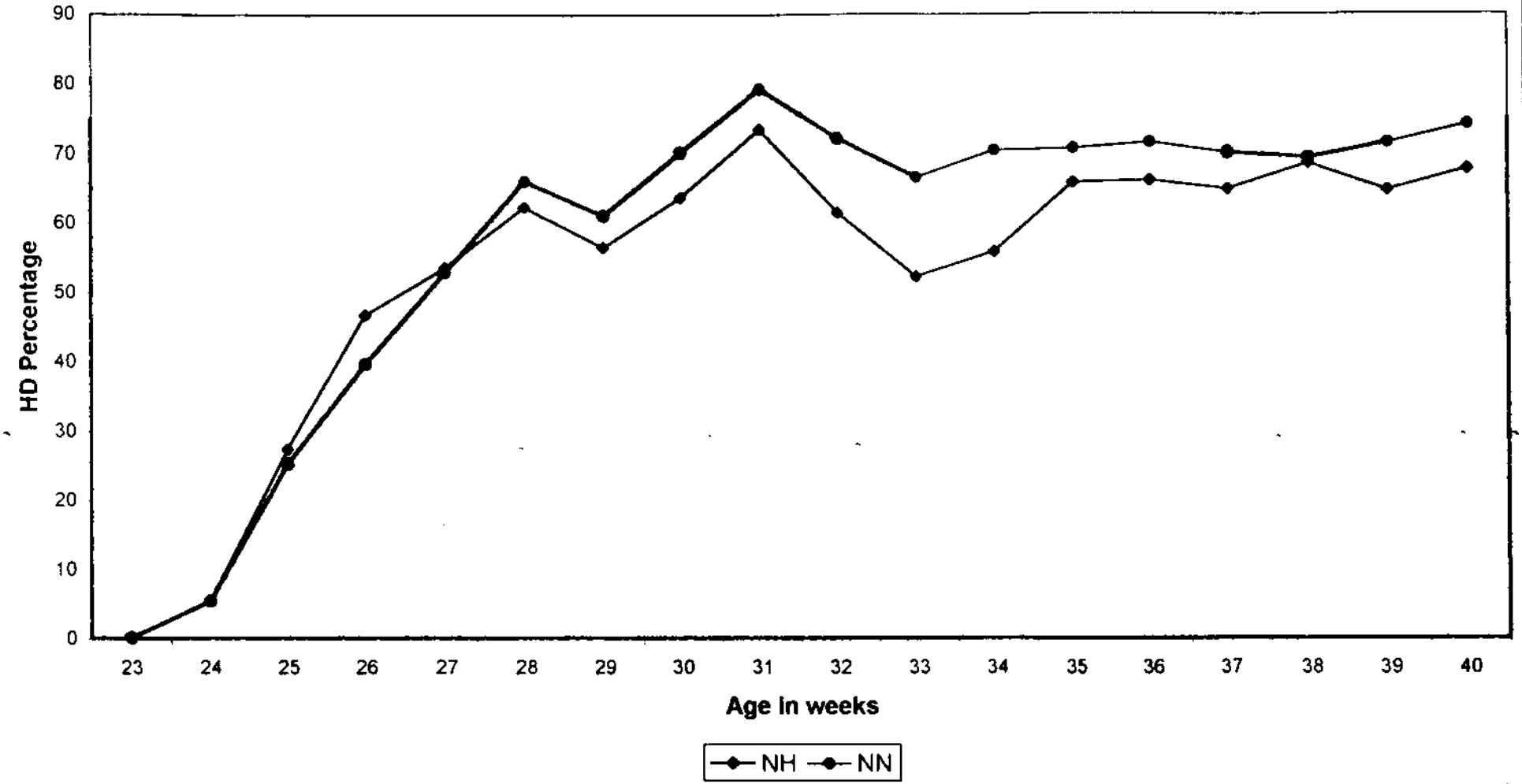


Table 7. Week-wise mean Hen-Day (HD) number and per cent in New Hampshire and Naked Neck hens in cages from 25 to 40 weeks of age

Periods	Age in weeks	HD Number		HD per cent	
		New Hampshire	Naked Neck	New Hampshire	Naked Neck
I	23	0.01	0.01	0.23	0.23
	24	0.38	0.38	5.47	5.47
II	25	1.91 ^{g} ± 0.29	1.77 ^{f} ± 0.22	27.28 ^{a} ± 4.20	25.28 ^{a} ± 3.24
	26	3.26 ^{f} ± 0.27	2.77 ^{e} ± 0.29	46.57 ^{a} ± 3.97	39.57 ^{a} ± 4.21
	27	3.76 ^{ef} ± 0.22	3.70 ^{d} ± 0.26	53.71 ^{a} ± 3.23	52.85 ^{a} ± 3.75
	28	4.35 ^{bcd} ± 0.21	4.62 ^{bc} ± 0.29	62.14 ^{a} ± 2.96	66.00 ^{a} ± 2.24
III	29	4.01 ^{cde} ± 0.23	4.29 ^{cd} ± 0.25	57.28 ^{a} ± 3.36	61.28 ^{a} ± 4.09
	30	4.47 ^{bcd} ± 0.17	4.91 ^{abc} ± 0.17	63.85 ^{a} ± 2.48	70.14 ^{a} ± 2.44
	31	5.14 ^{a} ± 0.18	5.55 ^{a} ± 0.19	73.42 ^{a} ± 2.68	79.28 ^{a} ± 2.82
	32	4.30 ^{abc} ± 0.20	5.05 ^{ab} ± 0.27	61.42 ^{a} ± 2.85	72.14 ^{a} ± 3.85
IV	33	3.65 ^{ef} ± 0.22	4.66 ^{bc} ± 0.24	52.14 ^{b} ± 3.26	66.57 ^{a} ± 3.55
	34	3.90 ^{de} ± 0.21	4.93 ^{abc} ± 0.24	55.71 ^{b} ± 3.06	70.42 ^{a} ± 3.56
	35	4.60 ^{ab} ± 0.21	4.95 ^{abc} ± 0.24	65.71 ^{a} ± 3.14	70.71 ^{a} ± 3.23
	36	4.62 ^{ab} ± 0.18	5.03 ^{ab} ± 0.24	66.00 ^{a} ± 2.66	71.85 ^{a} ± 3.63
V	37	4.53 ^{abc} ± 0.21	4.90 ^{abc} ± 0.25	64.71 ^{a} ± 3.11	70.00 ^{a} ± 3.63
	38	4.79 ^{ab} ± 0.19	4.88 ^{bc} ± 0.23	68.42 ^{a} ± 2.82	69.71 ^{a} ± 3.37
	39	4.52 ^{abc} ± 0.17	5.06 ^{ab} ± 0.25	64.54 ^{a} ± 2.53	72.28 ^{a} ± 3.15
	40	4.75 ^{ab} ± 0.12	5.19 ^{ab} ± 0.18	67.85 ^{a} ± 1.85	74.14 ^{a} ± 2.63
Overall mean	25-40	4.16 ^{a} ± 0.06	4.52 ^{a} ± 0.07	59.42 ^{a} ±0.95	64.57 ^{a} ± 1.09

Means carrying the same superscripts within NH and NN under HDN and between NH and NN under HDP did not differ significantly ($P<0.05$)

Overall mean carrying the same superscript between NH and NN did not differ significantly ($P<0.05$).

Fig.3. WEEK WISE MEAN HEN - DAY(HD) NUMBER FROM 23 TO 40 WEEKS OF AGE IN NEW HAMPSHIRE AND NAKED NECK BIRDS

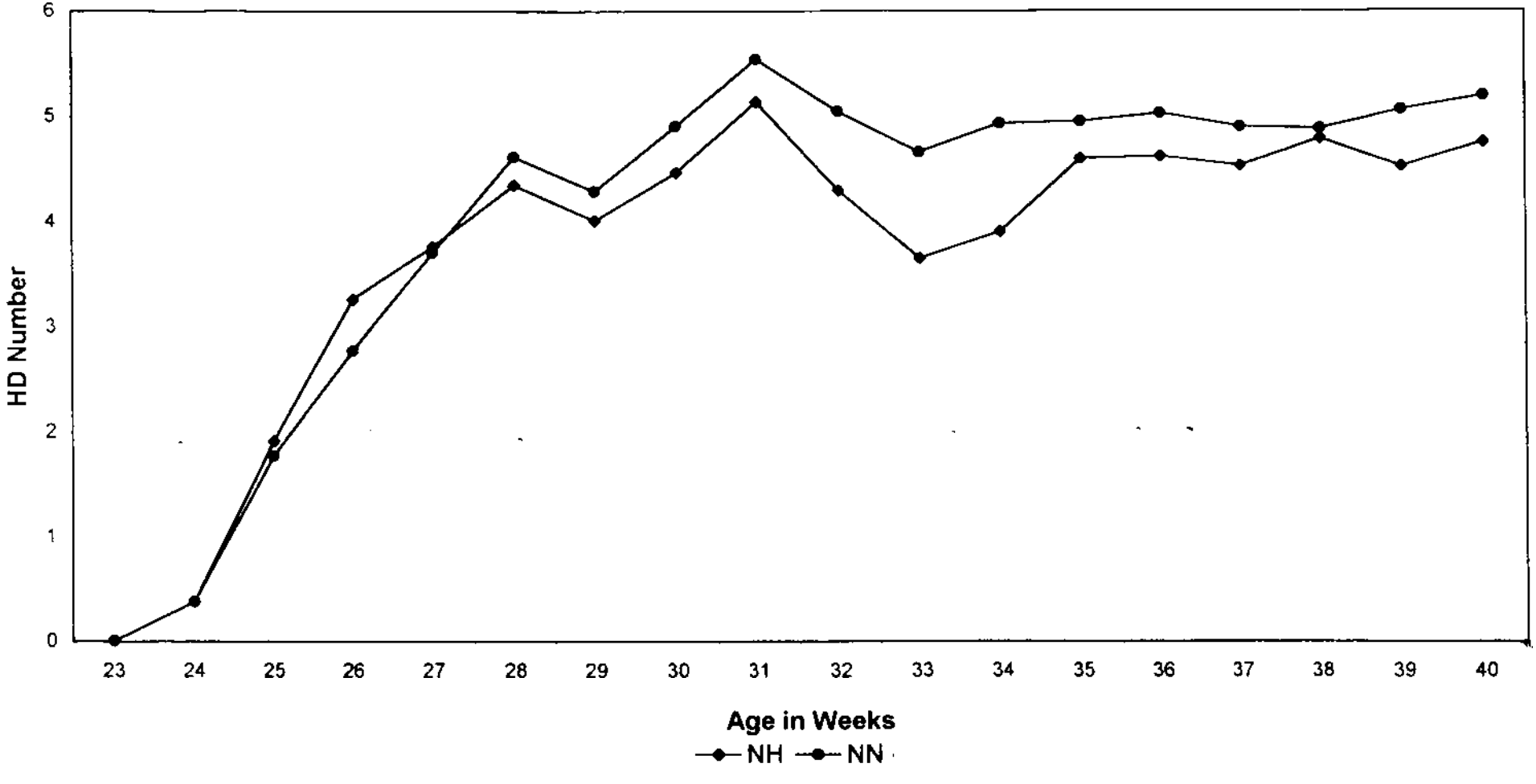
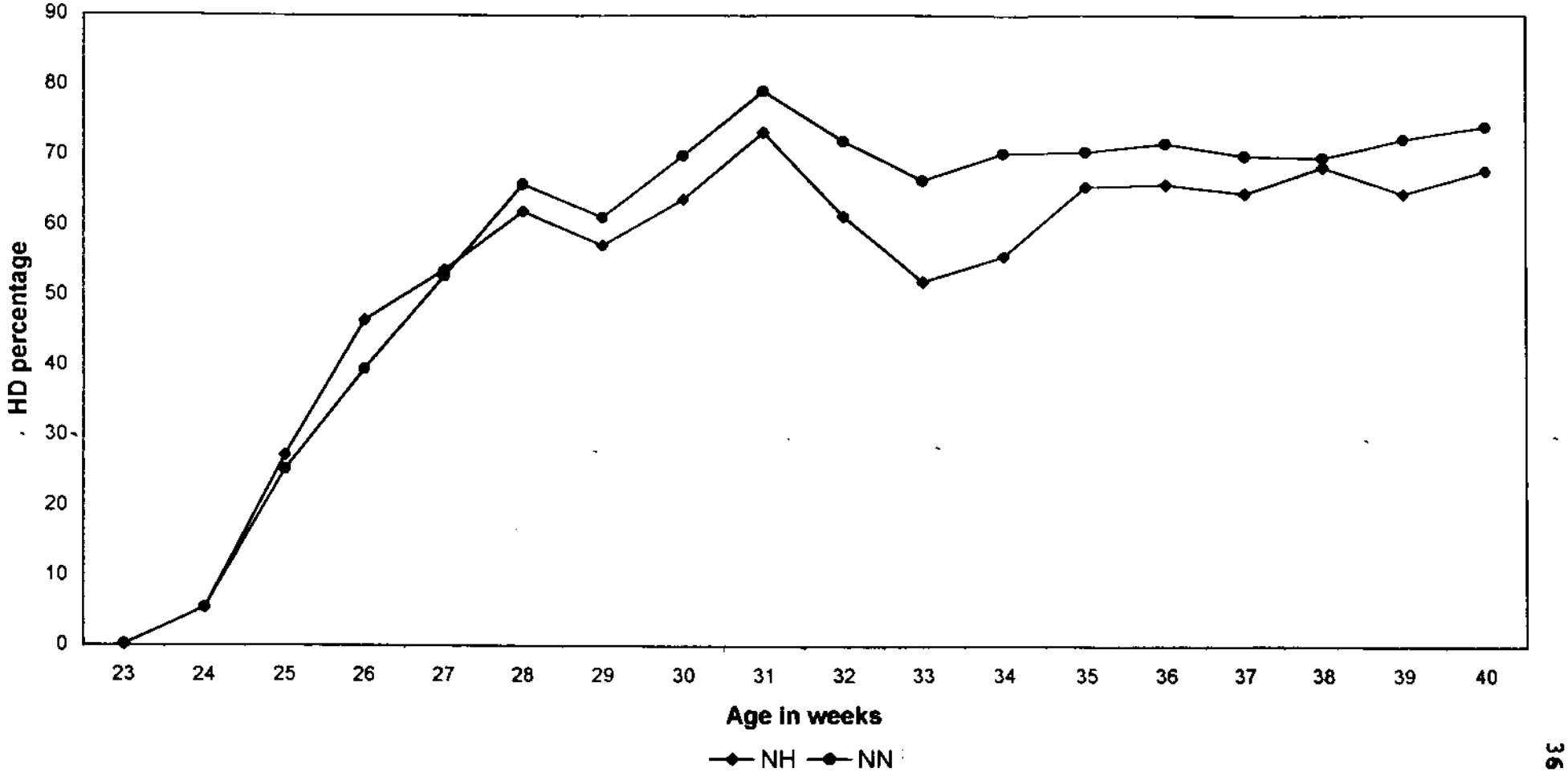


Fig.4. WEEK WISE MEAN PERCENTAGE HEN - DAY PRODUCTION FROM 23 TO 4O WEEKS OF AGE IN NEW HAMPSHIRE AND NAKED NECK BIRDS



Period-wise hen-housed egg number and per cent

The weekly egg production from 25th week onwards were pooled in 28-day periods. Since egg production commenced at 23 weeks of age, data for the first period was not included for statistical analysis. The pooled data on egg production for periods II to V in four weeks,duration are set out in Table 8.

The period-wise data presented in Table 8 revealed that in New Hampshire, the hen-housed number in period II was 13.26 and it was significantly lower than that of subsequent periods III, IV and V. The hen-housed production in the periods III to V were in a homogenous group. In New Hampshire the overall mean HH number per period from 25 to 40 weeks of age was 16.60 eggs with period-wise mean per cent of 59.28.

In Naked Neck hens, the period-wise performance showed the same trend as in NH. The hen-housed number and its percentages were significantly lower in period II than the subsequent periods which were in a homogenous group. The overall mean HH number from 25 to 40 weeks of age in Naked Neck was 18.04 with the overall mean per cent of 64.42.

The period-wise egg production in period IV was significantly higher in Naked Neck birds than that of NH birds. The overall period-wise mean HHN and per cent was though numerically higher in Naked Neck birds in comparison to NH breed, the difference was statistically non-significant.

Table 8. Period-wise mean Hen-Housed (HH) number and per cent production in New Hampshire and Naked Neck hens in cages from 25 to 40 weeks of age

Periods	Age in weeks	HH Number		HH per cent	
		New Hampshire	Naked Neck	New Hampshire	Naked Neck
I	21-24	0.39	0.39	2.78	2.78
II	25-28	b 13.26 ± 0.79	b 12.86 ± 0.76	a 47.35 ± 3.03	a 45.92 ± 2.75
III	29-32	a 17.81 ± 0.72	a 19.78 ± 0.78	a 63.60 ± 2.60	a 70.64 ± 2.83
IV	33-36	a 16.77 ± 0.52	a 19.55 ± 0.82	b 59.89 ± 1.87	a 69.82 ± 2.93
V	37-40	a 18.57 ± 0.55	a 19.94 ± 0.90	a 66.32 ± 1.97	a 71.21 ± 3.26
Overall mean (NS)	25-40	16.60 [a] ± 0.39	18.04 [a] ± 0.54	59.28 [a] ± 1.42	64.42 [a] ± 1.94

Period-wise means carrying the same superscripts within NH and NN under HHN and between NH and NN under HHP did not differ significantly ($P<0.05$)

Overall mean carrying the same superscript between NH and NN did not differ significantly ($P<0.05$).

Period-wise hen-day egg number and per cent

The period-wise data presented in Table 9 revealed that hen-day number in New Hampshire was 13.28 in period II and it increased significantly to 17.92 in period III subsequently reduced to 16.77 in period IV and then increased significantly to 18.59 in period V with an overall mean of 16.64 eggs. The corresponding percentages in periods II to V were 47.42, 64.00, 59.89 and 66.39 respectively with an overall mean of 59.42 per cent.

The period wise hen-day number in Naked Neck was 12.86 in period II and in the subsequent periods (III, IV and V) it was in a homogenous group with mean values above 19.57. The period-wise percentages were 45.92, 70.71, 69.89 and 71.53 in periods II to V respectively with an overall mean of 64.57 per cent.

On period-wise comparison between New Hampshire and Naked Neck, it was observed that the hen-day production was significantly higher in Naked Neck birds and in period IV. The overall mean period-wise hen-day number was 16.64 (59.42 per cent) in New Hampshire as against 18.08 (64.57 per cent) in Naked Neck birds.

Feed consumption

The mean daily feed consumption (g) pertaining to five 28-day periods in New Hampshire and Naked Neck birds from 21 to 40 weeks of age are presented in Table 10.

Table 9. Period-wise mean Hen-Day (HD) number and per cent production in New Hampshire and Naked Neck hens in cages from 25 to 40 weeks of age

Periods	Age in weeks	HD Number		HD per cent	
		New Hampshire	Naked Neck	New Hampshire	Naked Neck
I	21-24	0.39	0.39	2.78	2.78
II	25-28	c 13.28 ± 0.84	b 12.86 ± 0.76	a 47.42 ± 3.06	a 45.92 ± 2.75
III	29-32	ab 17.92 ± 0.60	a 19.80 ± 0.68	a 64.00 ± 2.14	a 70.71 ± 2.44
IV	33-36	b 16.77 ± 0.52	a 19.57 ± 0.80	b 59.89 ± 1.88	a 69.89 ± 2.89
V	37-40	a 18.59 ± 0.42	a 20.03 ± 0.80	a 66.39 ± 1.52	a 71.53 ± 2.92
Overall mean (NS)	25-40	a 16.64 ± 0.38	a 18.08 ± 0.52	a 59.42 ± 1.39	a 64.57 ± 1.90

Period-wise means carrying the same superscripts within NH and NN under HDN and between NH and NN under HDP did not differ significantly ($P<0.05$)

Overall mean carrying the same superscript between NH and NN did not differ significantly ($P<0.05$)

Table 10. Mean daily feed consumption (g) in New Hampshire and Naked Neck hens in cages from 21 to 40 weeks of age

Periods	Age in weeks	New Hampshire	Naked Neck
I	21-24	e 97.76 ± 0.17	e 97.55 ± 0.16
II	25-28	d 108.78 ± 0.25	d 109.53 ± 1.29
III	29-32	c 119.74 ± 0.21	c 120.89 ± 0.14
IV	33-36	b 130.62 ± 0.17	b 130.88 ± 0.13
V	37-40	a 158.40 ± 0.21	a 158.45 ± 0.44
Overall Mean	21-40	a 123.06 ± 2.09	a 123.46 ± 2.08

Period-wise means carrying the same superscript within NH andNN did not differ significantly ($P<0.05$)

Overall mean carrying the same superscript between NH and NN did not differ significantly.

In New Hampshire breed, the mean feed consumption during period I (21 to 24 weeks of age) was 97.76 g per bird per day. In all subsequent periods the mean daily feed consumption showed significant increase and the mean values were 108.78, 119.74, 130.62 and 158.40 g in periods II, III, IV and V respectively. The overall mean daily feed consumption from 21 to 40 weeks of age was 123.06 g in NH birds.

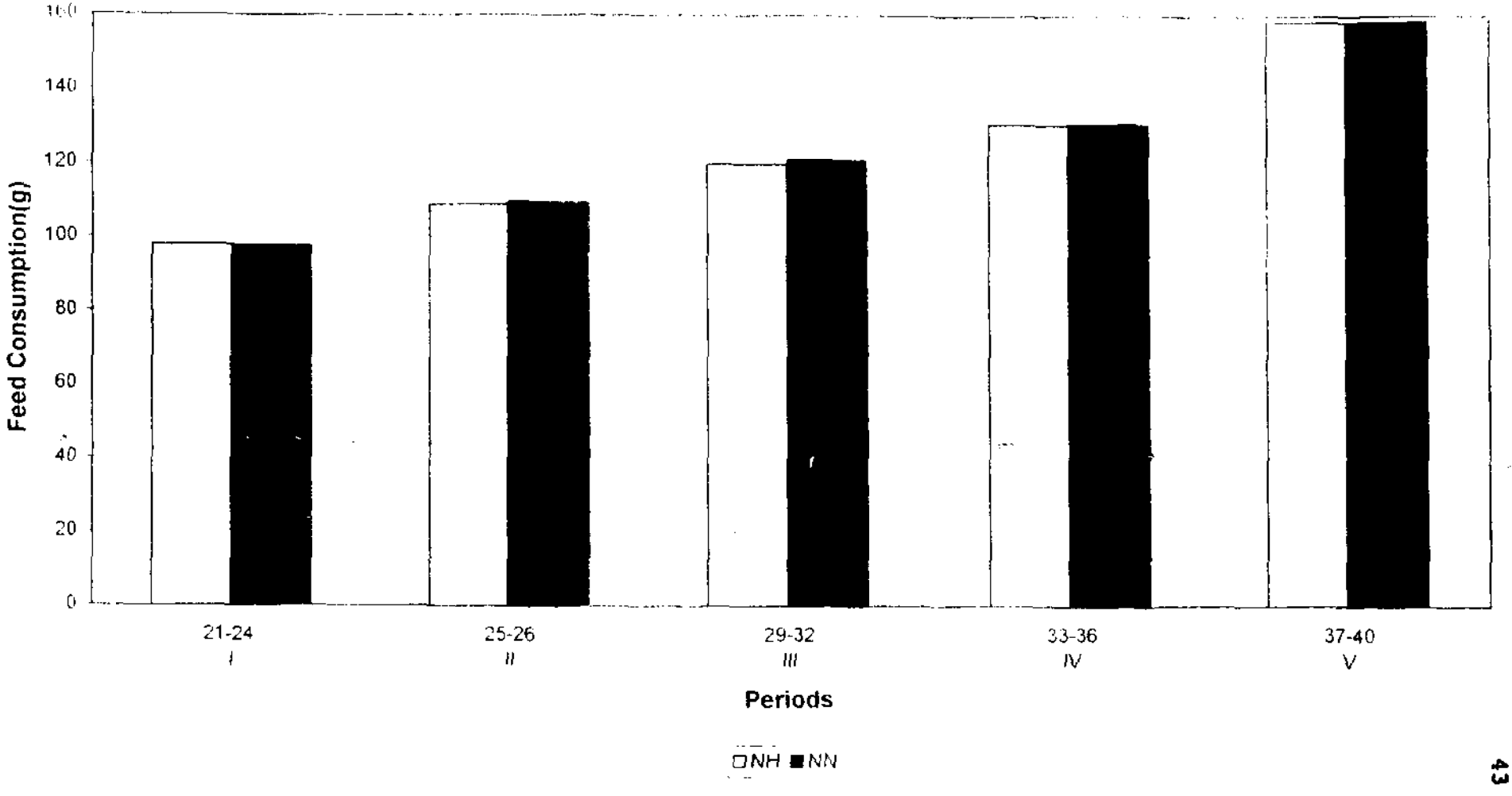
In Naked Neck birds, the mean daily feed intake during period I (21 to 24 weeks) was 97.55 g per bird per day and thereafter showed a significant increase ($P<0.05$) in subsequent periods. The feed consumption in periods II to V were 109.53, 120.89, 130.88 and 158.45 g per bird per day respectively. The overall mean daily feed consumption from 21 to 40 weeks of age was 123.46 g per bird per day in Naked Neck birds registering almost the same overall feed intake both in NH and NN birds.

On a comparison between New Hampshire and Naked Neck, the period-wise as well as the overall mean values did not differ significantly between New Hampshire and Naked Neck. The period-wise variations in daily feed intake are plotted in Figure 5.

Feed conversion ratio

The mean feed conversion ratio (FCR) per dozen eggs in New Hampshire and Naked Neck for the periods from II to V are presented in Table 11. Since the egg production was very low during period I (21 to 24 weeks) it was not

Fig.5.MEAN DAILY FEED CONSUMPTION(g) IN NEW HAMPSHIRE AND NAKED NECK BIRDS AT DIFFERENT PERIODS



considered for statistical analysis and hence the FCR value for period I was not shown in Table 11.

In New Hampshire, the mean feed conversion ratios during periods II, IV and V were 2.73, 2.59 and 2.86 respectively and were in a homogenous group. The FCR recorded in period III was 2.22 and was significantly better in comparison to the other periods. The overall mean feed conversion ratio from 25 to 40 weeks of age was 2.60 in New Hampshire breed.

The mean FCR in Naked Neck birds during period II was 2.86. FCR was significantly better in period III (2.05) in comparison to the mean values in the periods. The values in periods IV and V were statistically comparable with that of period II. The overall mean FCR in Naked Neck was 2.45.

On a comparison between New Hampshire and Naked Neck birds it was observed that the overall mean FCR did not differ significantly between New Hampshire and Naked Neck birds. The period-wise feed conversion ratios per dozen eggs are presented as a histogram in Figure 6.

Egg weight

The mean values of egg weight (EW) based on the individual egg weights recorded for three days each at 24, 28, 32, 36 and 40 weeks of age are presented in Table 12. Since egg production was very low during period I, the egg weights during the initial period was not considered for statistical analysis. At 28 week of age, the mean egg weight was 48.48 g in New Hampshire and it increased

Table 11. Mean feed conversion ratio per dozen eggs in New Hampshire and Naked Neck hens in cages from 25 to 40 weeks of age

Periods	Age in weeks	New Hampshire	Naked Neck
II	25-28	a 2.73 ± 0.21	a 2.86 ± 0.27
III	29-32	b 2.22 ± 0.08	c 2.05 ± 0.09
IV	33-36	a 2.59 ± 0.08	be 2.24 ± 0.17
V	37-40	a 2.86 ± 0.10	ab 2.65 ± 0.14
Overall Mean	25-40	a 2.60 ± 0.07	a 2.45 ± 0.10

Period-wise means carrying the same superscript within NH andNN did not differ significantly ($P<0.05$)

Overall mean carrying the same superscript btween NH and NN did not differ significantly.

Fig.6. MEAN FEED CONVERTION RATIO(FCR) PER DOZEN EGGS IN NEW HAMPSHIRE AND NAKED NECK BIRDS AT DIFFERENT PERIODS

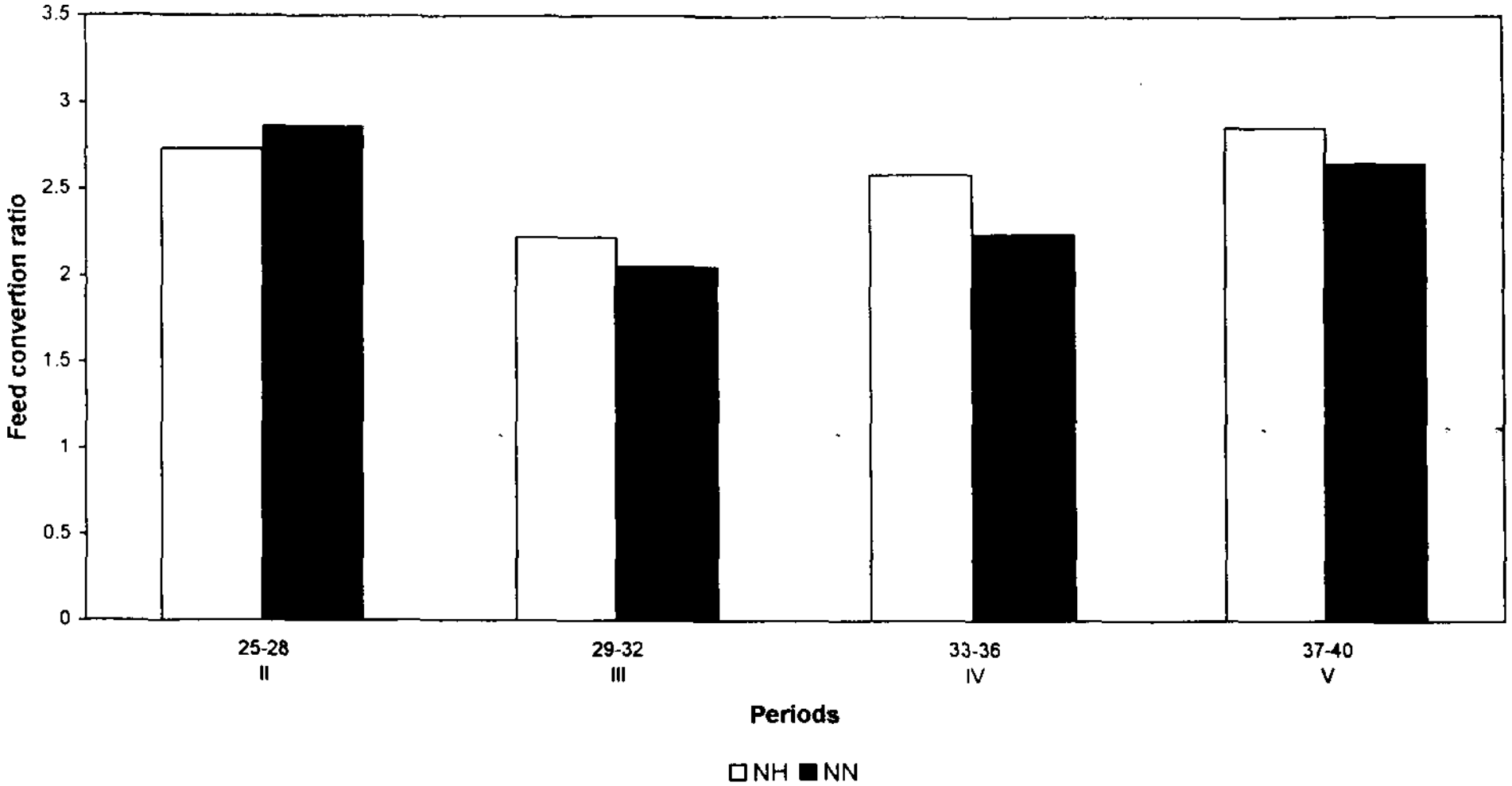


Table 12. Mean egg weight (g) in New Hampshire and Naked Neck hens in cages at 4 weeks intervals during 25-40 weeks of age

Periods	Age in weeks	New Hampshire	Naked Neck
I	24	41.24	41.83
II	28	48.48^{c} ± 0.46	50.49^{b} ± 0.46
III	32	49.21^{c} ± 0.50	52.13^{b} ± 0.27
IV	36	51.25^{b} ± 0.56	55.00^{a} ± 0.71
V	40	52.82^{a} ± 0.62	55.85^{a} ± 0.77
Overall mean		50.44^{b} ± 0.32	53.36^{a} ± 0.37

Period-wise means carrying the same superscripts within NH andNN did not differ significantly ($P<0.05$)

The overall means carrying the different superscripts between NH and NN differed significantly ($P<0.05$)

significantly from 32 weeks onwards. The mean egg weights were 49.21, 51.25 and 52.82 g at 32, 36 and 40 weeks of age, respectively. There was no significant difference between the mean egg weights at 28 and 32 weeks. The overall mean egg weight from 25 to 40 weeks of age was 50.44 g in New Hampshire birds.

The overall mean egg weight (53.36 g) recorded in Naked Neck birds were significantly higher than that of New Hampshire. The mean egg weight in NN was 50.49 g at 28th week and 52.13 g at 32nd week, and the difference between these mean values was statistically non-significant. The mean weight of 55.00 g and 55.85 g recorded at 36 and 40 weeks of age also was comparable but these weights were significantly higher than those at earlier ages in Naked Neck birds.

The overall mean egg weight from 28 to 40 weeks of age was significantly ($P<0.05$) higher in Naked Neck. The magnitude of variations in mean egg weights recorded at different ages are plotted in Figure 7.

Egg mass

The mean egg mass (kg) per day recorded in New Hampshire and Naked Neck birds are presented in Table 13. These mean values were arrived at on the basis of total egg mass recorded for three days each at an interval of four weeks from 28th weeks of age onwards.

The mean egg mass (EM) per day, in new Hampshire, during 28, 32 and 36 weeks of age were in a homogenous group. At these ages, the mean egg mass recorded were 1.82, 1.89 and 1.86 kg respectively. At 40th week, the mean egg

Fig.7.MEAN EGG WEIGHT(g) IN NEW HAMPSHIRE AND NAKED NECK BIRDS AT DIFFERENT AGES

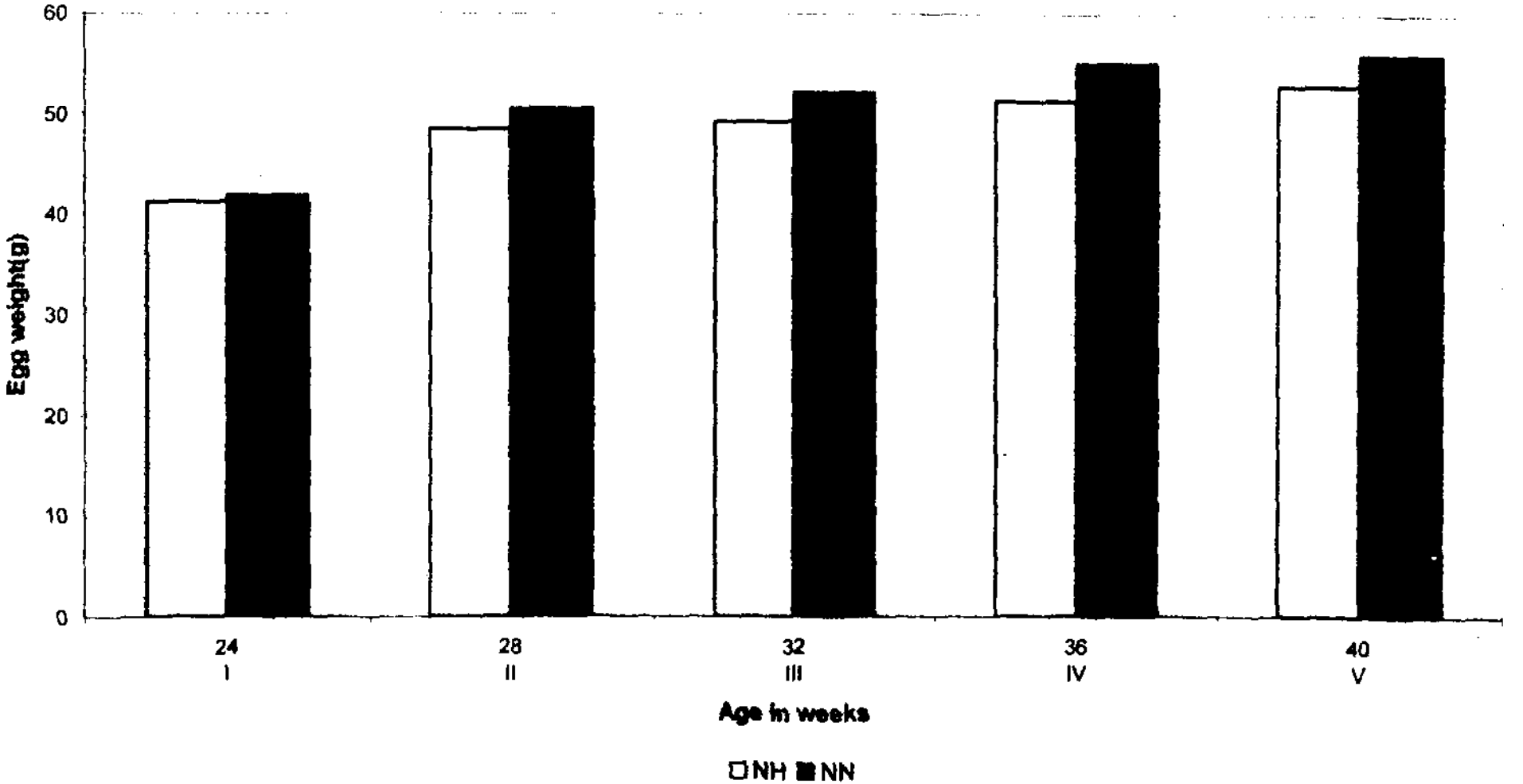


Table 13. Mean egg mass (kg) per day in New Hampshire and Naked Neck hens in cages at 4 weeks intervals from 25 to 40 weeks of age

Periods	Age in weeks	New Hampshire	Naked Neck
I	24	0.81	0.66
II	28	b 1.82 ±0.19	b 2.08 ±0.20
III	32	b 1.89 ±0.13	ab 2.18 ±0.22
IV	36	b 1.86 ±0.15	a 2.34 ±0.27
V	40	a 2.05 ±0.20	a 2.32 ±0.25
Overall mean		b 1.60 ±0.10	a 1.84 ±0.14

Period-wise means carrying the same superscript within NH and NN did not differ significantly ($P<0.05$)

The overall means carrying the different superscripts between NH and NN differed significantly ($P<0.05$)

mass recorded was 2.05 kg and was significantly ($P<0.05$) higher than the egg mass at earlier ages. Thus, the overall mean egg mass per day, in New Hampshire was 1.6 kg based on 12 days weight of total eggs recorded during the entire period of experiment.

In Naked Neck birds, the mean egg mass per day at 28 weeks of age was 2.08 kg and it increased significantly to 2.32 at 40th week of age. The mean egg mass recorded during 32 and 36 weeks (2.18 kg and 2.34 kg) were comparable. The overall mean value of egg mass per day in Naked Neck birds was 1.84 kg based on weight of 12 days.

The comparison of overall mean egg mass in New Hampshire and Naked Neck revealed higher mean daily egg mass in Naked Neck birds and was found to be statistically significant ($P<0.05$). The age-wise mean values were also higher in Naked Neck birds and hence, the overall mean value of egg mass per day was significantly higher in Naked Neck (1.84 kg) than that of New Hampshire birds (1.60 kg).

Egg quality traits

The mean values pertaining to the various egg quality traits recorded at 40 weeks of age are given in Table 14.

Table 14. Overall mean values of egg quality traits at 40 weeks of age in eggs from New Hampshire and Naked Neck hens in cages

Sl.No.	Parameter	New Hampshire	Naked Neck
1.	Per cent shell	10.17 ±0.16 [a]	9.41 ±0.09 [a]
2.	Per cent albumen	58.59 ±1.18 [a]	57.65 ±0.72 [a]
3.	Per cent yolk	31.24 ±0.71 [a]	32.94 ±0.65 [a]
4.	Shape index	1.34 ±0.00 [a]	1.32 ±0.01 [a]
5.	Albumen index	0.09 [a]	0.07 [b]
6.	Yolk index	0.36 [a]	0.34 [b]
7.	Haugh unit score	87.16 ±1.68 [a]	80.58 ±2.07 [a]
8.	Shell thickness (mm)	0.44 ±0.01 [b]	0.48 ±0.00 [a]
9.	Yolk cholesterol (mg per g of yolk)	14.54 ±0.60 [a]	14.46 ±0.11 [a]

Overall means carrying the same superscript between NH and NN did not differ significantly ($P<0.05$)

Per cent shell, albumen and yolk

The mean per cent shell at 40 weeks of age was 10.17 in New Hampshire and 9.41 in eggs from Naked Neck birds and the difference was statistically non-significant ($P<0.05$).

The mean per cent albumen was 58.59 and 57.65 in New Hampshire and Naked Neck respectively.

The mean per cent yolk was 31.24 in New Hampshire and 32.94 in Naked Neck. The mean values of albumen as well as yolk did not differ statistically between NH and NN.

Shape index, albumen and yolk indices

The mean shape index of eggs at 40 weeks of age in NH and NN were 1.34 and 1.32. The difference in mean shape index values in NH and NN was statistically non-significant.

The mean albumen index in NH and NN at 40 weeks of age were 0.09 and 0.07 and the mean yolk index value was 0.36 and 0.34 respectively. The mean values of both these indices were significantly higher in NH than NN ($P<0.05$).

Haugh Unit Score and shell thickness

The overall mean Haugh Unit Score in NH and NN was 87.16 and 80.58 respectively and there was no significant difference between NH and NN in Haugh Unit Score.

The mean shell thickness in NN (0.48 mm) is significantly ($P<0.05$) higher than NH (0.44 mm).

Egg yolk cholesterol

The mean values of yolk cholesterol (mg per g yolk) in New Hampshire and Naked Neck are presented in Table 14. The absolute values of egg yolk cholesterol in NH and NN at 40 weeks of age were 14.54 and 14.46 mg per g yolk and these values did not differ statistically between NH and NN.

Livability

The per cent livability in New Hampshire and Naked Neck birds at different ages from 21 to 40 week of age are presented in Table 15. The results indicated that the overall livability was 91.66 per cent in New Hampshire and 93.33 per cent in Naked Neck birds. The total number of birds died was five, in New Hampshire and four, in Naked Neck group. But the differencesin livability during the period of study was at all ages were non-significant between New Hampshire and Naked Neck birds.

Economics

The economics of egg production over feed cost from 24 to 40 weeks of age is set out in Table 16. The total feed consumed was 868.65 kg in New Hampshire and 893.78 kg in Naked Neck birds. The feed consumed per egg was 226.15 g in New Hampshire and 211.69 g in Naked Neck. The total number of eggs produced during the entire period of experiment was 3841 in New Hampshire

Table 15 Per cent livability in New Hampshire and Naked Neck hens in cages from 21 to 40 weeks of age

Age in weeks	New Hampshire	Naked Neck
21	100.00	100.00
27	98.33 (1)	--
29	96.61 (2)	98.33 (1)
30	98.24 (1)	--
36	--	98.30 (1)
38	--	98.27 (1)
39	--	98.24 (1)
40	98.21 (1)	--
Overall 21-40	91.66 (5)	93.33 (4)

Note: Number of deaths given in parenthesis

Table 16. Economics of egg production over feed cost from 25 to 40 weeks of age in New Hampshire and Naked Neck hens in cages

Particulars	New Hampshire	Naked Neck
Feed intake (kg)	868.65	893.78
Number of eggs produced	3841	4222
Feed consumed per egg (g)	226.15	211.69
Cost of feed per egg (paise)	226	212

Table 17. Summary of performance in New Hampshire and Naked Neck hens in cages from 20 to 40 weeks of age

Sl. No.	Parameter	New Hampshire	Naked Neck
1.	Body weight (g) at 20 weeks	1675.10 [a]	1682.30 [a]
2.	Body weight (g) at 40 weeks	2635.45 [a]	2703.65 [a]
3.	Age at first egg (days)	164.50 [a]	164.71 [a]
4.	Age at 10 per cent production (days)	168.15 [a]	170.35 [a]
5.	Age at 50 per cent production (days)	175.50 [a]	176.55 [a]
6.	Hen-housed egg number (25-40 weeks)	4.15 [a]	4.51 [a]
7.	Hen-housed per cent production (25-40 weeks)	59.28 [a]	64.42 [a]
8.	Hen-day number (25-40 weeks)	4.16 [a]	4.52 [a]
9.	Hen-day per cent (25-40 weeks)	59.42 [a]	64.57 [a]
10.	Daily feed consumption (g)	123.06 [a]	123.46 [a]
11.	Feed conversion ratio/dozen eggs (25-40 weeks)	2.60 [a]	2.45 [a]
12.	Egg weight (g)	50.44 [b]	53.36 [a]
13.	Egg mass (kg)	1.60 [b]	1.84 [a]
14.	Per cent shell	10.17 [a]	9.41 [a]
15.	Per cent albumen	58.59 [a]	57.65 [a]
16.	Per cent yolk	31.24 [a]	32.94 [a]
17.	Shape index	1.34 [a]	1.32 [a]
18.	Albumen index	0.09 [a]	0.07 [b]
29.	Yolk index	0.36 [a]	0.34 [b]
20.	Haugh Unit Score	87.16 [a]	80.58 [a]
21.	Shell thickness (mm)	0.44 [b]	0.48 [a]
22.	Yolk cholesterol (mg per g of yolk)	14.54 [a]	14.46 [a]
23.	Per cent livability	91.66 [a]	93.33 [a]

Means carrying same superscripts between NH and NN did not differ significantly ($P<0.05$).

and 4222 in Naked Neck. The feed cost which worked out to Rs.10.00 per kg indicated that the cost of feed consumed per egg was 226 paise in NH and 212 paise in NN birds.

The summary of production traits presented in Table 17 revealed that the body weights at 20 and 40 weeks of age, age at first egg and ages at 10 and 50 per cent production and HH and HD production in NH and NN were similar. Data on mean daily feed consumption and feed conversion ratios also were similar between New Hampshire and Naked Neck birds. Among the egg quality traits, mean egg weight, egg mass and shell thickness were significantly higher in Naked Neck birds. The internal quality of eggs in NH and NN did not show significant differences in respect of per cent shell, albumen and yolk. The shape index and Haugh Unit Score were similar in NH and NN group. The yolk cholesterol content in egg was also similar in NH and NN groups. However, the albumen and yolk indices were significantly higher in NH eggs. The livability was similar in NH and NN birds.

DISCUSSION

Meteorological observations

The meteorological observations presented in Table 3 showed that the mean daily maximum temperature ranged from 30.05 to 35.45°C. Moreover, the mean maximum temperature was significantly higher during the periods II and III corresponding to the age of birds from 25 to 32 weeks. Thus the experimental birds until 32 weeks of age were subjected to high temperature in periods I, II and III. During these periods the daily mean Sunshine hours were also high (9.3). The maximum temperature declined significantly to 32.97°C in period IV and further lowered to 30.05°C in period V indicating that the adverse effects due to maximum temperature towards the end of the experiment were of low magnitude. The minimum temperature during periods I and II (21.95 and 23.42°C) were within the comfort zone for poultry production.

The data pertaining to the per cent relative humidity (R.H) indicated that it was low in the initial two periods in the afternoon. In the forenoon hours, the R.H. per cent was high in all periods and particularly during periods III, IV and V. The extended sunshine hours and high wind speed with low humidity was prevailed during periods I and II. High humidity in the forenoon hours in periods IV and V also might have influenced the production performance of experimental birds.

Body weight

The mean body weight (BW) in New Hampshire (NH) and Naked Neck (NN) birds presented in Table 4 revealed that the overall mean body weights were similar in NH and NN at 20 weeks (1675.10 vs 1682.30 g) and 40 weeks (2635.45 vs 2703.65 g) of age. Bordas *et al.* (1982) reported lower body weight for Naked Neck birds. The present results are in agreement with the reports of Monnet *et al.* (1982), Ibe (1993) and Akthar and Bulbul (1994). The body weight obtained at 20 weeks of age in the present study is in close agreement with the finding of Monnet *et al.* (1982). Merat *et al.*(1991) and Yahav *et al.* (1998) reported that Naked Neck gene influenced the body weight at ambient temperature 30°C and above. The difference in body weights reported by the above authors might be due to the variations in the rearing conditions and season under which studies were carried out.

Age at sexual maturity

The age at first egg (AFE) in the flock was 161 day in both NH and NN which indicated that laying commenced at 23 weeksin NH and NN. Similarly, the age at 50 per cent production was comparable between NH and NN (Table 5) with mean values of 175.50 and 176.55 days, respectively. Bordas and Merat (1992) reported age at first egg as 146.2 days in heterozygous NN birds and 141 days in normal neck hens. Whereas, Akthar and Bulbul (1994) recorded 202 days as the age at sexual maturity in desi NN. The results obtained in the present study did not agree with the above reports. Aggarwal *et al.* (1971) observed age at first egg

as 223 days in desi females. Bordas *et al.* (1993) stated that homozygous and heterozygous Naked Neck and the normal neck genotypes affected age at first egg significantly in caged hens in temperature of 21 or 31°c. Bhatti and Sahota (1996) did not specify the exact criteria of measurement in respect of sexual maturity and stated 202.67 days as age at sexual maturity in desi fowls.

Weekly egg production

Hen-housed number and per cent

In order to have a precise interpretation of the results, the weekly egg production data were compared within and between NH and NN. After registering very low weekly egg production (Table 6) at 23 and 24 weeks, the hen-housed egg number (HHN) was increased to 1.91 per bird at 25th week. Thereafter it increased significantly at 26 weeks both in New Hampshire and Naked Neck. However, the magnitude of variation between genetic groups NH and NN was non-significant. This may be attributed to the fact that both the genotypes attained sexual maturity at the same age. The peak production was attained at 31st week of age, both in NH and NN (5.14 vs 5.55 eggs). The differences in hen-housed number and per cent production between NH and NN were significant only at 33 and 34 weeks of age.

The progressive total of HHN from 25 to 40 weeks of age was 66.41 in NH and 72.13 in NN. An increase in egg production in Naked Neck birds was reported by Horst *et al.* (1986), Merat *et al.*(1991) and Bordas *et al.* (1993). Asieudu and Weever (1993) recorded 59.5 eggs per hen for Creole birds. The

results of NN birds in the present study agree with the above findings. Szczerbinska (1996) recorded annual egg production of 192 for New Hampshire hens is not comparable with the part year records in the present study.

In the present study, the overall hen-housed number and percentage, although non-significant, were numerically higher in Naked Neck birds than New Hampshire. The weekly production showed significantly higher HHN in NN than that of NH at 33 and 34 weeks. In all the other weeks, the magnitude of difference was non-significant. The higher egg production in NN can be attributed to better tolerance of these birds at higher temperature and hence reduction in egg number after peak production was not much severe.

Hen-day number and per cent

The data presented in Table 7 showed that the HDN and percentages were same as that of respective hen-housed values since there was no mortality until 26 weeks in NH and upto 28 weeks of age in NN. The egg production efficiency of survivors indicated by the weekly hen-day number showed the same trend as observed in HH production (Table 6 and Figure 1). Figure 2 also indicated significantly higher egg yield in NN at 33 and 34 weeks. Significant variations might be due to the difference in mortality rates in NH and NN upto 34 weeks of age. The environment for production was more favourable in the case of NN. The overall hen-day number in NH and NN were 66.56 and 72.26 eggs with 59.42 and 64.57 per cent respectively. These values were higher than that reported by Asieudu and Weever (1993) in Creole birds.

Period-wise egg production

More meaningful comparisons were made on period-wise pooled data. Period-wise HH and HD production presented in Table 8 and 9 did not show any significant difference between NH and NN.

Within the NH group, the mean HH production in period II was 13.26 eggs per bird with a percentage of 47.35 and it increased significantly in subsequent periods. The HH egg production in periods III, IV and V were similar. This trend was also observed in Naked Neck birds. The overall mean though non-significant, was numerically higher in Naked Neck group. The magnitude of period-wise variations in hen-day production was due to the death of four birds in NH and one bird in NN up to period III.

In period V, the mean egg production was significantly lower in NH birds due to the drastic reduction in egg output at 33 and 34 weeks of age, after peak production. This is evident from data presented in Tables 6 and 7 and figures 3 and 4.

Bordas *et al.* (1993) reported significantly higher egg production for Naked Neck hens kept in cages at higher temperature of 31°C. Horst *et al.* (1986), and Merat *et al.* (1991) observed higher egg production in NN than normal Neck hens. The results obtained in the present study are in agreement with the above findings.

Feed consumption

The mean daily feed consumption presented in Table 10 did not show any significant difference between NH and NN. Moreover, the overall mean daily feed consumption was almost similar in NH and NN birds (123.06 g and 123.46 g). Significant difference between period-wise mean values were observed as age advanced. The pattern of increase in feed intake was also similar in NH and NN groups. This might be due to their comparable body weights at 20 weeks of age.

Bordas *et al.* (1982) recorded significantly higher feed intake in Naked Neck birds exposed to constant ambient temperature of 31°C. Merat *et al.* (1974), Rauen *et al.* (1986), and Yahav *et al.* (1998) reported higher feed intake in Naked Neck birds at low ambient temperature. The results obtained in the present study did not agree with the above findings.

Feed conversion ratio

Table II showed that the overall mean feed conversion ratio (FCR) per dozen eggs from 25 to 40 weeks of age in NH and NN was 2.60 and 2.45. This is in agreement with the report of Fathi *et al.* (1993) who opined that the feed efficiency did not differ significantly between Naked Neck and normal neck fowls. The period-wise mean values showed that FCR was significantly better in period III than other periods within the groups. This was due to the peak production registered at 31st week in both groups. The period-wise mean values of II, IV and V were statistically similar within NH group. The overall mean FCR in NN birds

is better and is in agreement with the reports of Rauen *et al.* (1986), Merat *et al.*(1991), Mathur and Horst (1990) and Eberhart and Washburn (1993) who reported better feed efficiency for Naked Neck hens than normal neck hens at higher ambient temperature. Inspite of similar feed intake in NH and NN and lower egg production in NH group the overall mean FCR was similar because of the narrow variations in period-wise feed conversion ratio.

Egg weight

The overall mean egg weight (EW) presented in Table 12 (50.44 g in NH and 53.36 g in NN) revealed that it was significantly higher in NN. The age-wise differences also showed that the EW was significantly higher in NN than NH at all ages studied ie., 28, 32, 36 and 40 weeks from 48.48 to 52.82 g in NH and 50.49 to 55.85 g in NN indicating higher egg weights in NN at all the weeks studied.

The reasons for lower egg weight in NH may be genetic or can be relatively higher temperature that adversely affected the egg weight in normal neck birds.

The results obtained in the present study are in close agreement with the reports of Merat (1981), Fraga *et al.*(1985), Horst *et al.*(1986), Merat *et al.*(1991) and Bordas and Merat (1992) who reported higher egg weight in Naked Neck than normal neck birds. Chand *et al.* (1972) observed lower egg weight (41.19 g) for Naked Neck birds and is contrary to the present finding. Szczerbinska (1996) reported mean egg weight of 60.4 g in New Hampshire birds in cages is higher

than the results obtained in the present study. These variations may be attributable to the breeding history of the stocks.

Egg mass

The overall mean egg mass (EM) per day measured at various ages (Table 13) showed statistically comparable data within NH and NN at 28, 32, 36 and 40 weeks of age studied. The results revealed that not only the mean egg weights but also mean egg mass were higher for NN at various ages studied (Table 12 and 13). This was due to the numerically higher egg number and significantly higher mean egg weight in NN. The high ambient temperature did not affect the Naked Neck birds adversely and this appears to be the reason for the high egg mass per day in NN birds. This is in close agreement with the finding of Horst *et al.*(1986), who reported that the NN gene is associated with an increase in total egg mass at high temperature. Thus it can be summarised that the NN eggs can be marketed advantageously on weight basis.

Egg quality traits

The egg quality traits at 40 weeks of age presented in Table 14 revealed that the variations in shell, albumen and yolk percentages between NH and NN were non-significant. The shape index and Haugh Unit Score of eggs and the cholesterol content in yolk were also statistically non-significant between NH and NN. The albumen and yolk indices were significantly better in NH eggs than NN eggs.

Per cent shell, albumen and yolk

The overall mean values of per cent shell (10.17 in NH and 9.41 in NN) did not differ significantly and the ambient temperature was low during 40 weeks of age when the egg quality was estimated. The results in the present study is contrary to the finding of Ezzeldin and El-Labban (1989) who reported lower per cent shell in New Hampshire eggs than other breeds.

The results pertaining to the internal quality (Table 14) revealed that the overall per cent albumen (58.59 in NH and 57.65 in NN) was almost similar in NH and NN. On the contrary, Ezzeldin and El-Labban (1989) reported lower per cent albumen in New Hampshire, might be due to the variation in the age group of birds studied.

The overall mean per cent yolk was 31.24 in NH and 32.94 in NN and the difference was statistically non-significant. The per cent yolk in eggs from NN though non-significant was numerically higher than NH eggs and might be due to more active synthesis and deposition of yolk material or difference in the moisture in egg contents. The weight of yolk in NN is higher than the value stated by Chand *et al.*(1972) who reported a yolk weight of 13.36 g in eggs from Naked Neck hens. Ezzeldin and El-Labban (1989) observed lower egg yolk in NH birds. The present findings agree with the results obtained in the above reports.

Shape index, albumen yolk and indices

The overall mean shape index was 1.34 in NH and 1.32 in NN and did not show much variation between the two groups. The present finding is not in agreement with Yeasmin *et al.* (1992) who found lower shape index for indigenous fowls.

The overall mean albumen index was 0.09 in NH and 0.07 in NN and the difference was statistically significant. The higher albumen index in NH indicated higher internal quality. The present finding of lower albumen index for indigenous fowls is in agreement with the report of Yeasmin *et al.* (1992).

The overall mean yolk index was 0.36 in NH and 0.34 in NN and the difference was statistically significant. The higher yolk index in NH also indicate better internal quality of egg. The present observation is in agreement with the findings of Yeasmin *et al.* (1992) who reported lower yolk index for indigenous fowls.

Haugh Unit Score and shell thickness

The overall mean Haugh Unit was 87.16 in NH and 80.58 in NN egg and the difference was found to be statistically non-significant. Eventhough the albumen index was higher in NH, the mean egg weight was higher in NN and hence the Haugh Unit Score in NH and NN eggs did not differ significantly. Ezzeldin and El-Labban (1989) observed lower Haugh Unit for New Hampshire

eggs while Yeasmin *et al.* (1992) reported lower Haugh Unit for indigenous fowl eggs and the present finding agree with the later report.

The overall mean shell thickness in NH (0.44 mm) was significantly lower than NN (0.48 mm). The higher shell thickness in NN indicated that this trait was improved in NN birds. This is in agreement with the results obtained by Merat *et al.*(1974) and Zulkifly *et al.* (1992) in Naked Neck hens. At higher ambient temperature, the shell quality was not affected in the eggs produced by Naked Neck birds whereas, in NH eggs, the shell quality was depressed. The results obtained in the present study is also concur with the finding of Ezzeldin and El-Labban (1989) who reported New Hampshire birds had lower shell thickness.

Egg yolk cholesterol

The overall mean yolk cholesterol (mg per g of yolk) was 14.54 in NH and 14.46 in NN eggs and the difference between NH and NN was negligible. Considering the positive correlation between yolk weight and yolk cholesterol, it will be higher in NN eggs in spite of statistically similar per cent yolk between the two groups. The yolk cholesterol content in this study agree with Kovacs *et al.* (1998) who observed similar yolk cholesterol in NH and NN eggs. The absolute values did not concur the findings of Hall and McKay (1992) and Maurice *et al.*(1995) who reported higher yolk cholesterol in NH eggs.

Livability

The overall livability during the period from 21 to 40 weeks (Table 15) was 91.66 in NH and 93.33 in NN and the difference was statistically non-significant. The reason for mortality did not indicate any specific disease in both the groups but the causes of death were oophoritis, hepatosis and peritonitis. Rauen *et al.* (1986) reported that the Na gene significantly reduced mortality of birds and Bordas and Merat (1992) observed the moftality rate as 10.5 for Naked Neck birds. the present findings is in agreement with Szczerbinska (1996) who found the mortality rate as nine per cent for New Hampshire birds in cages.

Economics

Data presented in Table 16 revealed that the cost of feed per egg was higher in NH than that of NN group (226 vs 212 paise). This indicated that *ad libitum* feeding is not economical in the case of brown egg layers under the present market price of feed and eggs.

Based on the overall performance set out in Table 17, it was concluded that the major traits viz., age at first egg and ages at 10 and 50 per cent production and hen-housed and hen-day production were statistically similar in New Hampshire and Naked Neck birds. Similarly data on mean daily feed consumption and feed conversion ratios did not differ significantlywere comparable between the two genetic groups.

Among the egg quality traits, the mean egg weight, egg mass, and shell thickness were significantly higher in eggs from Naked Neck birds. The internal quality of eggs in respect of per cent shell, albumen and yolk did not differ significantly between NH and NN groups. The egg yolk cholesterol (mg per g of yolk) content was the same in NH and NN eggs. The shape index and Haugh Unit Score of eggs were also statistically similar in NH and NN groups. The albumen and yolk indices are significantly better in NH eggs. The livability in both groups was almost similar.

SUMMARY

An experiment was carried out at the Kerala Agricultural University Poultry Farm, Mannuthy to evaluate and compare the production performance of New Hampshire and Naked Neck hens in cages.

Sixty (60) pullets each of New Hampshire (NH) and Naked Neck (NN) at the age of 18 weeks were housed in identical cages in four replicates each at the rate of 15 birds per replicate and three birds per cage at random. Layer mash with BIS specifications was fed throughout the experimental period. Standard routine management practices were followed in the study. The production performance of birds in cages for five periods of 28-days each were recorded during the period from January to June 1999. The body weight, age at sexual maturity, egg production, feed consumption, feed conversion ratio, egg weight, egg mass, egg quality in terms of per cent shell, albumen and yolk, shape index, albumen and yolk indices, shell thickness, egg yolk cholesterol, livability and the economics in terms of feed cost per egg were recorded. Data were analysed statistically and the following observations were made.

1. The mean body weight (BW) at 20 weeks of age was 1675.10 g in NH and 1682.30 g in NN and the BW at 40 week of age was 2635.45 g in NH and 2703.65 g in NN and were not significantly ($P<0.05$) different.

2. The age at sexual maturity estimated as age at first egg and ages at 10 and 50 per cent production revealed that the mean values were 164.50, 168.15

and 175.5 days in new Hampshire and 164.71, 170.35 and 176.55 in Naked Neck birds respectively.

3. The overall mean weekly hen-housed number from 25 to 40 weeks of age was 4.15 in NH and 4.51 in NN with the percentage of 59.28 and 64.42 respectively and the difference was statistically non-significant (P<0.05).

4. The overall mean weekly hen-day number was 4.16 and 4.52 with a corresponding per cent of 59.42 and 64.57 in New Hampshire and Naked Neck respectively and the difference was statistically non significant (P<0.05).

5. The highest weekly HH and HD egg number of 5.14 and 5.55 with corresponding percentages of 73.42 and 79.28 were recorded at the age of 31 weeks in NH and NN respectively.

6. The overall mean daily feed consumption during the period from 21 to 40 weeks of age was 123.06 g in NH and 123.46 g in NN and the difference between the genetic groups was statistically non-significant (P<0.05).

7. The overall mean feed efficiency on the basis of dozen eggs was 2.60 in NH and 2.45 in NN for the period from 25 to 40 weeks and the difference was statistically non-significant (P<0.05).

8. The overall mean egg weight recorded during the period from 25 to 40 weeks was 50.44 g in NH and 53.36 g in NN and the difference was significant (P<0.05).

9. The overall mean egg mass per day was 1.60 and 1.84 kg in New Hampshire and Naked Neck and were statistically significant (P<0.05).

10. The overall mean per cent shell at 40 weeks of age was 10.17 and 9.41 in New Hampshire and Naked Neck eggs and it was similar in both the genetic groups.

11. The overall mean shell thickness was 0.44 mm and 0.48 mm for New Hampshire and Naked Neck eggs and the difference was statistically significant (P<0.05).

12. The overall mean per cent albumen was 58.59 in NH and 57.65 in NN and the difference was statistically non-significant (P<0.05).

13. The overall men per cent yolk was 31.24 in NH and 32.94 in NN eggs and the figures did not differ significantly (P<0.05).

14. The overall mean shape index of egg was 1.34 in NH and 1.32 in NN and the figures were statistically similar in both the genetic groups.

15. The overall mean albumen index at 40 weeks of age was 0.09 in NH and 0.07 in NN eggs and the difference was observed to be significant (P<0.05).

16. The overall mean yolk index at 40 weeksof age was 0.36 in NH and 0.34 in NN eggs and the difference was found to be significant (P<0.05).

17. The overall mean Haugh Unit Score of eggs at 40 weeks of age was 87.16 in NH and 80.58 in NN and the difference was not statistically significant ($P<0.05$).

18. The overall mean cholesterol in yolk at 40 weeksof age was 14.54 mg per g of yolk in NH and 14.46 mg/g of yolk in NN eggs and the difference was observed to be non-significant ($P<0.05$).

19. Livability per cent from 21 to 40 weeks of age was 91.66 in NH and 93.33 in NN showing no significant difference ($P<0.05$) between NH and NN.

20 The cost of feed per egg was 226 paise in NH and 212 paise in NN.

Based on the above findings, it is evident that the overall mean egg weight, egg mass and shell thickness were significantly higher ($P<0.05$) in Naked Neck birds. The differences in body weight at 20 and 40 weeks, age at sexual maturity, overall HHN, HDN, feed consumption, feed conversion ratio, per cent shell, per cent albumen, per cent yolk, shape index, yolk cholesterol and Haugh Unit Score were non-significant between New Hampshire and Naked Neck.

Therefore, it was concluded that the New Hampshire and Naked Neck had similar characters in body weight, age at sexual maturity, egg production, feed consumption, feed conversion ratio, per cent shell; yolk and albumen, yolk cholesterol and Haugh Unit Score under cage system of rearing. However Naked Neck birds have an edge over New Hampshire birds in overall mean egg weight, egg mass and shell thickness.

Table 17. Summary of performance in New Hampshire and Naked Neck hens in cages from 20 to 40 weeks of age

Sl. No.	Parameter	New Hampshire	Naked Neck
1.	Body weight (g) at 20 weeks	1675.10 [a]	1682.30 [a]
2.	Body weight (g) at 40 weeks	2635.45 [a]	2703.65 [a]
3.	Age at first egg (days)	164.50 [a]	164.71 [a]
4.	Age at 10 per cent production (days)	168.15 [a]	170.35 [a]
5.	Age at 50 per cent production (days)	175.50 [a]	176.55 [a]
6.	Hen-housed egg number (25-40 weeks)	4.15 [a]	4.51 [a]
7.	Hen-housed per cent production (25-40 weeks)	59.28 [a]	64.42 [a]
8.	Hen-day number (25-40 weeks)	4.16 [a]	4.52 [a]
9.	Hen-day per cent (25-40 weeks)	59.42 [a]	64.57 [a]
10.	Daily feed consumption (g)	123.06 [a]	123.46 [a]
11.	Feed conversion ratio/dozen eggs (25-40 weeks)	2.60 [a]	2.45 [a]
12.	Egg weight (g)	50.44 [b]	53.36 [a]
13.	Egg mass (kg)	1.60 [b]	1.84 [a]
14.	Per cent shell	10.17 [a]	9.41 [a]
15.	Per cent albumen	58.59 [a]	57.65 [a]
16.	Per cent yolk	31.24 [a]	32.94 [a]
17.	Shape index	1.34 [a]	1.32 [a]
18.	Albumen index	0.09 [a]	0.07 [b]
29.	Yolk index	0.36 [a]	0.34 [b]
20.	Haugh Unit Score	87.16 [a]	80.58 [a]
21.	Shell thickness (mm)	0.44 [b]	0.48 [a]
22.	Yolk cholesterol (mg per g of yolk)	14.54 [a]	14.46 [a]
23.	Per cent livability	91.66 [a]	93.33 [a]

Means carrying same superscripts between NH and NN did not differ significantly ($P<0.05$).

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COMPARATIVE PERFORMANCE OF NEW HAMPSHIRE AND INDIGENOUS NAKED NECK HENS IN CAGES

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ABSTRACT OF A THESIS

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ABSTRACT

An experiment was carried out at the Kerala Agricultural University Poultry Farm, Mannuthy in order to evaluate the production performance of New Hampshire and Naked Neck hens in cages.

Sixty (60) pullets each of New Hampshire (NH) and Naked neck (NN) at the age of 18 weeks were housed at random in identical cages in four replicates each at the rate of 15 birds per replicate and three birds per cage. Layer mash with BIS specifications was fed *ad libitum* throughout the experimental period. Standard routine management practices were followed in the study. The production performance in cages for five periods of 28-days each were recorded during January to June 1999. The objective of the study was to evaluate and compare the production performance of New Hampshire and Naked Neck hens from 20 to 40 weeks of age in cages.

Body weight at 20 and 40 weeks of age in New Hampshire and Naked Neck were recorded individually and the respective mean values were found to be 1675.10 g and 1682.30 g at 20 weeks and 2635.45 g and 2703.65 g at 40 weeks of age. The average age at first egg was 164.50 days in New Hampshire and 164.71 days in Naked Neck hens. The mean ages at 10 and 50 per cent production were 168.15 and 175.5 days in New Hampshire and 170.35 and 176.55 days in Naked Neck respectively.

The mean egg production recorded was 4.15 with 59.28 per cent in New Hampshire and 4.51 eggs with 64.42 per cent in Naked Neck on hen housed basis and on hen-day basis 4.16 eggs with 59.42 per cent in New Hampshire and 4.52 eggs with 64.57 per cent in Naked Neck. The highest production was obtained at 31 weeks of age in New Hampshire and Naked Neck birds on hen-housed and hen-day basis. The mean daily feed consumption worked out was 123.06 g in NH and 123.46 g in NN. Feed conversion ratio on the basis of dozen eggs for New Hampshire was 2.60 and it was 2.45 in Naked Neck hens. Egg weight at last three days in each period was individually recorded and the overall mean egg weight for 21 to 40 weeks of age was 50.44 g in New Hampshire and 53.36 g in Naked Neck. The overall mean egg mass per day was 1.60 kg in NH and 1.84 kg in NN. The mean percentages of shell, albumen and yolk were 10.17, 58.59 and 31.24 in New Hampshire and 9.41, 57.65 and 32.94 in Naked Neck eggs respectively. The mean shell thickness was 0.44 mm in NH and 0.48 mm in NN eggs. The mean indices of shape, albumen and yolk were 1.34, 0.09 and 0.36 in New Hampshire and 1.32, 0.07 and 0.34 in Naked Neck. The mean yolk cholesterol was 14.54 mg per g of yolk in New Hampshire and 14.46 mg per g of yolk in Naked Neck eggs. The mean Haugh Unit Score was 87.16 in New Hampshire and 80.58 in Naked Neck hens. The livability per cent from 21 to 40 weeks of age was 91.66 in New Hampshire and 93.33 per cent in Naked Neck.

The feed cost per egg was 226 paise in New Hampshire and 212 paise in Naked Neck hens.

Based on the above findings, it is evident that the overall egg weight, egg mass and shell thickness were significantly higher ($P<0.05$) in Naked Neck birds. The overall mean albumen index and yolk index were significantly higher ($P<0.05$) in New Hampshire birds. The differences in body weight at 20 and 40 weeks, age at sexual maturity, overall HHN, HDN and its percentages, overall feed consumption, feed conversion ratio, per cent shell, per cent albumen and per cent yolk, shape index, yolk cholesterol and Haugh Unit Score were non-significant between New Hampshire and Naked Neck. Therefore it was concluded that Naked Neck birds have an edge over new Hampshire birds in egg production, egg weight, egg mass and shell thickness. However, New Hampshire birds had better albumen and yolk percentage. New Hampshire and Naked Neck were similar in characters of body weight, age at sexual maturity, egg production, feed consumption, feed conversion ratio, per cent shell, per cent albumen, per cent yolk, yolk cholesterol and Haugh Unit Score, when reared in cages.