STUDIES ON CAPON PRODUCTION

By

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "STUDIES ON CAPON PRODUCTION" 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.

Place: Mannuthy

Date : 14.11 86

Signature:

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CERTIFICATE

Certified that this thesis, entitled "STUDIES ON CAPON PRODUCTION" is a record of research work done independently by Sri. Jyotirmoy Chakraborty under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to him.

Name of the guide : Dr. R. Sabarinathan Nair
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Introduction

INTRODUCTION

The decade of the 70's saw an upswing in the production of chicken for meat. Tremendous progress have been made in enhancing the efficiency of broiler production as also the effective utilization of surplus chicken for meat production. As availability of chicken meat increases, it is natural that demand for specialised quality product will also increase. The per capita availability of poultry meat in 1985 was 240 g (Anon., 1986). This is much below the theoretical safe protein level of 29 g per head per day (FAO, 1973). Considerable effort has to be made to reach this consumption level by exploiting all available poultry for quality meat production. Poultry has high potential for helping to reach this target, being an efficient converter of feed and its acceptability as a meat source by all sections of the populace. The role of poultry production in helping to achieve this target needs no emphasis. India today requires large number of hybrid high resistance chicken to be reared under the typical rural rearing system - designated as the backyard system of poultry rearing. Large number of surplus hybrid males are available, which if economically utilized could add to the chicken meat output. Specialised managemental procedures are to be applied for improving the quality and acceptability of such surplus males.

Ninty per cent of eggs produced in Kerala are from chicken kept under the backyard system (Radhakrishnan and Ramakrishnan, 1982). In this system each household keeps few chickens basically of 'Desi' stock, providing only night shelter facilities. They feed on kitchen waste and forage in the land around the household, laying few eggs in the process. With a view to increase egg production by exploiting this system, developmental agencies made available superior White Leghorn germ plasm to the rural sector. The rural households started introducing highly productive strains of White Leghorn into the backyard system with negative results, as this sophisticated germ plasm could not become successful under the stressful backyard existence. This prompted research to identify a suitable cross breed for this system which will be able to survive and produce reasonably well braving the rigours of the system. Research indicated that the crossbred Austra-White (Australorp x White Leghorn) is efficient in this regard (Radhakrishnan and Ramakrishnan, 1982). The males of this combination thus became available in large number for exploitation as a meat source.

Caponization of chicken is employed to produce special quality poultry meat. A capon is reported to be of special preference in many places and there are special markets for capons. The Indian type of tandoori cooking needs firmer meat than the very tender broiler and since capons are usually marketed 5-7 months of age, the feasibility of utilizing the

Austra White surplus males for capon production is worth exploring. The technology of caponization and capon production do not seem to have been explored under Indian conditions. If the technology is economically viable there is better scope for effective utilization of surplus cockerels.

The present study therefore, was designed and carried out with the following objectives:

1. To utilize Austra-White and White Leghorn surplus cockerels for capon production.
2. To ascertain the practical and economic feasibility of rearing capons.
3. To compare meat qualities between roasters and capons and to compare economics of capon production with roaster production and
4. To ascertain the feasibility of employing surgical caponization as a routine managemental procedure for economic utilization of surplus cockerels.

Review of Literature

REVIEW OF LITERATURE

Literature reveals that caponization has been in practice from very early times, dating back to 37 B.C. (Winter and Funk, 1960). There are two methods of caponization, one by the use of chemicals (Hormones) and the other by surgical means (Winter and Funk, 1960; U.S.D.A., 1977). Out of these, hormonal caponization raises the question of dangerous side effects and the use of hormones is strictly controlled, especially in food production. Surgical caponization hence assumes importance.

A perusal of literature shows that though research had been carried out in caponization, the quantum of information available is limited and far between. Available literature is placed traitwise.

Weight gain

Annin and Halpin (1938) utilized different pure breeds and cross breeds for a comparison between capons and roasters, and reported inconsistent results. They noted that two years average was slightly better for capons. Eventhough this difference was not statistically significant, the profit from capons over feed and chick cost was just double compared to roasters.

Rapidly growing breeds such as Plymouth Rock, Rhode Island Red, Cornish and Orpington were shown to attain maximum weight at 7 to 10 months of age when caponized than any other roasting birds (Poley, 1940; Payne, 1943; Irwin, 1946).

Utilizing modern meat strains, Adams (1955) compared capons, caponettes and roasters, with two different feed formulations. He found better performance to the extent of 12.5 per cent on caponization. Caponettes also had comparable performance.

In a similar experiment, Lauffer (1957) concluded that caponettes were significantly heavier than either capons or roasters, both at the 13th and 24th week of age. Capons had lesser body weight at 13th week of age but by the time they attained 24 weeks of age they compensated the depression and attained heavier body weight than the roasters, although the difference was not statistically significant.

Begin and Grainger (1957) comparing diethylstilbestrol (Pellet, paste, and supplementation in feed) with surgical capons and intacts found significantly better gain for pellet treated caponettes followed by capons, control and paste treated caponettes at 17th week in that order. Caponization initially depressed growth but it was compensated in the later stages.

Winter and Funk (1960) opined that though the principal objective of caponizing cockerels was to improve quality of meat, it also produced a weight advantage over cockerels when sold at 7 to 8 months of age.

York and Mitchell (1969) compared performances of cockerels, surgically caponized at 4 weeks with those implanted with 10 mg oestradiol 17 β monopalmitate at 5 weeks. The birds were processed at 11 weeks of age and found that caponettes and intacts had significantly heavier weight than capons. They also added that capons had suffered caponization stress two weeks post-caponization.

Layfield et al. (1971) studied the effect of different protein levels of 14, 16, 18 and 20 per cent and found that different protein levels in feed had no significant effect on capon growth. Different diets with varying calorie:protein ratios of 50:1, 56:1, 61:1 and 68:1 were found to significantly improve weight gains. They further reported that weight gain and feed utilization increased in proportion to the increase in calorie:protein ratio levels. A trend for better gain and efficiency was observed when feed was restricted by manual control to 85 to 90 per cent of full feed in another trial by the same authors.

In a direct comparison between capons and roasters, Walter (1976) found a depression in rate of gain for one week post-caponization but during the second week the treated birds gained weight comparable to controls and at 18½ weeks of age caponized birds were significantly heavier than their counterparts of the same age. By using varying energy levels no significant interaction was observed by the same author in any of the parameters tested.

Cockerels of New Hampshire, Rhode Island Red, Plymouth Rock and Cornish breeds and their crosses caponized at 2-3 weeks performed better as capons when marketed at 8-10 months of age. White Leghorn cockerels were recommended suitable to be raised as small sized capons (Neshiem et al., 1979). Ensmiger (1980) reported a slight weight advantage for capons when marketed at 7-8 months of age.

In a comparative study of partial caponization (removal of either right or left testicle), full caponization and intacts involving White Hubbard Mountain and Penobscot, Mast et al. (1981) concluded that complete or partial caponization produced significantly better gain than roasters in White Hubbard Mountain but between complete and partially caponized birds, complete capons showed numerical weight advantage. Partial caponization by removing right testicle resulted in significantly heavier weight than full caponization and intacts in Penobscot. Partial caponization by removing left testicle however, produced negative results than full caponization.

North (1984) reported that cockerels can be grown to heavier weights than roasters and broilers by caponizing them at 2-4 weeks of age and marketed at 18 to 20 weeks of age when they can be classed as a special category of poultry.

Feed efficiency

Published works on the feed efficiency of capons, caponettes and cockerels exhibits considerable inconsistency.

Annin and Halpin (1938) reported that feed conversion efficiency did not differ at any time during a 28 week experiment involving capons and cockerels. Due to the increased quantum of feed required to produce a quantum of gain towards the last few weeks, feed efficiency during this period tend to become inferior, they further opined.

Adams (1955) considered the cost of chicks and feed to evaluate performance and found that caponettes performed best with both the 1936 and 1951 feed formulation whereas capons only with the 1936 feed formulation. He also concluded that caponization produces little benefit at 17 weeks of age unless a premium price is paid for capons.

Begin and Grainger (1957) studied the performances of diethyl stilbestrol pellet, paste treated and feed supplemented caponettes with capons and roasters. They found the best efficiency in terms of feed per unit gain for the pellet treated caponettes 5-9 weeks of age. At 13 weeks of age paste treated caponettes returned better efficiency, but at 17 weeks of age surgical capons had the best efficiency.

Lauffer (1957) found that hormone treated caponettes tended to utilize feed more efficiently than both the controls and capons at 13 and 24 weeks of age. The intacts had better feed conversion than the capons at 13 weeks of age while capons had better feed conversion than the intacts at 24 weeks of age.

Winter and Funk (1960) observed that pound of feed required to produce a pound of capon was greater than for producing a pound of broiler, fryer, small roaster, duck or turkey.

York and Mitchell (1969) reported better feed efficiency for roasters than capons and caponettes. While Layfield et al. (1971) observed better feed efficiency for capons and a trend for the efficiency to improve along with the increased calorie:protein ratios.

Significantly better feed efficiency was observed for intacts over capons at $18\frac{1}{2}$ weeks of age by Walter (1976).

Neshiem et al. (1979) and Ensminger (1980) opined that though the White Leghorn cockerels produced satisfactory small sized capons, they were not commercially viable because of lesser efficiency in feed utilization.

Mast et al. (1981) in a study with White Hubbard Mountain strain involving complete and partially caponized birds, concluded that complete capons convert feed more efficiently than partial capons and roasters. However, they observed better efficiency for partially (right testicle) caponized birds with regard to the Penobscot strain.

North (1984) suggested that restriction of 10-15 per cent of full feed for 6-14 weeks and full feeding thereafter improves feed efficiency of capons.

Processed/ready to cook yields

Jull (1951) reported that the fattened capons had significantly higher (62.1%) ready to cook yield than fattened roasters (57.8%) when compared on live weight basis.

In contrast, Adams (1955) reported highest dressing percentage (eviscerated) for roasters, followed by caponettes when fed a new ration (formulated in 1951) and no difference was observed between roasters and caponettes when fed an old ration (formulated in 1936). Capons had lesser eviscerated yield both in the old and new type of ration at 17 weeks of age.

Significantly higher carcass yields for caponettes than capons and roasters, at the 24th week of age was observed by Lauffer (1957). Capons had slightly lesser carcass yields when compared to roasters.

York and Mitchell (1969) observed that both oestrogen treated caponettes and surgical capons returned higher dressing percentage than roasters.

In a direct comparison between capons and roasters, Walter (1976) reported that capons had significantly higher eviscerated yield than roasters, whereas dressing percentage and cooking loss was not affected by surgical caponization.

Mast et al. (1981) reported significantly higher ready to cook yield for capons of Penobscot birds, whereas partially caponized (left testicle) birds had significantly the lowest yield. There was no significant difference in ready to cook yield between partially (right testicle) caponized and roasters. They further stated that in case of White Hubbard Mountain, no significant difference was observed in any of the treatments. Mountney (1982) observed that the ready to cook yield of capons and roasters slaughtered at 18.7 and 16 weeks of age were 74.7 and 73.2 per cent respectively for capons and roasters.

Market quality and carcass composition

Annin and Halpin (1938) reported that capons had more abdominal fat than roasters. The muscles of the thigh and drumstick of capons were much lighter in colour than the corresponding sections of roasters. In some instances he observed that the outer thigh muscles were indistinguishable from that of pectoral muscles of same bird when cooked.

Both oestrogen treatment and surgical caponization were reported to improve the market quality of chicken (Foley, 1940; Payne, 1943; Lorenze, 1943 and 1945; Irwin, 1946).

Adams (1955) concluded that in so far as conformation and fat grades were concerned, caponettes were the best, followed by capons and roasters.

Lauffer (1957) reported similar findings that caponettes had vastly better finish, feathering and fleshing than either capons and roasters. Capons had lesser finish, feathering and fleshing at earlier age but by 24th week they compensated and became superior to that of roasters in finish, feathering and fleshing.

Begin and Grainger (1957) observed improved carcass quality in terms of fat covering and abdominal fat in the diethyl stilbestrol pelleted caponettes, followed by the diethyl stilbestrol paste treated caponettes, the capons and the roasters. When capons were compared with roasters in the earlier ages they were inferior in carcass quality, but this was reversed by the time they reached 17 weeks of age.

Winter and Funk (1960) reported that improvement in the quality of the meat insures a better price for capons than cockerels which have become staggy. They also added that contrary to public opinion capons tend to become tough meated when kept for more than a year.

York and Mitchell (1969) investigating the carcass qualities of capons, caponettes and roasters observed that the fat content of light and dark meat was affected by surgical caponization. The fat and moisture content of the liver was also affected. While the fat content increased, moisture was decreased when compared with roasters. They further reported that both the treated groups had higher score for tenderness, juiciness and flavour than the roasters except the flavour of dark meat. Overall preference score, though not significantly different, had higher score for treated groups.

Layfield <u>et al</u>. (1971) reported that muscle protein of caponized birds was not affected by different protein levels in the diet and so also the energy:protein ratios. They also reported a trend of increasing fat content and decreasing moisture content in the breast and thigh muscles in tune with increasing levels of calorie:protein ratio.

Walter (1976), in a direct comparison of capons and roasters reported that capons had non-significant overall higher score in tenderness and juiciness. He also added that freezing of carcass exercised a tenderising effect in the meat. He observed better personal preference for fresh cooked capon meat and when tested with frozen meat there was definite preference for frozen capon meat than frozen roaster meat.

It was reported that "persons who once tasted roast capon of top quality are likely to be repeat customers year after year" (Neshiem et al., 1979; Ensminger, 1980).

Mast et al. (1981) concluded that result of sensory panel evaluation and shear value indicated that meat from capons was consistently the most tender. This difference was most pronounced in the thigh muscles. They also added that meat from slips or partially caponized was as or more tender than intacts. Sensory evaluation was highly correlated with multiple blade shear test than single blade shear test.

Mountney (1982) reviewed the literature available on tenderness and flavour of poultry meat and summarised that flavour is made up of a combination of taste, aroma, body and mouth satisfaction. Though fat gives the aroma to poultry meat, it does not influence the flavour of chicken meat. It appeared from the above review that sex, variety, exercise, treatment with oestrogen and testosterone has no influence on muscle toughness. Post-slaughtering factors such as beating by rubber fingers of the defeathering machine, overscalding, short time aging temperature, the media on which aged and freezing, may influence tenderness of poultry meat.

North (1984) reported that caponized chicken produce unique type of poultry with more tender, juicier and more flavourful meat which rates a premium price.

Materials and Methods

MATERIALS AND METHODS

Location

The study was carried out at the University Poultry Farm of the College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy, Trichur. The chicks were hatched during October 1985 and the trial was held during the period December 1985 through May 1986.

Mannuthy is located at longitude 76° 16'E, latitude 10° 32'N and altitude 22.25 MSL. The climate of Mannuthy is classed as tropical maritime monsoon type.

The season can be broadly described as two viz., Dry/ Summer season and monsoon season, there occurring two monsoons, the south west and north east monsoon. The south west is heavy. The seasonal rhythm other than this is not very discernible. There is little variation in day length and relative humidity is high throughout the year. The mean ambient temperature is 27°C and temperature as high as 40°C used to be experienced during the months of March and April. The seasonal profile is described as below:

Rainy season (May to November)	Cold wet (June to August) Warm and wet (May and September to November)
Dry season (December to April)	Warm and Dry (December and January) Hot and Dry (February to April)

(Somanathan, 1980)

Meteorological data, the average of five years (1974-1978) are presented in Table I.

<u>Experiment</u>

Day old male chicks from pure bred 'F' strain of White Leghorn and Austra-White crossbred varieties (Australorp ♂ x 'F' strain White Leghorn ♀) were brooded and reared breedwise, under identical conditions of management upto eight weeks of age. Feed and water were provided *ad lib*. A standard commercial chicken starter mash was fed.

At eight weeks of age, birds were winghanded, weighed and were randomly allotted to eight groups of 12 birds in each breed. From these eight groups of each breed, four groups randomly selected were subjected to surgical caponisation and the other four groups were kept as intact controls. Each treatment was replicated four times as detailed below:

Treatment	Breed details	Number of birds	Replicate
Treatment I	Austra-White caponized	12	4
Treatment II	Austra-White intacts (control)	12	4
Treatment III	White Leghorn caponized	12	4
Treatment IV	White Leghorn intacts (control)	12	4

Table I. Meteorological profile (1974-1978)

Location: Mannuthy

Period	Number of hours of bright sunshine (Daily average)	Wind velocity (Km/hr) (Daily average)	Maximum temperature (°C) (Daily average)	Minimum temperature (°C)	Mean ambient temperature (°C) (Daily average)	Rainfall (mm) (monthly average)
January	8.16	9.67	31.14	21.15	26.15	Nil
February	8.11	7.66	33.63	22.89	28.26	10.06
March	7.64	5.16	35.14	24.65	29.90	21.16
April	6.29	4.85	34.55	25.80	30.18	76.62
May	4.44	4.78	32.35	25.27	28.81	220.08
June	2.31	3.72	29.26	23.84	26.55	501.48
July	1.38	3.75	28.15	23.28	25.72	796.41
August	1.67	4.17	28.55	23.62	26.09	511.62
September	3.61	3.82	30.25	24.06	27.16	260.76
October	4.15	3.19	30.13	23.67	26.9	220.34
November	5.21	3.86	30.23	23.27	26.75	242.34
December	6.69	10.62	30.21	22.52	26.37	9.10

(Somanathan, 1980)

PROCEDURE OF SURGICAL CAPONIZATION

Preparation of birds

Birds were subjected to overnight fasting to reduce the load of intestine, to facilitate better view of testicles and to reduce the chances of injury during caponization.

Location of testicles

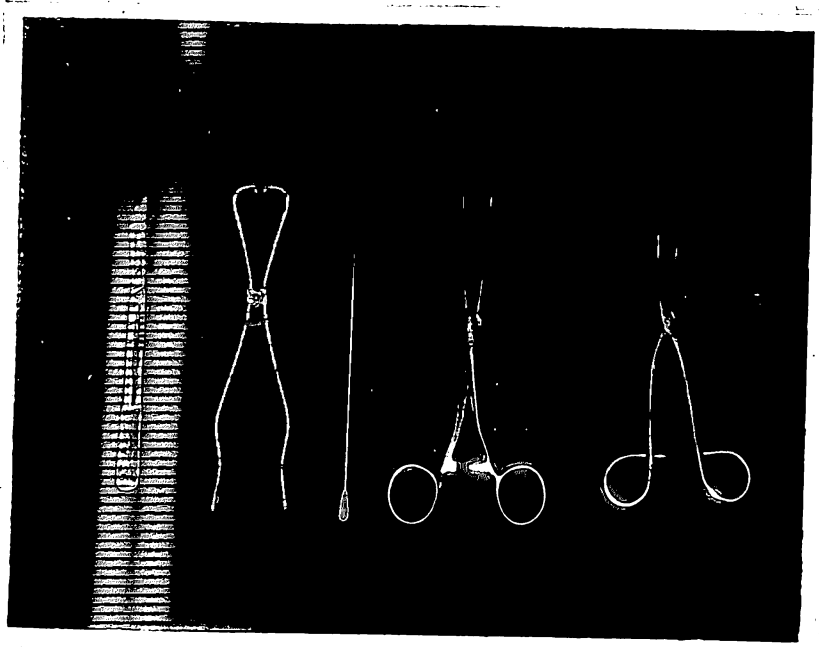
Right and left testicles are situated anterior to the cranial lobe of kidneys in between the kidney and the lung on both sides parallel to the dorsal midline. These are yellowish to creamy white in colour, attached to the dorsal body wall by a short mesorchium on each side and situated in close proximity of the common iliac vein.

Instruments

1. B.P. blade and handle
2. Self retaining rib retractor
3. Caponizing hook with one end sharp and curved and other end blunt and flat
4. Testicle extracting forceps (Type I & II)
5. Rat toothed tissue forceps
6. Straight suturing needle and black silk thread (No. 30) (Plate I)

Surgical technique

Caponization was carried out in indirect sunlight as suggested by O'connor (1980) and Saikia and Pathak (1965). However, no anaesthetic was employed in this study.



Birds were held in lateral recumbancy and the skin was stretched and feathers in the area between the 6th and 7th ribs were plucked (Plate II). An incision of about 3.7 cm long was made on the skin at the site of operation. The skin was retracted and the tensor fascia lata muscle was grasped by forceps and retracted posteriorly, away from the last rib. A stab wound was made on the intercostal muscles. The curved blunt end of the self retaining retractor was introduced through the wound. The stab wound on the intercostal muscles was enlarged gradually. The retractor was then fixed allowing a space of 1.27 cm between two ribs and the tensor fascia lata muscle was released (Plate III, IV). The peritoneum was then torn with the hook and the intestine was pushed caudally and ventrally with the help of blunt end of the hook, exposing the testicle. The testicle was grasped by the testicle extracting forceps ensuring that the whole testicle along with a portion of mesorchium was held by the forceps. The testicle was then extracted by gentle traction and twisting movement taking care not to injure the common iliac vein (Plate V). The self-retaining retractor was then released facilitating tensor fascia lata muscle to cover the wound of the intercostal muscles. The skin wound was closed by interrupted mattress sutures using No.00 black silk.

The same procedure was repeated to remove the other testicle and the birds were released immediately.

POST CAPONIZATION MANAGEMENT

The birds were housed in pens of 26100 cm^2 floor area with individual bird allowances of 2175 cm^2. The replicate distribution in pens was done at random. All the pens had litter floor equipped with hanging tube feeder and linear PVC water channel. Feed and water were provided *ad lib*. From the 10th week of age the birds were provided with a standard commercial grower mesh.

Recordings were made on the weekly body weight and weekly feed consumption. Daily indoor maximum and minimum temperature were recorded using a Six's maximum and minimum thermometer and a Mason's dry and wet bulb thermometer was used to record and ascertain depression level, to monitor relative humidity. The recordings were made at 8 a.m., 12 noon and 4 p.m.

At 20 weeks of age, the cumulative gain in weight by individual birds, group feed efficiency and economics of production were calculated.

Four birds from each group were randomly collected and processed to evaluate the processing yields and losses. These birds were weighed and starved overnight. After pre-slaughter starvation they were weighed to assess the pre-slaughter starving shrinkage. The birds were then killed by the outer cut method (Kotula and Helbacka, 1965) and processed by standard techniques to ascertain further losses and yields (Kilpatrick and Pond, 1960).

Similar assessments were made at 24 weeks of age and 28 weeks of age to compare the performances at those stages.

The losses under evaluation at different stages of processing were dressing loss (loss due to fasting shrinkage, blood and feather), evisceration loss (loss due to viscera) and due to head and shank loss. The edible carcass after all these processing losses was evaluated as Ready to Cook Yield. All the losses were assessed as percentages of live weight.

Birds of the caponized groups showing greater comb and wattle development were marked as suspected slips and were scrutinised at slaughter. Those with portion of testicle left remaining were classed as slips.

Four randomly selected ready to cook carcass, one from each treatment were taken and minced to a fine homogenous paste by repeated mincing. Double samples from each birds were taken and analysed for moisture, protein and ether extract. Moisture was determined by drying the sample in hot air oven at 110°C for 8 h. The protein and ether extract were analysed by using standard methods (A.O.A.C., 1970).

The breast muscle was taken from four randomly selected ready to cook carcass, one from each treatment for taste panel evaluation at 28th week of age. Whole pectoralis muscle was cooked for 10 mt in pressure cooker. Cubes measuring 1.27 cm were taken from the muscle and served to panelists drawn from different sections of the faculty. Cooked cubes of meat was served after coding. Qualities of preference evaluated were tenderness, juiciness and overall personal preference.

STATISTICAL ANALYSIS

The data generated were subjected to appropriate statistical analysis as per the methods of Snedecor and Cochran (1967). Treatment effects within the same breed were only statistically compared for significance.

Results

RESULTS

Thermal environment

The average monthly data of the meteorological variables of maximum and minimum temperature, hours of sunshine, wind velocity, relative humidity and rainfall for the five year period from 1974-1978 are presented in Table I. The monthly averages of the meteorological variables of maximum and minimum temperature, ambient temperature, relative humidity and total monthly precipitation for the experimental period are presented in Table II.

The average maximum and minimum temperature, ambient temperature, relative humidity and total rainfall for the experimental period were 34.51°C, 25.03°C, 29.00°C, 63.83 per cent and 202.30 mm respectively.

Body weight gain

Average gain in weight due to treatments along with the average body weight at the 20th, 24th and 28th week of age are presented in Table III. Analysis of variance of weight gain are presented in Table IV.

The gain in weight at the 20th week of age by Austra-White caponized, Austra-White intacts, White Leghorn caponized and White Leghorn Intacts were 1131.46 g, 1057.40 g, 935.42 g and 915.10 g respectively. In both the pure and the crossbred groups the caponized birds gained significantly ($P < 0.05$)

Table II

Monthly average meteorological data during the experimental period

Period	Maximum temperature average (°C)	Minimum temperature (°C)	Ambient temperature average (°C)	Relative humidity average per cent	Monthly total precipitation (mm)
December '85	32.5	23.9	28.2	57	58.0
January '86	32.9	23.8	28.4	58	1.2
February '86	35.5	23.5	29.5	64	1.9
March '86	36.5	26.3	31.4	67	0.4
April '86	36.9	27.6	32.3	66	23.2
May '86	32.8	25.1	29.0	71	106.8

Table III

Average body weight and weight gain (g) at the 20th, 24th and 28th week of age[1]

Age in weeks	Austra-White caponized		Austra-White intacts		White Leghorn caponized		White Leghorn intacts	
	Body weight	Weight gain[2]	Body weight	Weight gain[2]	Body weight	Weight gain[2]	Body weight	Weight gain[2]
Twenty weeks	1637.40	1131.46*	1645.52	1057.40	1470.00	985.42*	1407.71	915.10
Twentyfour weeks	1809.38	1296.88*	1778.13	1199.22	1654.06	1159.53	1584.53	1094.53
Twentyeight weeks	1915.00	1406.25	1936.38	1344.06	1773.75	1249.69	1673.13	1148.75

* Significantly different ($P < 0.05$)

1 Treatment comparison within each variety

2 Weight gain from 9 weeks onwards for the respective stages

Table IV

Analysis of variance for body weight gain at 20, 24 and 28 weeks of age

20th week (9th to 20th week)

Source	Degrees of freedom (df)	Sum of sources(SS)	Mean sum of sources (MS)	F
Block	47	885744.00	18845.617	0.0000403
Treatments	3	1254016.00	418005.333	20.214 **
Error	141	2915632.00	20678.241	
Total	191	5055392.00	26468.020	
			CD (5%) = 57.531	
24th week (9-20 weeks)				
Block	31	864096.00	27874.064	1.0352
Treatments	3	688816.00	229605.333	8.528 *
Error	93	2503904.00	26923.698	
Total	127	4056816.00	31943.433	
			CD (5%) = 81.221	
28th week (9-28 weeks)				
Block	15	388200.00	25880.00	0.9857
Treatments	3	607712.00	202570.666	7.715
Error	45	1181408.00	26253.511	
Total	63	2177320.00	34560.634	
			CD (5%) = 115.144	

** Highly significant (P $\angle$0.01)

better weight than intacts. At the 24th week of age, gain in weight were 1296.88 g, 1199.22 g, 1159.53 g and 1094.53 g respectively in the above order. At this stage the Austra-White caponized had significantly ($P < 0.05$) better gain than Austra-White intacts. Though the gain in weight between White Leghorn caponized and intacts was not significantly different, the caponized group had numerical advantage over intacts. At the 28th week of age, the gain in weight were 1406.25 g, 1344.06 g, 1249.69 g and 1148.75 g respectively, for Austra-White caponized, Austra-White intacts, White Leghorn caponized and White Leghorn intact controls. At this age gain in weight did not differ significantly between caponized and intacts, neither in case of Austra-White, nor in case of White Leghorn. But caponized had appreciable higher numerical gains than the controls in both the pure and cross breeds.

Feed efficiency

The quantum of feed required to produce one kg weight gain by the different treatments at the 20th, 24th and 28th week of age are presented in Table V. The analysis of variance for the different stages are presented in Table VI.

At the 9th-20th week period the feed efficiency of Austra-White caponized, Austra-White intacts, White Leghorn caponized and the White Leghorn intacts were 5.22 kg, 5.98 kg, 5.81 kg and 6.36 kg respectively. At 24 and 28 weeks of age the feed efficiency were 7.01 kg, 8.26 kg, 7.27 kg, 8.04 kg and 8.50 kg, 9.55 kg, 9.08 kg and 10.02 kg respectively for the treatments in the same order as above.

Table V

Feed efficiency[1] of different treatment groups[2] at the three stages of experiment

Age in weeks	Austra-White caponized	Austra-White intacts	White Leghorn caponized	White Leghorn intacts
20th week	5.22	5.98 *	5.81	6.36*
24th week	7.01	8.26*	7.27	8.04*
28th week	8.50	9.55*	9.08	10.02*

* Significant ($P < 0.05$)

1 Feed efficiency = kg of feed to produce kg of live weight gain

2 Comparison within each variety

Table VI

Analysis of variance for feed efficiency at the 20th, 24th and 28th weeks of age

20 weeks

Source	Degrees of freedom (df)	Sum of squares (SS)	Mean sum of squares (MS)	F
Treatment	3	2.70	0.90	7.22**
Error	12	1.49	0.12	1.00
Total	15			
			CD (5%) = 0.543	
		24 weeks		
Treatment	3	4.31	1.44	6.61 -
Error	12	2.61	0.22	1.00
Total	15			
			CD (5%) = 0.718	
		28 weeks		
Treatment	3	5.08	1.69	8.79**
Error	12	2.31	0.19	1.0
Total	15			
			CD (5%) = 0.676	

** Highly significant (P < 0.01)

The caponized birds both pure and cross bred utilized feed significantly (P $<$ 0.05) better than the intacts during the three periods tested.

Processing loss and yield

Processing loss and yield of each treatment are presented in Table VII. The analysis of variance are presented in Table VIII, IX, X and XI, for dressing loss, loss due to viscera, loss due to head and shanks, and ready to cook yield respectively.

Dressing loss

At 20 weeks of age the dressing loss for Austra-White caponized, Austra-White intacts, White Leghorn caponized and White Leghorn intacts were 22.56, 20.53, 21.63 and 19.46 per cent respectively. At 24 weeks of age the dressing loss were 20.13, 18.91, 21.01 and 19.33 per cent and at the 28th week it was 19.98, 17.65, 19.70, 17.04 respectively for the treatments in the same order as above (Tables VII and VIII).

The dressing loss was significantly higher ($P < 0.05$) for caponized than the intacts for both pure and cross bred during the three stages of evaluation.

Visceral loss

Periodwise and treatmentwise loss due to viscera are presented in Table VII, and analysis of variance in Table IX.

Table VII

Processing loss and yield at three stages of experiment

Factors	Austra-White caponized Age in weeks			Austra-White intacts Age in weeks			White Leghorn caponized Age in weeks			White Leghorn intacts Age in weeks		
	20	24	28	20	24	28	20	24	28	20	24	28
Live body weight (g)	1542.50	180[illegible].13	1919.38	1717.13	1784.38	1936.88	1348.13	1615.63	1773.75	1360.00	1576.56	1673.[illegible]
Dressing loss	22.56*	[illegible].13*	19.98*	20.53	18.91	17.65	21.83*	21.01*	19.70*	19.46	19.33	17.[illegible]
Evisceration loss	7.80	4.99	4.14	7.25	5.55	3.67	8.05	6.11	4.53*	8.04	5.53	3.[illegible]
Loss due to head and shanks	6.64	7.58	7.02	7.87*	9.16*	9.80*	6.85	7.53	7.39	8.66*	9.80*	10.[illegible]*
Total loss	37.00	32.71	31.14	35.66	33.62	31.11	36.73	34.64	31.62	36.15	34.65	30.[illegible]
Dressing yield	77.44	79.87	80.02	79.47	81.09	82.35	78.17	78.99	80.30	80.54	80.67	82.[illegible]
Ready to cook yield	63.00	67.29	68.86	64.34	66.38	68.89	63.27	65.36	68.38	63.85	65.35	69.[illegible]

* Significant ($P<0.05$)

Note: Comparison between treatments within each variety

Each value represent average of 16 birds

Values are in per cent of live weight

Table VIII

Analysis of variance of dressing loss at the 20th, 24th and 28th weeks of age

20 weeks

Source	Degrees of freedom (df)	Sum of squares (SS)	Mean sum of squares (MS)	F
Replication	15	40.24	2.68	0.67
Treatment	3	90.80	30.27	7.57
Error	45	179.88	4.00	1.00
			CD (5%) = 1.423	
		24 weeks		
Replication	15	40.72	2.71	1.48
Treatment	3	41.55	13.85	7.58**
Error	45	82.27	1.83	1.00
			CD (5%) = 0.962	
		28 weeks		
Replication	15	51.22	3.41	1.24
Treatment	3	102.98	34.33	12.48**
Error	45	123.75	2.75	1.00
			CD (5%) = 1.180	

** Highly significant ($P < 0.01$)

Table IX

Analysis of variance for evisceration loss at 20, 24 and 28 weeks of age

Source	Degrees of freedom (df)	Sum of squares (SS)	Mean sum of squares (MS)	F
20 weeks				
Replication	15	19.42	1.29	0.45
Treatment	3	6.63	2.21	0.76 NS
Error	45	130.54	2.90	1.00
			CD (5%) = 1.212	
24 weeks				
Replication	15	67.74	4.52	1.73
Treatment	3	10.06	3.35	1.29 NS
Error	45	117.48	2.61	1.00
			CD (5%) = 1.150	
28 weeks				
Replication	15	46.54	3.10	2.95
Treatment	3	17.20	5.73	5.46**
Error	45	47.25	1.05	1.00
			CD (5%) = 0.739	

** Highly significant ($P < 0.01$)

NS Non-significant

At 20 weeks of age the visceral loss were 7.80 per cent for Austra-White caponized, 7.25 per cent for Austra-White intacts, 8.05 per cent for White Leghorn caponized and 3.04 per cent for White Leghorn intacts. At the 24th week of age the visceral loss were 4.99, 5.55, 6.11 and 5.53 per cent, and at the 28th week of age it was 4.14, 3.67, 4.53 and 3.14 per cent respectively in the same order.

The visceral loss between Austra-White caponized and Austra-White intacts did not differ significantly at any stage of the experiment. At the 28th week of age White Leghorn caponized had significantly ($P < 0.05$) higher visceral loss than White Leghorn intacts. But at the 20th and 24th week of age, visceral loss between White Leghorn caponized and intacts did not differ significantly.

Loss due to head and shanks

Treatmentwise loss due to head and shanks for the three stages are presented in Table VII. The analysis of variance for the three stages are presented in Table X.

The loss at 20 weeks of age for Austra-White caponized, Austra-White intacts, White Leghorn caponized and White Leghorn intacts were 6.64, 7.87, 6.35 and 8.66 per cent respectively. Shrinkage due to losses of head and shanks in both the caponized groups were significantly lessor ($P < 0.05$) than the intact controls.

Table X

Analysis of variance for loss due to head and shanks at 20, 24 and 28 weeks of age

20 weeks

Source	Degrees of freedom (df)	Sum of squares (SS)	Mean sum of squares (MS)	F
Replication	15	6.30	0.42	0.55
Treatment	3	42.06	14.02	18.35**
Error	45	34.37	0.76	1.00
			CD (5%) = 0.6[illegible]2	
		24 weeks		
Replication	15	20.59	1.37	0.92
Treatment	3	62.65	20.88	13.93**
Error	45	67.45	1.50	1.00
			CD (5%) = 0.[illegible]71	
		28 weeks		
Replication	15	25.78	1.72	1.50
Treatment	3	147.22	49.07	42.69**
Error	45	51.73	1.15	1.00
			CD (5%) = 0.763	

** Highly significant ($P < 0.01$)

At 24 and 28 weeks of age losses were 7.58, 9.16, 7.53, 9.80 per cent and 7.02, 9.80, 7.39 and 10.56 per cent respectively in the same order. Controls at both these stages had significantly ($P < 0.05$) higher losses than their caponized counterparts.

Ready to cook yields

Treatmentwise yields at 20, 24 and 28 weeks of age are presented in Table VII and the analysis of variance in Table XI.

The yields for the Austra-White caponized, Austra-White controls, White Leghorn caponized and White Leghorn controls were 63.00, 64.34, 63.27, 63.85 per cent; 67.29, 66.30, 65.36, 65.35 per cent and 68.86, 68.89, 68.38 and 69.25 per cent respectively for the 20th, 24th and 28th week of age.

The yields did not differ significantly at any stages of the experiment between caponized and intacts within breeds.

Slips

Five birds from the caponized groups showing larger comb and wattle development and exhibiting more 'maleness' than their pen mates were subjected to detailed investigation at slaughter. Each of these had testicular mass of varying sizes left in them. These were classed as 'slips' and they constituted 5.2 per cent of the total.

Table XI

Analysis of variance for ready to cook yield at the 20th, 24th and 28th weeks of age

Source	Degrees of freedom (df)	Sum of squares (SS)	Mean sum of squares (MS)	F
20 weeks				
Replication	15	39.27	2.62	0.43
Treatment	3	17.22	5.74	0.94 NS
Error	45	273.88	6.09	1.00
			CD (5%) = 1.756	
24 weeks				
Replication	15	81.22	5.41	1.95
Treatment	3	42.13	14.04	5.06**
Error	45	124.84	2.77	1.00
			CD (5%) = 1.106	
28 weeks				
Replication	15	106.25	7.08	1.93
Treatment	3	6.13	2.04	0.56 NS
Error	45	165.44	3.68	1.00
			CD (5%) = 1.365	

** Highly significant ($P < 0.01$)

NS Non-significant

Ready to cook carcass composition

Result of proximate composition of ready to cook minced carcass for different treatments at the 28th week of age is presented in Table XII.

Caponized birds returned higher values for moisture, protein and ether extract than their intact counterparts.

Taste panel evaluation

The result of the taste panel evaluation for tenderness, juiciness and overall personal preference for fresh cooked meat from each treatment at the 28th week of age are presented in Table XIII. The figures are percentages of personal preference.

Evaluation of score sheet indicated definite superiority for capon meat on tenderness and juiciness. There was absolute personal preference by panelists for capon meat.

Economics of production

The economics of production worked out on the basis of the chick cost, feed cost and surplus cockerels meat value as per the University Poultry Farm rates is presented in Table XIV.

At the 20th week stage there was positive returns of +3.37, +1.68, +1.81 and +0.71 rupees for the Austra White caponized, Austra White intact controls, White Leghorn caponized, and White Leghorn intact controls respectively. Figures for the 24 and 28 weeks were negative. At 24 weeks the negative figures ranged from -0.05 to -2.75 whereas the range was -3.64 to -6.21 rupees for 28 weeks of age.

Table XII

Composition of ready to cook whole minced carcass at 28 weeks of age

Treatments	Component analysed[1]			
	Moisture	Dry matter	Protein	Ether extract
Austra-White caponized	68.72	31.28	20.02	6.00
Austra-White intacts	66.59	33.41	19.44	5.95
White Leghorn caponized	69.91	30.09	21.33	3.46
White Leghorn intacts	69.46	30.54	18.60	3.14

1 Values are in percentages

Table XIII

Taste panel score card

Quality factors[1]	Samples			
	Austra-White caponized	Austra-White intacts	White Leghorn caponized	White Leghorn intacts
I. Tenderness:				
Tender	42.86	57.14	28.57	57.14
Very tender	57.14	28.57	57.14	28.57
Not tender	Nil	14.29	14.29	14.29
II. Juiciness:				
Very juicy	42.86	28.57	71.42	14 29
Mild juicy	57.14	71.43	14.29	57.14
Dry	Nil	Nil	14.29	28.57
III. Personal preference score	85.71	Nil	14.29	Nil

1 Values as per cent preferences

Table XIV

Economics of production by different treatments at the three stages of the experiment (20th, 24th and 28th weeks)

Items	Austra-White caponized Age in weeks			Austra-White intacts Age in weeks			White Leghorn caponized Age in weeks			White Leghorn intacts Age in weeks		
	20	24	28	20	24	28	20	24	28	20	24	28
Number of birds	48	32	16	48	32	16	48	32	16	48	32	16
Total gain in weight* (kg)	54.31	41.50	22.50	50.76	38.38	21.50	47.30	37.10	20.00	43.92	35.02	18.38
Total feed consumption** (kg)	283.50	290.92	191.25	303.54	317.02	205.33	274.34	269.72	181.60	279.33	281.56	184.17
Cost of feed @ Rs.1.75/kg and cost of chicks @ Rs.1/chick	544.12	541.11	350.69	579.20	586.79	375.33	528.18	504.01	333.80	536.83	524.73	338.30
Income from the sale of birds @ Rs.13/kg live weight	706.03	539.50	292.50	659.88	498.94	279.50	614.90	482.30	260.00	570.96	455.26	238.94
Profit of total birds in each treatment and in each stage	+161.91	-1.61	-58.19	+80.68	-87.85	-95.83	+86.72	-21.71	-73.80	+34.13	-69.47	-99.36
Profit per bird	+3.37	-0.05	-3.64	+1.68	-2.75	-5.99	+1.81	-0.68	-4.61	+0.71	-2.17	-6.21
Profit per bird when sold @ Rs.17/kg live weight for capons	+7.90	+5.14	+1.99	X	X	X	+5.75	+3.96	+0.39	X	X	X

* Weight gain from the 9th week onwards for the respective stages

** Feed consumed = 9 to 20 weeks, 9 to 24 weeks and 9 to 28 weeks

Discussion

DISCUSSION

Thermal environment

A bird's environment is the sum total of all factors that influence its growth, response and production. The macroclimatic factors forms one segment of this environment and is mainly composed of the ambient temperature, relative humidity, wind velocity, solar radiation and precipitation. The productivity is closely linked with those thermal environmental factors. It is therefore, essential that the climatic factors prevailing in the area where the experiment was conducted is presented and discussed.

Mannuthy is located at longitude 76° 16'E, latitude 10° 32'N at an altitude of 22.25 MSL. The thermal environmental data during the experimental period indicates a warm humid type of environment. The maximum ambient temperature is encountered during March and April and the minimum during the month of December. The average temperature varied from the low of 28.2°C of December to the high of 32.3°C during the month of April. The average amplitude of variation is 4°C only.

Above an average temperature of 20°C, depression in growth rate have been reported in birds, even if the daily minimum is within the zone of the temperature for maximum growth. It has also been reported that temperature as high as 40°C can be tolerated, if there is sufficient diurnal variation (Harris *et al.*, 1974). From the climatic variables it is evident that the climate of Mannuthy can be described as tropical maritime monsoon type. Nair (1973) and Somanathan (1980) has also indicated the climate as such. A monitoring of the thermal environment therefore, reveals that poultry will be exposed to the stress of higher temperature and higher humidity during the better part of the year in the location.

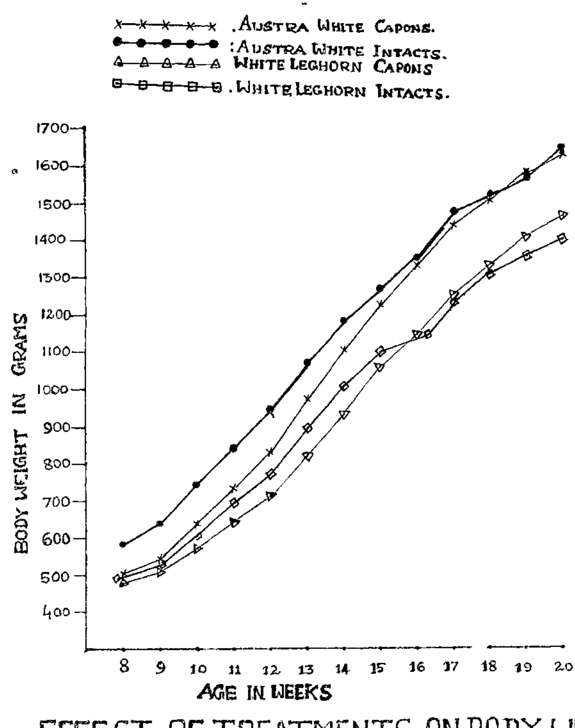
Weight gain

The average body weight of the birds at the 20th week were 1637.40 g, 1645.52 g, 1470.00 g and 1457.71 g for the Austra-White caponized, Austra-White intacts, White Leghorn caponized and White Leghorn intacts respectively. The gain during the trial period for the above groups were 1131.46 g, 1057.40 g, 985.42 g and 915.10 g respectively.

A perusal of the data indicated that the body weight of Austra-White caponized and Austra-White intacts at the 20th week of age exhibited no appreciable difference, the weight gain for the period under trial (9th to 20th week) showed significant ($P < 0.05$) gain for the caponized groups over intacts. Positive significant weight gain ($P < 0.05$) was also observed for the White Leghorn caponized group, giving definite indication of treatment effect on this trait. Improved gain advantage for capons had earlier been reported by Adams (1955); Lauffer (1957); Walter (1976) and Mast et al. (1981). These reports were from abroad and literature failed to reveal similar type of work under Indian conditions. Most of the trials had been carried out with cockerels of heavier breeds, such as New Hampshire, Plymouth Rock and their crosses. The present study indicated that the surplus cockerels of the Australorp-White Leghorn cross when caponized and grown, attain heavier weights than their intact counterparts under Indian conditions. This trend is exhibited by the White Leghorn surplus cockerels also, eventhough the weight gain by these birds are much lower than their cross-bred caponized counterparts. The caponized White Leghorn cockerels had significantly ($P < 0.05$) better gain than their intact counterparts. The higher gain attained by the Austra-White crosses could be attributed to the effect of heterosis.

The better performance in weight gain by the caponized groups indicates that both Austra-White cross-bred and White Leghorn surplus cockerels can be effectively utilized for capon production. The Austra-White cross-bred cockerels would form heavier capons and the White Leghorn surplus cockerels could be effectively reared as small sized capons. This observations are in agreement with that of Moshien et al. (1979), Ensminger (1980) and North (1984).

A perusal of the weekly weight gain starting from the 9th week revealed an interesting pattern of gain (Appendix I and Fig.1). The capons exhibited a slower gain rate when compared to their respective intact counterparts. This trend was evident till the 12th week in the case of the Austra-White



EFFECT OF TREATMENTS ON BODY WEIGHT (9-20 WEEKS).

capons and till the 14th week in White Leghorn capons. After these stages the capons seems to have compensated and started gaining faster than the intacts. This initial depression had been noticed by Lauffer (1957), Begin and Grainger (1957) and York and Mitchell (1969) and they attributed it to post caponization stress. It is natural that surgical intervention does induce stress and this post-caponization stress would have contributed to the depression in this study also. Since the birds completely compensated and attained higher gains it is evident that the slow initial gain was due to the surgical stress. The Austra-White caponized birds were able to withstand the rigours better than the pure-bred White Leghorn. This could be due to their better resistance capacity contributed by hybrid vigour.

At the second stage of evaluation (24th week) the Austra-White capons registered maximum body weight gain compared with their intact controls, the difference was statistically significant ($P < 0.05$). But in the case of White Leghorn the capons did not differ significantly from the intacts in body weight gain, though the capons had an average 65 g numerical weight gain advantage. It is also evident that rate of gain has shown a tendency to even out at this stage. It is an accepted fact that as the birds advances in age and reaches the maturity stage there is a progressive slowing down of growth. This could be the reason for the slowing down of the rate of gain This is in agreement with the findings of Annin and Nalbin (1938).

However, Annin and Halpin (1938) and Lauffer (1957) did not obtain any difference at 24 weeks of age for capons from different breeds though they noted numerical advantages for capons over the intacts.

At the third stage of evaluation (28th week) it was observed that none of the caponized groups differed from the intact controls, confirming the observation that as age advances body weight gain tends to even out nullifying the advantages of earlier treatment effects. This is true since growth slows down as birds mature and indicates that maximum gain effects could be expected at the 20th week. It is therefore evident that the best stage at which maximum gain can be expected in terms of caponization is at the 20th week of age under Indian conditions. Market age for capons had been indicated as 7-10 months by Jull (1951), Winter and Funk (1960), Ensminger et al. (1979). Others suggest 18-24 weeks as suitable stage for marketing of capons (Annin and Halpin, 1938; Walter, 1976; and North, 1984). Since many factors such as type of bird, feed, management, location and economic situation, are involved in the production of capons, it is suggested on the basis of the present study that the suitable stage at which maximum gain could be expected is at the 20th week in the existing Indian conditions.

<u>Feed efficiency</u>

The profitability of poultry meat enterprises is not only dependent upon the final gain achieved by the bird but also on the efficiency by which feed is converted to attain the end gain. The feed efficiency in this experiment has been worked out based on the quantum of feed required to attain one kg live weight gain. The efficiency has been calculated for the three stages as the quantum of feed required to produce the gain for the 9th to 20th week, 9th to 24th and 9th to 28th week periods. The total quantity of feed consumed by the Austra-White capons for the first period (9th to 20th week) was 283.50 kg (Table XIV), returning a feed efficiency of 5.22 which was significantly less ($P < 0.05$) than 5.98 returned by their intact counterparts at this stage. The data indicated that the Austra-White capons utilized significantly ($P < 0.05$) less feed to attain a kg live weight gain, compared to their intact controls. This is a significant observation in that caponization not only improves weight gain but also improves efficiency of feed conversion. The treatment effect of significant better ($P < 0.05$) feed conversion efficiency is also noticed in the case of White Leghorn capons, for this period. Adams (1955), Begin and Grainger (1957) and Hast et al. (1981) had earlier reported the trend of better feed efficiency for capons. Begin and Grainger (1957) reported best efficiency for capons after a 12 weeks trial involving meat strain males, caponized at 5 weeks. Winter and Funk (1960), York and Mitchell (1969), Hoshiem et al. (1979) and Ensminger (1980), reported inferior feed efficiency for capons compared to roasters. However, all these trials have been carried out with the cockerels involving meat type chicken. The feed efficiency is linked with almost all the environmental factors and a direct comparison with trials involving different types of birds in different environments would not be meaningful in this case. The present study has indicated clearly that the caponized groups did show improved feed efficiency not only at the first period of evaluation (9th-20th week) but also at the second (9th-24th week) and third stages of evaluation (9th-28th week). It is interesting to note that eventhough the significant difference ($P < 0.05$) in feed efficiency was maintained during all the three periods under study, the efficiency at the 24th and 28th weeks showed a tendency of decline compared to the efficiency at the 20th week. It is an established fact that as birds mature, feed efficiency will decrease. The data therefore, clearly suggest that caponization improved feed efficiency and the best efficiency can be expected to be achieved for capons at 20 weeks and Austra-White cockerels would make desirable capons in terms of better efficiency in feed utilization.

Processing loss and yield

It is necessary that chicken raised for meat purpose are not only evaluated for gain and feed efficiency but also on the processing loss and gains, so that the overall viability of the enterprise can be judged. The processing losses and yields were evaluated at the three stages, namely, the 20th, 24th and 28th weeks.

Dressing loss

The dressing loss made up of pre-slaughter shrink, bleeding and defeathering was significantly higher ($P < 0.05$) for capons than the intacts. Out of these losses, feather accounted for the maximum loss of 10.69 to 11.16 per cent of live weight for the capons and 9.12 to 9.62 per cent in the case of intacts. The fasting shrinkage contributed 6.95 to 7.24 per cent of the live weight for the capons and 6.05 to 6.68 per cent of the live weight in the case of intact controls. The loss due to blood varied from 3.91 to 4.45 per cent of the live weight for capons and 4.24 to 4.29 per cent of the live weight in the case of intact controls at the 20th week of evaluation (Appendix II).

Maximum loss due to feather was for the Austra-White capons, so also the loss due to blood, whereas maximum shrinkage due to fasting was for the White Leghorn capons. Increased dressing loss due to caponization had earlier been reported by Adams (1955). However, Walter (1976) reported that dressing loss was not influenced by caponization. It had been suggested that there is a tendency for development of more quantum of feathers in capons contributed by longer hackle and saddle feathers and main tail feathers (Ensminger, 1980). This tendency was observed both for the Austra-White capons and the White Leghorn capons, in this study also. It has been observed that capons had a tendency for higher fasting shrinkage.

Same trend was observed in the dressing loss at the 24th and 28th weeks of evaluation, capons registering more dressing loss than their respective intact counterparts.

The percentage however, showed a tendency to decrease in terms of live weight. This is due to the subsequent increase in the live weight out of proportion to the factors contributing to the shrinkage.

Evisceration loss

The evisceration loss did not show any treatment effect in the Austra-White groups during the three stages of evaluation (20, 24 and 28 weeks). Whereas the White Leghorn groups exhibited significant ($P < 0.05$) difference between capons and intacts at the 28th week, there was no difference during the 20th and 24th weeks. No plausible explanation could be given for this stray finding and be considered as a chance occurrence.

Loss due to head and shanks

The shrinkage due to head and shanks was separately evaluated, since caponization affects development of secondary sex characteristics like comb and wattle development which would have a say in total shrinkage. All caponized groups did exhibit significantly ($P < 0.05$) lower shrinkage values due to head and shank loss. As clearly evident from plates VI and VII, comb and wattle growth were very much depressed in the case of capons and this appreciably had contributed to the lower values. The breeds used in this study were single comb variety

and greater comb development is a breed characteristic. Large comb attract pecking and cannibalism and more often results in injuries and bruises and consequent loss. This is especially so when males are reared together for longer periods. On observation it was evident that the caponized birds were less aggressive and interaction between individuals were much less compared to the intact groups. Caponization therefore, had the added advantage of reducing loss due to injury to head appendages, and also exerted an influence in reducing processing shrinkage.

Ready to cook yield

The per cent ready to cook yield between treatments did not differ significantly. This lack of difference was contributed by a higher dressing loss in the capons being evened out by a lesser loss due to head and shanks and vice-versa in the case of intacts.

Since none of the treatments had any effect on the ready to cook yield it is felt that caponization did not affect this factor appreciably. This finding is consistent with the earlier report of Mast et al. (1981) and Mountney (1982).

Slips

During surgical caponization of large number of birds, it is possible that portions of testis may be left inside the abdomen during the traction process. The portions of testis thus left behind may sometimes become partly functional. These birds develop secondary sex characteristics of varying degree than complete capons. In the present study five birds showing larger comb and wattle development in the caponized groups, on investigation during slaughter were found to have varying sizes of testicular mass. These were therefore, ear-marked as 'slips'. In the present study they constituted 5.2 per cent. It is therefore, pointed out that 'slips' developed more 'maleness' than capons. Literature reveals that as per meat quality, 'slips' rank in between capons and roasters (Winter and Funk, 1960; Mast et al., 1981). No such evaluation was undertaken in this study.

Carcass composition

Random samples of ready to cook carcass evaluated for proximate composition, revealed higher percentage for moisture and protein in the case of Austra-White capons than the intacts. Better carcass quality for capons have been reported earlier by Begin and Grainger (1957); Winter and Funk (1960); York and Mitchell (1969); Walter (1976); Hechiem et al. (1979); Ensminger (1980); Mast et al. (1981) and North (1984). No report is available on the capon carcass proximate composition in India and thus this could be considered as a preliminary report.

Taste panel evaluation

In order to evaluate the consumer acceptance qualities of the capon meat, a taste panel was constituted. The quality factors under evaluation by the panelists were tenderness, juiciness and overall personal preference.

The capon meat was rated superior over intact controls in the three quality parameters assessed. The panelists preferred Austra-White capon meat over others, rating it by a high 85.71 per cent personal preference score. The Austra-White capon meat was rated as tender to very tender and very juicy to mild juicy by all the panelists. There was a definite trend of preference for meat from Austra-White capons. It is worthwhile to note that caponization had resulted in absolute personal preference for the meat by panelists. The preference for capon meat over others had been observed earlier by York and Mitchell (1969); Walter (1976) and Mast et al. (1981). The indication of a superior liking for capon meat by the Indian palate hold much promise for this enterprise in our country. In this context, the observation of Neshiem et al. (1979) and Ensminger (1980) that "persons who once tasted roast capon of top quality are likely to be repeat customers year after year", is particularly significant.

Economics of production

An applied technology of this sort can be successful commercially only if it is economically viable. The economic consideration involved in this technology had been worked out based on returns over chick and feed cost. This assessment were made for the 20th, 24th and 28th weeks.

The evaluation indicated that based on the present University Poultry Farm selling price of Rs.13/kg live weight, the per bird returns over chick and feed cost were Rs.+3.37, -0.05, -3.64 for the 20th, 24th and 28th weeks respectively, for the Austra-White capons. The Austra-White intact's returns were Rs.+1.68, -2.75, -5.99 respectively, and for the White Leghorn capons, the figures were Rs. +1.81, -0.68, -4.61 respectively and their intact controls returned Rs.+0.71, -2.17 and -6.21 respectively for the three periods of evaluation. The work out clearly indicated that capons had positive returns only during the 20th week of evaluation. Evaluation of the 24th and 28th week resulted in negative returns which when compared to intacts for the same periods were found to be highly different, suggesting that capons have definite advantage over intacts. Based on this assessment it is suggested that Austra-White capons are the most economically viable group of capons, returning a profit of Rs.3 plus per bird. The White Leghorn capons at 20 weeks registered Rs.+1.81 return per bird which is Re.1/- plus more than their intact controls, suggesting that it would be more economical to rear capons than roasters of this breed. The Austra-White capons registered Rs.1.69 increase in return compared to their intacts at the 20th week. During the 24th and 28th week period of study, the return have gone to the negative sides both for the capons and their intact controls, capons registering much lesser loss compared to intacts.

According to the economic work out, the economically optimum stage of marketing Austra-White and White Leghorn capons seems to be the 20th week of age or 12 weeks post-caponization as per this study. Since the trend of advantage of capons over intacts is observed to be maintained throughout in almost all the parameters under evaluation and concomitant with the superior personal preference for capon meat as evidenced by organoleptic evaluations, it is to be considered whether the calculation of returns based on the low culled chicken meat rates existing in the University Poultry Farm would suffice. In other countries, capons fetch premium prices because of superior preferences (Annin and Helpin, 1938; Winter and Funk, 1960; Ensminger, 1980). A comparison can be drawn in our country with the broiler chicken meat which fetches a higher rate than ordinary culled/spent chicken. The market rate for spent chicken is around Rs.16/kg live weight and for broiler chicken Rs.18/kg live weight. If a work out is made on the existing market rates (Rs.17/kg L.wt.), the return per capon is substantially increased at the 20th week and it becomes a very profitable enterprise even at the 24th and 28th weeks. The attention is drawn to this point to highlight the possibility of this enterprise being economically used to produce quality chicken meat. Capons will be more suitable to withstand the rigours of the Indian tandoori type cooking compared to the very tender broiler which is more suited to the Western cusine.

Summary

SUMMARY

An experiment was carried out at the University Poultry Farm attached to the College of Veterinary and Animal Sciences of Kerala Agricultural University to ascertain the feasibility of employing surgical caponization as a means for achieving the twin objectives of efficiently utilizing surplus cockerels of the cross-bred and pure-bred types and production of superior quality poultry meat, economically.

A total number of 192 male chicks comprising of 96 each of the Austra-White and White Leghorn were brooded and reared under standard conditions of management, till 8 weeks of age. A commercial chick starter ration was used. At 8 weeks of age all the chicks were weighed and wing banded. Fortyeight chicks from each group were randomly selected and subjected to surgical caponization by a modified method of O'cannor (198_). The modifications in the study were the nonuse of anaesthetic and application of suture for closing the wound. After caponization, the birds were randomly allotted to 4 replicates of 12 birds each, in both the types. Twelve intact birds each were randomly allotted to 4 replicates in both the types which constituted the intact controls. The lay out of the experiment was as detailed below:

Treatment	Breed details	Number of birds	Replicate
I	Austra-White caponized	12	4
II	Austra-White Intacts	12	4
III	White Leghorn caponized	12	4
IV	White Leghorn intacts	12	4

The experimental house was of standard type with asbestos roofing and welded mesh side walls. The pens were of 26100 cm^2 area with wood shaving litter floor, and running PVC water channel. Feed was provided in a hanging drum feeder ad lib. A standard commercial grower feed was fed from the 10th week onwards. The experimental period was from the 9th week of age to the 28th week of age.

The data monitored were daily maximum and minimum temperature, dry and wet bulb readings, weekly body weight, weekly feed consumption. At the 20th, 24th and 28th week of age 16 birds randomly collected from each treatment were subjected to slaughter studies. The data pertaining to dressing loss, loss due to evisceration, loss due to head and shanks and ready to cook yield were collected. Based on these data o the three periods (20th, 24th and 28th week) average gain in weight, feed efficiency, processing loss and yield, and economics were worked out.

The result indicated that the Austra-White capons had significantly ($P<0.05$) higher gain than their controls at the 20th and 24th weeks but had only numerical advantage at the 28th week. In the case of White Leghorn capons there was significant difference ($P<0.05$) at the 20th week and only non-significant advantage during the 24th and 28th week. Feed efficiency also reflected significantly ($P<0.05$) better trend for the capons, with the Austra-White capons registering the best feed efficiency for all the periods.

Perusal of the processing data indicated that the capons had a significantly ($P<0.05$) higher dressing loss than their intact counterparts. A fractionized scrutiny of the dressing loss indicated that feather component had contributed the maximum loss followed by fasting shrinkage and bleeding in that order. Loss due to viscera on evisceration and loss due to head and shanks were ascertained separately. The visceral loss did not differ significantly in none of the treatments. Loss due to head and shanks differed significantly ($P<0.05$) with capons indicating significantly ($P<0.05$) lesser loss than their intact controls. There was greater comb and wattle development for intact controls which made this difference. There was no treatment effect in the ready to cook yield percentage. Among the caponized birds those with larger comb and wattle development and exhibiting more 'maleness', on scrutiny were found to contain testicular mass of varying sizes. These constituted 5 per cent of the caponized groups and were classed as 'slips'.

Taste panel evaluation revealed high preference for capon meat over the meat from intacts.

The economics of production was worked out based on returns over feed and chick cost at the University Poultry Farm rates, indicated a positive returns of Rs. +3.37 for the Austra-White capons and Rs.+1.81 for White Leghorn capons at 20 weeks of age which was much higher than Rs.+1.68 and Rs.+0.71 respectively, obtained for their intact counterparts. The returns for the 24th and 28th week periods, though negative at the above rate, became positive when computed at the prevalent market rates.

The following conclusions were drawn based on this study:

1. Austra-White surplus cockerels can be effectively utilized for capon production since they form efficient capons. White Leghorn surplus cockerels can be used for producing small sized capons.

2. Capon production can be an economic practical feasibility in Indian conditions.

3. Capon meat is more acceptable than roaster meat in terms of juiciness, tenderness and overall personal preference.

4. Surgical caponization can be effectively employed as a routine managemental procedure for economic utilisation of surplus cockerels, and

5. The optimum economic stage for marketing capons is 20 weeks of age as per this study.

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Appendix

APPENDIX I

Weekly body weight in grams

Treatments	Age in weeks													
	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th	19th	20th	21st
Austra White caponized	505.94	546.15	639.48	736.46	829.17	973.75	1107.29	1231.33	1338.02	1442.08	1508.85	1586.98	1637.40	1706.88
Austra White intacts	588.12	641.25	744.69	844.27	945.31	1069.69	1168.85	1272.23	1358.85	1478.58	1524.73	1583.44	1645.52	1671.56
White Leghorn caponized	484.58	508.44	572.62	643.25	714.81	819.91	932.93	1061.37	1149.49	1257.83	1337.93	1413.03	1470.00	1553.13
White Leghorn intacts	492.61	532.50	605.73	695.42	771.67	894.79	1008.96	1100.42	1149.58	1240.52	1313.33	1359.06	1407.71	1471.72

Treatments	22nd	23rd	24th	25th	26th	27th	28th
Austra White caponized	1759.69	1792.82	1809.38	1849.38	1847.19	1904.19	1915.00
Austra White intacts	1726.56	1770.00	1778.13	1850.00	1855.63	1916.88	1936.88
White Leghorn caponized	1605.63	1637.66	1654.06	1715.63	1751.57	1759.38	1773.75
White Leghorn intacts	1531.56	1575.63	1584.53	1620.63	1658.13	1668.75	1673.13

Note: 9 weeks to 20 weeks are the average of 48 birds.
21 weeks to 24 weeks are the average of 32 birds.
25 weeks to 28 weeks are the average of 16 birds.

APPENDIX XI

Stepwise processing losses due to treatments at the three stages of evaluation

Factors	Austra-White caponized			Austra-White intacts			White Leghorn caponized			White Leghorn intacts		
	20 weeks	24 weeks	28 weeks	20 weeks	24 weeks	28 weeks	20 weeks	24 weeks	28 weeks	20 weeks	24 weeks	28 weeks
Live body weight (average)	1542.50	1808.13	1919.38	1717.81	1784.38	1936.88	1348.13	1615.63	1773.75	1340.00	1576.56	1673.13
Fasting shrinkage (per cent live weight)	6.95	6.20	5.69	6.68	6.29	5.97	7.23	7.02	6.51	6.05	6.98	5.45
Loss due to bleeding (per cent live weight)	4.45	3.79	3.69	4.24	4.39	4.15	3.91	3.83	3.65	4.29	4.14	4.24
Loss due to feather (per cent live weight)	11.16	10.14	10.60	9.61	8.23	7.53	10.69	10.16	9.54	9.12	8.21	7.35
Dressing loss (per cent live weight)	22.56	20.13	19.98	20.53	18.91	17.65	21.83	21.01	19.70	19.46	19.33	17.04
Loss due to viscera (per cent live weight)	7.80	4.99	4.14	7.25	5.55	3.67	8.05	6.11	4.53	8.04	5.53	3.14
Loss due to head and shanks (per cent live weight)	6.64	7.58	7.02	7.87	9.16	9.80	6.85	7.53	7.39	8.66	9.80	10.56

STUDIES ON CAPON PRODUCTION

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ABSTRACT OF A THESIS

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ABSTRACT

The thesis incorporates the results of a feasibility study on economic utilization of Austra-White and White Leghorn surplus cockerels for capon production in the existing Indian conditions.

Production performances of surgically caponized Austra-White and White Leghorn males were compared with their respective intacts at three stages, namely, 20th, 24th and 28th week of age. A total number of 192 cockerels were involved in the study. Each treatment group comprised 12 birds and replicated four times. Caponisation was carried out at 8 weeks of age. The production traits evaluated were body weight gain, feed efficiency, processing losses and yield, percentage 'slips', taste panel evaluation, proximate composition of meat and economics of production. Recordings of thermal data, weekly body weight and weekly feed consumption were made. At the 20th, 24th and 28th weeks 16 birds randomly selected from each group were subjected to slaughter studies.

The results indicated significantly ($P < 0.05$) higher body weight gain for the capons over intact controls at 20 weeks. Austra-White capons had significantly ($P < 0.05$) higher gain at the 24th week but White Leghorn capons did not differ significantly from their intacts at this stage. Capons and intacts did not differ significantly at 28 weeks of age. Feed efficiency was significantly ($P < 0.05$) better for capons during

all the periods under tests. The capon registered significantly ($P < 0.05$) higher dressing loss than intacts whereas intacts registered significantly ($P < 0.05$) higher loss due to head and shanks. Ready to cook yield did not differ significantly between treatments. Capons registered increased percentages of moisture, protein and ether extract. Five per cent of capons were registered as 'slips'. Austra-White capon meat top scored in tenderness, juiciness, and personal preference. Economic evaluation registered profitable returns for capons at 20th week, based on culled/spent hen meat value at University farm rates. Significantly higher returns were indicated when economic evaluations were made on market rates.

From the results of the study it was concluded that Austra-White surplus cockerels can be effectively utilized for capon production and White Leghorn cockerels form small sized capons. Capon production can be an economic practical feasibility in Indian conditions and also capon meat is preferred over roaster meat. Surgical caponization can be effectively employed as a routine managemental procedure for economic utilization of surplus cockerels. It was also indicated that the optimum economic stage for marketing capons is 20 weeks of age.