THE EFFECT OF THYROPROTEIN FEEDING ON EGG PRODUCTION, FERTILITY, AND HATCHABILITY OF BROILER BREEDING HENS

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ABSTRACT

Five hundred and fifty two Hubbard hens (26 weeks of age) were used to study the effect of dietary thyroprotein on egg production, fertility, hatchability and other related parameters over seven consecutive 28-day periods. Four levels of thyroprotein were formulated and prepared to supply 0, 11, 22 and 44g per 100 kg of feed. The 11 and 22g levels were fed both throughout the laying cycle (periods 1 to 7) and during the latter part of the cycle (periods 4 to 7) while the 44g level was fed only during the latter part of the laying cycle. This resulted in six treatments with four replicates of 23 hens within each treatment.

Results indicated that egg production over the seven 28-day periods was improved significantly in those hens fed 11g of thyroprotein per 100 kg of feed. The thyroprotein-fed hens showed no significant difference in feed consumption or feed efficiency compared with controls. Both body weight gain and egg weight were significantly reduced, relative to that of controls, in those hens fed the higher levels of thyroprotein during the latter part of their laying cycle. Egg shell thickness and mortality remained unchanged irrespective of either dietary thyroprotein level or stage of the laying cycle at which it was fed.

Fertility was significantly reduced in the hens fed

22 and 44g thyroprotein per 100 kg of feed. In contrast, the semen of males fed dietary thyroprotein showed no significant difference in viability when compared with that of controls.

Hatchability of eggs of thyroprotein treated hens was significantly reduced in the first setting, when thyroprotein was fed from the start of the laying cycle. This reduction was only temporary, since hatchability returned to a level comparable with that of control for the remainder of the laying cycle, once the hens had become physiologically adjusted to the dietary thyroprotein. It was also observed that the eggs of the thyroprotein-fed hens required additional incubation time (24 hours). Thus, for increased egg production and normal fertility and hatchability rates in broiler breeding hens, the results show that thyroprotein should be fed at a level of 11g per 100 kg of feed and only after the hens have reached their peak production level.

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INTRODUCTION

It is the policy of commercial poultry producers to use two breeding flocks per year in their broiler breeder operations. Each breeding flock is kept in production for a six month period, at the end of which it is replaced with a younger flock. This is neither the most efficient nor most profitable system, but it is necessary because it becomes unprofitable to maintain a breeding flock once its egg production decreases below 50 percent. Since broiler breeders are fast growing and early maturing they tend to become obese by the time they are fifty weeks of age. Obesity it appears leads to decreased egg production of hens and poor mating performance of roosters.

With the advent of iodinated-proteins attention was focused on determining the influence of dietary iodinated-casein on egg production and egg quality of layer-type birds. There is considerable information available on the influence of iodinated-casein on layer type birds. However, information concerning the effects of this compound on the physiological activities of broiler type layers is limited.

Therefore the primary objective of this study was to examine the effect of dietary iodinated-casein on egg production in the broiler breeder and to investigate the influence of iodinated-casein on body weight, egg weight, and mortality.

Feed consumption, feed efficiency, egg shell quality, fertility and hatchability, as related to dietary levels of iodinated-casein, were also observed.

LITERATURE REVIEW

The Role of Thyroid Gland on Growth and Egg Production

Thyroidectomy in the hen reduces egg production (Winchester, 1939; Taylor and Burmester, 1940). The reduction is slight when thyroidectomy is incomplete and 70 to 80 percent when a completely hypothyroid individual is obtained. The first attempts to restore egg production to the preoperative level by thyroxine administration were not altogether successful (Winchester, 1939). Winchester and co-workers found that egg production was definitely dependent upon a relatively narrow range of concentrations of circulating thyroxine. Furthermore when thyroxine injection into thyroidectomized hens was interrupted, egg production declined to near zero, but returned to the control level when thyroxine was readministered at levels favourable to egg production. Although thyroxine is necessary for growth in the chicken it was found that thyroidectomized chicks attained nearly normal body size with thyroid replacement therapy through a range extending from far below normal glandular output to far above that level. However, body weight change was unaffected by the absence of the hormone (Winchester, Comar, and Davis, 1949; Winchester and Scarborough, 1953).

The Effect of Iodinated-Proteins on Egg Production

Crew and Huxley (1923) failed to observe any increase in egg production in two groups of hens which were fed small quantities of desiccated thyroid for a period of four weeks. In a subsequent experiment Crew (1925) reported a remarkable "rejuvenesence" of seven hens and five cocks, 5 to 8 years of age, following the feeding of desiccated thyroid gland over a period of six months. The birds molted rapidly soon after the treatment was started and their new plumage was characteristic of younger fowls. The head furnishings became red and turgid and the low egg production, which was 7 eggs in six months previous to the experiment, was increased to 34 eggs in the same period of time. Cole and Hutt (1927) found no comparable stimulating effect on egg production when desiccated thyroid gland was fed to White Leghorn hens. Furthermore Asmundson and his associates found that when large amounts of desiccated thyroid were fed to laying hens a depression in egg production and body weight resulted (Asmundson, 1931; Asmundson and Pinsky, 1935). These observations would suggest that iodinated-protein feeding at optimal dosages might increase egg production especially in older hens.

Research regarding the role of thyroxine in egg production in the laying hen received a fresh stimulus with the development of iodinated-casein having the properties of natural thyroid protein by the action of iodine on casein in alkali solution (Reineke and Turner, 1942). Turner and associates studied the possibility of using this compound in a continuous experiment lasting for six laying years. The results of their first experiment (Turner, Irwin and Reineke, 1945) which involved the use of small numbers of birds indicated that relative to controls, hens receiving 22g iodinated-casein per 100 kg feed had a greater yearly egg production record. They also found that the level of iodinated-casein per 100 kg feed was suboptimal while 44g seemed to be excessive. Thus Turner and co-workers deemed it advisable to feed diets supplemented with iodinated-casein to a larger number of birds so that they might investigate; firstly if the decline in egg production during the summer months could be retarded, secondly, the possible harmful effects of continuous iodinated-casein feeding; and thirdly, the effects on the rate of senescence.

An experiment was designed (Turner *et al.*, 1945) in which 242 White Leghorn pullets were fed a diet supplemented with 22g iodinated-casein per 100 kg of feed for one year. Egg production of the experimental group was the same as that of the control group during the fall and winter months. However, after the first week in May, the control group gradually declined in production while the group on iodinated-casein continued to lay at the winter level until August, when egg production fell off very rapidly. The control group had a 44 percent decrease in production during the second half of the year while the iodinated-casein-fed birds exhibited only a 6 percent reduction over this period. In fact over the three subsequent laying years hens receiving iodinated-casein at a 22g per 100 kg of feed level continued to lay at a considerably higher rate than did controls of the same age (Turner, Kempster, and Hall, 1946; Turner and Kempster, 1947, 1948). Actually in the last year reported, experimental hens in their sixth year of production averaged 119 eggs per bird compared to 35 for controls. Thus these experiments indicate that iodinated-casein supplemented at a low level may be used to prevent, in part, the yearly decline in egg production due to the senescent changes associated with increasing age as well as to maintain egg production during periods of hot weather when a decline in production parallels the seasonal decline in metabolism (Winchester, 1940).

Iodinated-casein seems to have different effects in different breeds of chickens. Rhode Island Red pullets showed a greater egg production during the summer months when fed 22g iodinated-casein per 100 kg feed than did controls (Turner et al., 1945). In contrast White Plymouth Rock hens which have a relatively low thyroid secretion rate (Schultze and Turner, 1945, as quoted by Blaxter et al., 1949) showed a similar increase in egg production which was maintained throughout the entire year rather than being confined to the summer when fed an equal level of iodinated-casein (Turner, 1948).

Contrary to the results of Turner and his colleagues iodinated-casein failed to retard the normal decline in production after the first week in May (Hutt and Gowe, 1948). Furthermore these authors reported that there was no difference in production between the controls and the group of White Leghorn hens fed 22g iodinated-casein per 100 kg ration. Gutteridge and associates, in short term trials designed for purposes other than testing the efficacy of iodinated-casein to stimulated egg production, failed to show any influence of iodinated-casein on egg production (Gutteridge and Pratt, 1946; Gutteridge and Novikoff, 1947). Subsequently, similar results have been reported by other researchers (Godfrey, 1949; Lillie _et al._, 1952).

Detrimental effects of iodinated-casein feeding on egg production have also been reported (Berg and Bearse, 1951). They found that feeding 34g iodinated-casein per 100 kg ration, caused a marked depression (22%) in the rate of lay in White Leghorn hens. Similarly other workers have found that egg production in layers was significantly reduced below their controls when fed iodinated-casein at a level of 22g per 100 kg feed (Hoffman and Wheeler, 1948; Savage _et al._, 1952; Oloufa, 1953).

The Effect of Iodinated-Proteins on Egg Weight

The influence of the thyroid on egg weight has been studied and it appears that there is some discrepancy with regard to its effect. Hyperthyroidism caused a decline in egg size (Asmundson, 1931; Asmundson and Pinsky, 1935; Wilson, 1949). They also reported that egg production ceased in many of the smaller birds because equivalent amounts of thyroid tissue would produce a greater hyperthyroid condition in these birds. Furthermore they noted that the yolk size decreased but the albumen was unaffected under hyperthyroid conditions and it was concluded that this effect was due to a reduction in growth rate of the ovum rather than physiological malnutrition. However, Crew and Huxley (1923) using small doses of desiccated thyroid, did not observe such an effect. A similar lack of response was obtained when birds were fed 22g iodinated-casein per 100 kg feed (Turner et al., 1945a, b, 1946; Hutt and Gowe, 1948; Hoffmann and Wheeler, 1948a; Turner, 1948). Thus it would appear that this effect on egg weight is only apparent at high treatment levels.

It has been shown that high environmental temperatures cause a decline in egg shell thickness (Warren and Schnepel, 1940). Furthermore desiccated thyroid feeding to produce a hyperthyroid condition was observed to increase egg shell weight (Asmundson, 1931; Asmundson and Pinsky, 1935). Similarly Gutteridge and Pratt (1946), Gutteridge and Novikoff (1947) measured the specific gravity of eggs and found that during the summer months the egg shells of hens fed iodinated-casein were significantly stronger than those of the controls. Hoffmann and Wheeler (1948) reported that the egg shells of Rhode Island Red pullets fed 22g iodinated-casein per 100 kg feed from June to October were significantly stronger than those of the controls. This response was accompanied by a loss in body weight in the birds receiving iodinated-casein. Such an improvement in egg shell thickness together with a reduction in body weight was also observed by Berg and Bearse (1951), and Lillie et al., (1952). Oloufa (1953) reported that birds on iodinated-casein supplemented diets produced eggs with thicker shells than those of controls, but the hens did not sustain a loss in body weight. Thus, the majority of evidence indicates that the decline in shell weight and strength characteristic of the end of the laying season and during periods of high environmental temperature might be counteracted by feeding iodinated-casein.

Perhaps the loss of body weight in those birds maintained on an iodinated-casein supplemented ration was due to a reduced feed consumption. Actually it has been reported that iodinated-protein feeding causes a reduction in feed intake (Asmundson and Pinsky, 1935). Iodinated-casein also appears to exhibit an effect on the efficiency of feed utilization (Wheeler, Hoffmann and Graham, 1948; Berg and Bearse, 1951). Wheeler and co-workers reported that Rhode Island Red birds, fed iodinated-casein, used feed more efficiently than did controls during the first six weeks on trial as shown by the more rapid rate of growth. However, over the full twelve week study period, the treated birds were no more efficient than were the controls. Godfrey (1949) confirmed that feed efficiency in laying hens was not affected by feeding iodinated-casein. Furthermore he also reported that body weight was unaffected in the birds fed iodinated-casein. It is possible that the inconsistency of the results of various experimenters may be explained on the basis that adipose tissue deposition may be affected differently in different strains of birds.

There was no demonstrable effect of iodinated-casein on the mortality of the hens involved in the series of experiments conducted by Turner's group at Missouri (Turner et al., 1945a, b, 1946; Turner and Kempster, 1947, 1948). The validity of the results can be questioned due to the small number of birds included in this study. However, similar investigations, using much larger numbers of birds, showed that the mortality of groups consuming iodinated-casein at levels from 11g to 44g per 100 kg feed was not significantly different from that of controls (Hutt and Gowe, 1948; Berg and Bearse, 1951; Oloufa, 1953). Furthermore the fact that these experiments were not all conducted in the same season lends credence to the idea of little or no effect of normal dietary levels of iodinated-casein on mortality in laying hens.

The Effect of Iodinated-Proteins on Reproduction

Seasonal influence on semen production in roosters has been thoroughly studied. The greatest volume of semen is produced in the period from November to March (Wheeler and Andrews, 1943). Andrews and Schnetzler (1946) found that thiouracil in the diet at levels as high as 0.2 percent and fed between the sixth and fourteenth weeks slightly reduced the size of the testes. Shaffner and Andrews (1948) reported that neither sperm concentration nor total number of spermatozoa was affected by feeding roosters 0.2 percent thiouracil. However, the inclusion of thiouracil in the diet caused a significant reduction in actual fertility; as a result they concluded that the gonads of thiouracil treated males were incapable of producing spermatozoa that were sufficiently viable to survive a normal length of time in the oviduct of the hen. Therefore it was reasoned that since thiouracil feeding lowers the quality and/or quantity of semen produced by treated cocks, then iodinated-casein feeding might have the opposite effect on rooster semen.

Shaffner (1948) fed a group of two-year-old Barred Rock roosters 22g iodinated-casein per 100 kg feed for a four month period and found that there was little or no effect on the volume or concentration of semen, but there was a definite reduction in semen quality as evaluated by actual fertility-tests. These tests showed that the males had a score or 91.5 percent but this was reduced to 61.3 percent with the incorporation of iodinated-casein into their diet.

Contrary to the results obtained by Shaffner (1948), Huston and Wheeler (1949) reported that feeding iodinated-casein at the same level (22g per 100 kg feed) to mature Rhode Island Red cocks, did not decrease semen quality nor did it prevent the seasonal decline in semen production as determined by natural mating tests. However, in pullets fed iodinated-casein during the growing period, the onset of egg production was retarded from the 20th to the 25th week (Wheeler and Hoffmann, 1948a). They also found that testes weights of cockerels on the same treatment was increased. This would suggest that iodinated-casein retards gonad development in hens but not in roosters.

Wheeler and Hoffmann (1948b) also reported that in pullets fed iodinated-casein (44g per 100 kg feed) from the day of hatching the fertility of eggs laid was unchanged but the fecundity was significantly increased above that of control birds. At first it appeared that hatchability was less in the group fed iodinated-casein. However, if the incubation period of eggs from this group was prolonged, hatchability was comparable with that of the controls. In fact the eggs of iodinated-casein fed birds required 12.3 hours' more incubation time than those of the control birds (McCartney and Shaffner, 1949).

The chicks from the iodinated-casein treated hens had enlarged thyroids (Wheeler and Hoffmann, 1948b). This phenomenon has been noted by McCartney and Shaffner (1949) and Godfrey (1949). It is generally believed that the chicks from hyperthyroid hens are themselves hypothyroid. The thyroid size is reduced to normal, however, after 15 days on a standard diet (Wheeler and Hoffmann, 1948b).

EXPERIMENTAL PROCEDURE

An experiment was designed to study the effect of thyroprotein (iodinated-casein) on egg production, egg weight, feed efficiency, fertility and hatchability. Five hundred and fifty two Hubbard breeding hens (22 weeks of age) were randomly allotted into twenty four pens (5 ft. x 12 ft.) of twenty three birds each. Subsequent to the beginning of the experiment the hens were fed a basal breeder diet (Table I) for a four week adjustment period. Two cockerels, selected at random, were placed in each pen at the start of the adjustment period. Throughout the experiment males were replaced with spares whenever they became lame, lost body weight or if there was repeated fighting between the two males in the same pen. Both water and feed were supplied *ad libitum* during this period and for the extent of the experiment.

On termination of the adjustment period, the twenty four pens of hens were divided at random into six experimental treatments (4 replicates per treatment). At this time six dietary treatments which consisted of a control and three levels of thyroprotein fed for different intervals of time were randomly assigned to the six groups. Subsequent to the adjustment period, the experiment was conducted for seven 28-day periods and terminated when the birds were

TABLE I. Composition of Basal Diet[1,2] (Diet 1)

Ingredients	Amount (%)
Wheat (13% PROTEIN)	71.0
Soybean meal (44% PROTEIN)	13.0
Fish meal (70% PROTEIN)	2.0
Alfalfa meal (17% PROTEIN)	2.0
Animal tallow	3.0
Limestone	5.0
Rock phosphate	2.5
Vitamin premix[3]	1.0
Mineral premix[4]	0.5

[1]Calculated analysis of ration: Crude protein, 16.70%; Crude fibre, 4.32%; Metabolizable Energy (kcal/kg) 2795; Methionine, 0.32%; Lysine, 0.83%; Calcium, 3.01%; Phosphorous, 0.77%.

[2]Diets 2, 3, and 4 were formulated by incorporating respectively 11, 22 and 44g of thyroprotein into 100 kg of basal diet.

[3]Vitamin premix supplied the following per kilogram of ration: Vitamin A, 7313 I.U.; Vitamin D_3, 837 I.C.U.; Vitamin E, 11 mg; Vitamin B_{12}, 11 mcg; Choline, 112.5 mg; Riboflavin, 2.25 mg; Niacin, 6.75 mg; Pantothenic acid, 4.5 mg; Methionine, 50g; Santoquin, 25g.

[4]Mineral premix supplied the following per kilogram of ration: Manganese, 81.4 mg; Zinc, 44 mg; Sodium Chloride, 4.8g.

fifty four weeks of age.

The dietary treatment groups and interval of thyroprotein feeding were as follows:

Treatment I	-	basal diet (diet 1) from twenty six weeks of age to the end of the experiment (seven 28-day periods).
Treatment II	-	diet 2, containing 11g thyroprotein per 100 kg, for the seven 28-day experimental periods.
Treatment III	-	diet 3, containing 22g thyroprotein per 100 kg, for the seven 28-day experimental periods.
Treatment IV	-	diet 1 from 26 to 38 weeks of age (three 28-day periods) at which time diet 1 was replaced with diet 2 for the remaining four 28-day periods.
Treatment V	-	diet 1 from 26 to 38 weeks of age when diet 3 was substituted for diet 1 for the last four 28-day periods.
Treatment VI	-	diet 1 for the first three 28-day periods at which time diet 4 (44g thyroprotein per 100 kg) replaced the basal diet for the remaining four 28-day periods.

The thyroprotein was incorporated into the basal diet by premixing the iodinated-casein with wheat middlings at the rate of 11 grams to 1 kilogram wheat middlings. This premix was then incorporated into the basal breeder diet at the expense of wheat (Table I) in the appropriate quantities to supply the desired levels of thyroprotein in the experimental diets.

The hens were weighed at the beginning and end of the adjustment period and during the experiment forty hens were randomly selected from each group (10 per replicate) and weighed at the end of each period. Egg production and mortality were recorded daily, and any dead birds were taken to the Provincial Veterinary Laboratory for a post-mortem autopsy to ascertain the cause of death. Daily feed consumption (g feed/hen/day), egg production (%) and mortality were calculated for each period. Feed efficiency as measured by grams of feed required to produce one egg was calculated for each experimental period.

Fertility (%) and hatchability (% of fertile eggs) were calculated for each period except the second one. Eggs for incubation were collected for at least three consecutive days within each period and stored for five days in a cooler at 10 C until they were incubated. Before traying the eggs, they were individually candled and those with a crack or an incorrectly located air-sac were rejected. Hence, the soundest thirty eggs from each replicate were selected, weighed as a group and then put in the incubator trays. The eggs were allowed to warm up to room temperature before being placed inside the incubator, where they remained for 19 days. On day 20 the eggs were removed and candled. At this time all eggs showing no development and those containing dead embryos were separated from the eggs with live embryos. All live embryos were transferred to hatching trays and placed in the hatcher until the 22nd day. The eggs without embryo development and those containing dead embryos were broken out as a precautionary check for infertility and to examine the dead embryos for any morphological abnormalities. On the 22nd day the chicks which had hatched were counted and removed while the unhatched eggs were broken out and a macroscopic examination of the dead embryos was conducted.

Egg shell thickness for a total of 240 eggs was measured during the fourth and seventh periods (20 eggs per group per period). For the measurement to be made, five eggs were randomly selected from each replicate, broken and the shells washed and dried. The thickness of the shell was then measured with an Ames micrometer.

On account of the repeated variability in fertility with natural matings, it was decided to carry out an additional fertility study with the Hubbard hens and roosters. Thus a two-way reciprocal cross involving White Leghorn cocks and hens (De Kalb strain) as the other group was set up. The objective of this study was to determine if thyroprotein feeding over the previous seven 28-day periods had had any ill effects on the gonads of the Hubbard birds.

When the egg production study was terminated, the roosters were removed from the pens and each hen in the six experimental treatments was examined to determine its production status. The hens having the least amount of depot fat in the abdomen, as well as the greatest distance between pubic bones, and with a moist and smooth vent were judged to be the ones laying most frequently. Finally ten hens were selected from each of the six treatments for the fertility study. Each treatment was maintained on its original diet from the previous study. An adjustment period was allowed during which a daily egg production record was kept. In the course of this period one hen was removed from treatment I because it went into a molt two days after the study was set up. Furthermore, it was discovered that a hen in treatment VI was laying eggs with twin yolks. The hen responsible was determined by the use of trap nests and was removed from the pen. Thus, for the fertility study, where the effect on the Hubbard females was being determined, all treatments had ten hens except treatments I and VI which had nine hens per treatment. In addition forty White Leghorn hens, to be used to check the fertility of the Hubbard males, were kept in pairs in community cages and fed a standard layer diet.