AN ABSTRACT OF THE THESIS OF

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Title: Reproductive Performance of Wrolstad Medium White Turkey Hens Fed a Breeder Diet Containing a Yeast Culture

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An experiment was conducted to evaluate a breeder diet containing a yeast culture as a means of improving the reproductive performance of two genetically dissimilar lines of turkey hens (designated as L and H). Two hundred hens of lines L and H, 100 hens per line, were housed in a curtain sided breeder house (10 hens/line/pen). Starting at 31 weeks of age (WOA), the hens were fed either Corn-soy (CS) or Corn-soy+yeast (CS+Y,.5% Diamond V Mills "XP" yeast culture, Saccharomyces cerevisiae) diets. Between 33 and 45 WOA, the hens were mated inter se and from 45 to 51 WOA reciprocal line matings were established. Hen reproductive parameters measured between 31 and 51 WOA were, body weight (BW) change, feed intake, feed per dozen eggs, egg production, egg size, fertility, embryonic mortality, and hatchability of fertilized eggs from 7 biweekly egg settings.

No differences (P>.05) were observed with yeast culture supplementation of the diet for changes in BW, egg production, egg weight, embryonic mortality, and hatchability of

fertilized eggs (n= 5 biweekly hatches) of either line. A significant time by diet interaction was evident only in feed intake. There was an improved ($P<.05$) hen fertility in line H as a result of feeding the dietary yeast culture.

When reciprocal line crosses were established between 46 and 51 WOA, hatch of fertilized eggs (n= 2 biweekly hatches) was substantially improved ($P<.05$) from hens fed the yeast culture containing diet. The results of this study suggest that there is a genetic factor associated with the feeding of a diet containing a yeast culture to turkey breeder hens.

REPRODUCTIVE PERFORMANCE OF WROLSTAD MEDIUM WHITE TURKEY HENS FED A BREEDER DIET CONTAINING A YEAST CULTURE

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CHAPTER I

INTRODUCTION

The term "yeast culture" is defined as a dry product comprised of the yeast and the medium on which it was grown, where drying secures the fermentation capability of the yeast (Cheeke, 1991). The yeast culture has become an innovative and convenient feed additive which is used as a natural nutrient source and also as a microbial supplement in animal feeds.

The importance of maintaining an ideal intestinal microflora for subsequent digestive performance of animals and poultry is well recognized. Since continuous legislative changes, fueled partly by the consumer, have prohibited the inclusion of certain health alarming feed additives (drugs and hormones) in animal rations, yeast cultures, as naturally produced, non-antibiotic, and non-chemical feed additives, are being considered for use in poultry rations. Beneficial effects from the inclusion of yeast culture in the diets for ruminants, equine, swine, poultry and aquatic species have been reported, although little scientific evidence is provided to support the claims.

The association of yeast culture and turkeys is not unique. Turkeys, as a source of animal meat protein and being

bottom-line oriented with rapid growth rate and good feed conversion, increase the scope for dietary supplementation of yeast culture in a manner that may alter the bird's nutritional profile. There could be breed or strain differences of turkeys in response to yeast culture supplementation in their ration. Further, the level of yeast culture incorporated into the feed may also influence the performance of turkeys and the yeast culture's own performance.

The present investigation was undertaken to study the effect of a yeast culture (Saccharomyces cerevisiae Diamond V Mill's "XP") on hen reproductive performance of two lines of Wrolstad Medium White turkeys in which the males have been divergently selected for semen ejaculate volume.

CHAPTER II

REVIEW OF LITERATURE

BIOTECHNOLOGY

Biotechnology is the process of manufacturing various kinds of useful substances through the application of biological phenomena (Smith, 1988). It involves a wide variety of distinct subject areas and in essence, it implies the use of biology for profit. It has undoubtedly made important contributions to the health and welfare of man and animal. The use of microorganisms such as bacteria, yeast, fungi and algae as protein producers is a phenomenal biotechnological innovation. These microbes also contain and produce carbohydrates, fats, vitamins and minerals (Smith, 1988). Further, the use of microbially derived compounds such as growth hormones and other feed additives may bring about spectacular improvements in nutrition, growth, quality, disease prevention and control, and reproductive performance of livestock and poultry (Smith, 1971; Smith, 1988). Certain products like bakers yeast, brewers yeast and yeast extracts from microbiological process, from both nutritional and functional standpoints, have been accepted for food and feed additive uses by the regulatory agencies (Litchfield, 1987). The interaction of biotechnology and animal nutrition plays an important role in disease control, animal breeding, and animal

productivity and feed conversion efficiency (Armstrong, 1984 and 1986 a,b).

FEED ADDITIVES

Feed additives are the non-nutritive compounds mixed in the feeds of animals to improve feed acceptance and feed efficiency. In addition, they may have a beneficial effect on the metabolism and the health of the animal. These compounds are widely accepted as economically important in the live-stock and poultry feeds and their presence in the feeds claims enhanced productive and reproductive performance of the animals in some way (Cheeke, 1991).

Classification of Feed Additives

The following classification of feed additives is based on fundamental biological and economic effects.

a) Additives That Influence Feed Stability, Manufacturing and properties of Feed.

The major role of this type of additive is to prevent mold growth, rancidity and feed wastage. Antioxidants, antifungals and pellet binders are the examples of this class of additive (Cheeke, 1991).

b) Additives That Bring About Modifications in Growth, Feed Efficiency, Metabolism, and Performance of Animals.

This type of additive can be sub-categorized as follow

1) Feed Flavors

These enhance the acceptance by stimulating the animal to consume more feed which result in increased intake of usually unpalatable but nutritious feed. Examples are sweeteners such as sucrose, glucose, and saccharin and aromatic compounds such as phenol, cresols, and benzoic acid (McLaughlin et al., 1983).

2) Digestion Modifiers

These compounds are added to facilitate the digestion of complex food ingredients, maintain acid base balance, improve metabolic efficiency, increase saliva production and improve gastrointestinal microbial balance. Ionophores, probiotics, and acidifiers are the examples of digestion modifiers.

3) Metabolism Modifiers

When added to the feed of the animals, these compounds may aid in improving growth, feed efficiency, muscle mass, and decreasing body fat. These compounds are added in the feeds due to their estrogenic and repartitioning properties. Hormones (estrogen) and repartitioning agents (cimaterol) are the examples of this kind.

4) Growth Promotants

Feed additives which improve growth and feed efficiency, destruction of growth depressing organisms, reduce the microbial destruction of essential nutrients and enhance efficiency of nutrient absorption come under the category of growth promotants. Antibiotics (bacitracin, chlortetracycline, virginiamycin, oxytetracycline, etc.), chemotherapeutic agents (sulfonamides, nitrofurans, and arsenicals), and saponin are the important examples belonging to this category of feed.

c) Feed Additives That Modify Animal Health

These additives are included in the feed to treat or prevent disease occurrence, enhance the resistance against pathogenic organisms, and keep the interior environment of the facilities (control of ammonia) suitable for normal functioning. Drugs (phenothiazine, piperazine), coccidiostats (monensin, amprolium), immunomodulators (cytokines), and zeolites are the examples of such feed additives.

d) Feed Additives that modify the consumer acceptance

The inclusion of such compounds in the feed promote pigmentation, stimulate the immune system and reduce the cholesterol content of the meat. Pigments (enhance skin pigmentation etc.) are an example of this kind of feed

additives (Bendich and Shapiro, 1986; Mader and Brumm, 1987; and Cheeke, 1991).

Feed Additives In Poultry

Use of feed additives is now being questioned by the consumer. Concerns for human health and safety have led to the restricted use of certain additives such as drugs and hormones in poultry feeds. Drug residues, withdrawal requirements, bacterial resistance, and less buffering capacity might be reasons implicated in the prohibition of such additives (Jernigan et al., 1985). However, restriction on the use of certain valuable but controversial feed additives such as antibiotics and hormones may lower the production efficiency of the animal and result in higher producer and consumer costs (Cheeke, 1991). This situation sets forth the emphasis on the use of other potential feed additives like probiotics and yeast cultures. These are designated as generally recognized as safe (GRAS) by the US and Drug Administration (Pollmann, 1980).

Before reviewing the effect of yeast culture on breeder turkeys, it is pertinent to consider the definition and classification of yeast and to explain the mode of action of yeast culture.

YEAST

Yeasts can be defined as unicellular, eukaryotic organisms of biochemical interest which can reproduce sexually and asexually. Sporulation constitutes a phase of the sexual life cycle while vegetative reproduction, which utilizes both budding and fission as means of reproduction, represents the asexual phase of yeast's reproduction. These tiny unicellular organisms were described as globular bodies, some times oval or spherical in shape, by Leeuwenhoek in 1680 (Kreger-Van Rij, 1984). Yeasts do not contain chlorophyll and are unable to synthesize their organic needs from inorganic components, therefore they lead a saprophytic or parasitic life (Phaff et al., 1978).

Yeasts without doubt are a versatile group of micro-organisms exploited commercially. They grow actively at lower pH, are easier and cheaper to harvest than bacteria, and large scale cultures of yeasts can be produced and kept without any threat from contaminating microorganisms and liability for problems of public health (Barnett et al., 1990). Yeast are major contributors in the brewery and bakery industries and also contribute to research in many fields such as microbiology, nutrition and genetics. A primary yeast like *Candida utilis* and certain secondary yeasts such as baker's and brewer's are reported to be good sources of thiamine, riboflavin, pantothenic acid, pyridoxine, folic acid, biotin, para-aminobenzoic acid, insitol, and choline. Yeast have

received emphasis as a protein and vitamin supplement for much of this century (Burden and Eveleigh, 1990). The dried yeast is not only a highly nutritive source, but also makes possible the nutritional perfection of less nutritive feeds which are inexpensive and abundantly used (Spencer and Spencer, 1983).

Taxonomy

Yeasts are taxonomically and functionally diverse organisms and a similar criteria of biological classification has been followed in their taxonomy. The most recent yeast classification, presented by Kreger-Van Rij (1984), consists of 60 genera and 500 species. Strains of yeast, which are made up of a single cell colony and are generally specified by a number, are employed as the basic unit for the classification of yeasts. A collection of strains (a clonal population) is called a specie and species having certain features in common are classified as genera. Families are comprised of a group of genera which are then further assembled into orders. Orders form classes and classes eventually divisions. This taxonomic system of yeast agrees with the International Code of Botanical Nomenclature (Kreger-Van Rij, 1984). The Following characteristics have been commonly used to classify yeasts.

1) Microscopic appearance of the cells
2) Mode of reproduction (sexual)
3) Selected physiological properties

4) Biochemical properties

5) DNA reassociation (Barnett et al., 1990).

Yeast Strains as Food and Feed Additives

Yeasts belonging to the genera, Saccharomyces, Candida and Kluyvero are of substantial economic importance as sources protein and vitamins. Certain strains from the above listed genera are widely used in their dried inactive form, live yeast cells in active dried form or yeast culture as feed supplements for livestock and poultry at a 2-3 % level (Stone, 1977). Yeasts have a high protein content with very high yield per unit area (Cheeke, 1991). Selected yeast strains are also rich sources of water soluble vitamins. Strains of Candida, Ashbya, Eremothecium, and Pichia produce large quantities of riboflavin. Rhodotorula and Saccharomyces are employed in the production of carotene and ergosterol which are the precursors of vitamin A and D_2, respectively (Perlman, 1979; Atkinson and Marituna, 1983; and Ratledge and Boulton, 1985).

By Products of yeast.

Yeast metabolism produces a variety of products which differ qualitatively and quantitatively depending on the species. Their production differ under two principal environmental conditions. In anaerobic conditions, ethanol and CO_2 are produced as major products with small amounts of glycerol, succinic, acetic and lactic acids. In aerobic

conditions, specific lipids, succinic, acetic and zymonic acids are the most important by-products produced (Phaff et al., 1978).

MODE OF ACTION OF YEAST CULTURE

The intestinal tract of animals display a complicated ecosystem of micro-organisms. The dietary inclusion of such micro-organisms offer a variety of beneficial activities which lead towards substantial growth and reproductive performance. Some of the possible metabolic activities in the digestive system of livestock and poultry exerted by the administration of these micro-organisms are illustrated in the following:

The living yeast culture is now a recognized biological feed additive. It may perform a series of metabolic activities within the digestive tract of animals where the microbial flora assists in the digestion process. Therefore, a great amount of interest is associated with the microbial activities in the digestive tract of the ruminants (Fallon and Harte, 1987; Lyons, 1990). Acid production during microbial activity might assist increased nutrient uptake by decreasing the pH of the intestinal content. The oxidation-reduction potential of microbial growth might also improve nutrient uptake. Micro-organisms producing certain enzymes in the digestive system might enhance the digestion of certain complex nutrients such as cellulose, lactose and proteins. Synthesis of certain vitamins might also be attributed to the presence of these

beneficial micro-organisms in the digestive tract. Sterol modification is another key role of these organisms as dietary adjuncts which elevate cholesterol excretion through feces (Gilliland, 1988). The alteration of microbial metabolism may also be a supportive role of yeast culture incorporation in the diets of non-ruminants (Fuller, 1988). The mode of action of yeast culture in rumen metabolism is still a mystery. Dietary supplements of yeast culture in some studies suggest alteration in rumen pH, acetate : propionate ratio and rumen ammonia concentration (Dawson and Newman, 1987; Harrison et al., 1987). The addition of a yeast culture into diets stimulate the initial forage digestion rate which could be accounted by increased cellulolytic numbers and also favorable changes in the rumen environment due to yeast culture addition (Dawson, 1990).

Possible Modes of Action

The following mechanisms are considered possible pathways of yeast culture activity in influencing digestive efficiency of both ruminants and non-ruminants.

1) Secretion of certain enzymes and vitamins during the live yeast cultures metabolic function, supplement their counterparts in improving an overall digestive performance (Dawson, 1987).

2) Increased microbial population in the digestive tract through yeast culture administration may enhance fiber

breakdown process resulting in more nutrients available from the fibrous ingredients of the ration (Streeter et al., 1981; Glade and Sist, 1987).

3) The chelating ability of the live yeast culture may promote the availability of certain minerals (potassium, copper, and zinc) to the animal. Since many of these minerals serve as an important part of enzyme systems and are also involved in nutrient metabolism, thus maximizing their availability would increase feed utilization and feed efficiency (Dildey, 1988, 1989).

Mode of Action in Ruminants

Ruminants have a greatly enlarged stomach divided into four compartments, rumen, reticulum, omasum, and abomasum. The degradation of food is achieved by the enzymes secreted by microorganisms. The large activity of microbial digestion occurred in rumen (Bondi, 1982). In a broad sense the mode of action of yeast culture in ruminants can be explained by following three ways.

a) Increased ruminal cellulose digestion

b) Increased microbial growth in the rumen

c) Changes in ruminal metabolic activities (Dawson, 1990).

1) Yeast Culture And Ruminal Digestion

Two studies (Wiedmeier et al., 1987; Dawson and Newman, 1987) have demonstrated an increased effect of inclusion of yeast culture on ruminal digestive processes. The effects observed are improved hemicellulose digestion, nitrogen retention and crude protein digestion in ruminants.

2) Interaction Of Yeast Culture And Ruminal pH.

The rise in rumen pH to an extent is suitable for the growth and activation of cellulolytic bacteria present in rumen (Dawson and Newman, 1987). The presence of yeast cultures in the dairy cow's complete diet increases feed intake. The effect is attributed to the alteration in ruminal fermentation patterns and pH of the rumen due to the presence of the yeast culture (Williams et al., 1991).

3) Yeast Culture And Methane Production

The buffering capacity of the yeast cell offers an efficient hydrogen transfer system limiting the methane production in rumen which prevents a significant loss of digestible energy from the diet (Cartwright et al., 1986). A 28 to 50% reduction in methane production has been observed when a yeast culture was supplemented into the diets of young steers (Williams, 1989).

4) Microbial Protein Production and Yeast Culture

The supply of a yeast culture in the ruminant's diet resulted in increased milk yield and total protein and fat yield (Clark, 1975; and Istasse, 1983). The responses obtained were due to an improved digestibility of the ration and increased microbial protein production.

5) Mineral and yeast culture interaction.

Minerals have an important role during the manufacture of yeast culture. This provides a strong base for its presence in yeast cultures. Diets of dairy cows supplemented with yeast has resulted in the improvement of immune and reproductive systems especially with the presence of zinc (Chase, 1987; and Williams, 1988).

6) Utilization of Excessive Ruminal Ammonia

Yeast cells facilitate the conversion and utilization of excessive ruminal ammonia into single cell protein. A slight decrease in ruminal ammonia levels was apparent with yeast culture dietary adjuncts (Dawson, 1988; Harrison et al., 1988)

7) Yeast Culture and Cellulolysis

The shift of microbial populations from amylolytic to cellulolytic and an increase in fiber digestion is attributed to the addition of yeasts in the ruminant's diet (Streeter et al., 1981). Yeast cultures are not cellulolytic but may

provide stimulatory factors for cellulolytic microorganisms (Wiedmeier et al., 1987). Supplementing the diets of lactating cows with yeast culture suggests a shift in metabolic activities of ruminal microflora (Harrison et al., 1988).

8) Yeast Culture And Carbohydrate Fermentation

It has been suggested recently that several varieties of the yeast, Saccharomyces cerevisiae, produce extracellular amylases which could degrade starch (Klein and Zaworski, 1990). The fermenting ability of Saccharomyces and related genera has shown improved sugar and starch utilization (Panchal and Tavares, 1990).

Mode of Action in Non-Ruminants

Similarities exist in the mode of action of yeast culture in the gastrointestinal tract of both ruminants and non-ruminants. The fact that yeast cultures may bring about significant effect on digestive processes in non-ruminants has been acknowledged (Glade and Sist, 1987; Pagan, 1989) however, the exact mode of action of yeast culture is not yet known. Several possible modes of actions of yeast culture in non-ruminants have been suggested.

1) Colonization of microbial population

Microbial population colonizing the gastrointestinal tract of the animals may perform the following activities.

a) Undigested feed residues approaching the hindgut of the animal may be digested by the enzymatic activity of the yeast culture. The nutrients made available in this manner may depend on the composition of diet and may respond in enhanced growth and feed efficiency (Williams, 1988).

b) It may contribute in boosting the nutrient supply (hemicellulose and nitrogen digestibility), through a similar mechanism described above in the hind gut of the monogastric animals, of the host when yeast culture dietary adjuncts are provided (Glade and Sist, 1987).

c) The presence or administration of the beneficial microorganisms in the digestive tract may aid in the suppression of E.coli or other organisms. The bottom line is having sufficient microorganisms growing in the intestinal tract that they can compete favorably with the E.coli population (Jernigan et al., 1985).

2) Fiber Digestion

Yeast culture has been documented as enhancing the fiber digestion and mineral availability (Glade and Sist, 1987). The evidence that the yeast culture may stimulate activities of fibrolytic bacteria resulting in enhanced fibrous digestion has been suggested by Lyons (1990). This digestion of fibrous

ingredients of food in the gut by microbial population may provide a small amount of dietary energy for the bird (Glade and Sist, 1987).

3) Phytase Activity

Improved phytate phosphorus digestion in non-ruminants has been attributed to the inclusion of yeast culture in the feed. Such an improvement is considered as the ability of yeast cultures to increase phytase activity of the microbial population already present in the hindgut of the animals (Thayer et al, 1978; Pagan, 1989).

4) Resistance of Microbes Against Acidic pH

Viable yeast culture and acid producing microorganisms may lower the pH of the digestive tract and also may bring about subsequent performance responses regarding weight gain and feed efficiency (Chapman, 1988). There is evidence that certain live yeast cells (Saccharomyces cerevisiae) have the ability to act as pH buffer and exist in the stomach's acidic environment. These yeast cells pass through the stomach and remain active in the lower digestive tract (Rose, 1980; Cartwright et al., 1986; Newbold et al., 1990).

5) Change In Gut flora

Introduction of yeast culture (microbial population) to non-ruminants may result in changes to the gastrointestinal

environment of the animals. Therefore, by administrating the microbial population to animals by diet supplementation we actually re-establish the natural conditions which have been disrupted by dietary or environmental influences in their gastrointestinal tract (Fuller, 1989). Intensive changes in the microflora of the gut resulting from yeast culture inclusion could help in microbial synthesis of certain nutrients such as vitamins (niacin, biotin), amino acids (glycine, lysine, methionine), and minerals (zinc). The changes in microflora due to microbial enzymatic activities such as protease activity on dietary or endogenous proteins and urease activity on non-protein nitrogenous compounds are of particular interest (Freeman, 1983; Fuller, 1988).

6) Yeast Cultures During Stress

Non specific pathogen free (SPF) birds being loaded with microbial populations such as enteric pathogens could be considered under stress and consequently may have excessive excretion of cholesterol, cholesterol derived compounds, and bile acids, and may require a higher concentration of nutrients than their germ-free counterparts (Feighner and Dashkevicz, 1987). Dietary adjuncts of yeast cultures have been suggested to in stimulate the feed intake during stress conditions (Dawson, 1988). Newly hatched poults have a pH in their digestive pathway making it an ideal site for the proliferation of many pathogenic organisms such as coliforms

In a previous study (Barnes, 1987), it has been suggested that the application of a natural additive such as yeast culture in poults following 2 to 3 days hatching could help in controlling the coliform proliferation.

YEAST CULTURE SUPPLEMENTATION AND NON-RUMINANTS

It is not the objective of this review to list all suggested beneficial effects of yeast culture dietary supplements in non-ruminants. However, it appears appropriate to provide some information about yeast culture's beneficial effects in non-ruminants regardless of class or specie.

Lyons (1990), observed that addition of viable yeast culture to corn-based diets had significantly improved feed efficiency and rates of gain of growing pigs. Inclusion of yeast culture in the feed of yearling horses resulted in greater biological value of the diet. A significantly increased nitrogen retention and enhanced microbial ammonia liberation and amino acid synthesis in yearling horses have been reported (Glade and Biesik, 1986; Glade and Pagan, 1988). Addition of yeast culture to promote weight gains, efficiency, and reduced mortality has been reported in rabbits (Hollister, 1990). Improved performance of productive and reproductive traits in different avian species such as growing chickens, market turkeys, and breeder turkeys have been reported (Thayer and Jackson, 1975; Thayer et al., 1978; Savage et al., 1985; and Savage and Mirosh, 1990 a,b).

PROBIOTICS

Probiotics are the feed additives containing desirable microbial products which enhance the growth of desirable gastrointestinal microbes of the host (Gilliland, 1988; Fuller, 1989). Many different micro-organisms are being used as probiotics such as Lactobacillus acidophilus, L. plantarum, L. fermentum, L. casei, Bifidobacterium, Streptococcus faecium and certain propionibacteria species. Their usage as feed additive may offer a possible replacement for the subtheraputic levels of antibiotics in animal feeds. Further, probiotics may exert an inhibitory action for undesirable micro-organisms in the digestive tract of poultry . Antibacterial growth promotants were effective only when growth depressing bacteria had colonized the bird's digestive tract (Gilliland, 1988).

Mode of Action of Probiotics in Poultry

Probiotic supplementation in poultry feeds may perform the beneficial effects in following possible ways.

a) Lactate Production

Lactobacillus produces large amounts of lactate from simple carbohydrates and Lactobacillus are resistant to a higher degree of acidity than other bacteria.

b) Inhibition of Growth of Pathogenic Organisms

Probiotics may inhibit the growth of E. coli and Salmonella infantis in the caeca of chicken. A significant reduction in the mortality in chicken due to S. typhimurium and Staph. aureus infections has been reported when chickens were treated with both prophylactic and therapeutic levels of L. acidophilus. The inhibitory effect of Lactobacillus is also attributed to their production of hydrogen peroxide (Watkins and Miller, 1983).

c) Colonization of Micro-organisms

Association of certain endogenous lactobacillus strains with alimentary epithelial surfaces has been documented by Fuller, (1988). This colonization of beneficial organisms maintain a bacterial balance in the intestines of the animals.

Lack of Effect of Probiotics as Feed Additive in Poultry

Lactic acid producing bacteria are reported to have a limited influence on fat digestibility and nitrogen retention in poultry (Tortuero, 1973). Probiotic inclusion in the feed of chicken having adequate levels of dietary amino acid, demonstrated no growth response regarding growth rates (Day, 1977). Empirically based results suggest that feeds supplemented with probiotics showed no significant differences in body weight gain. When supplemented in combination with yeast culture however, there was an increased pigmentation and

fat deposition in poultry (Burkett et al., 1977). There were no effects of probiotics and gentian violet supplementation in the feeds of broilers and Leghorn hens that of either separate treatments or in combination on growth and the fertility and hatchability of those birds (Krueger et al., 1977). Cage and floor reared laying hens fed diets containing liquid non-viable lactobacillus, dried non-viable lactobacillus, and dried viable probiotic product have shown no beneficial results on percent hen day egg production, mortality or body weight gain (Gerniglia et al., 1983; Nakaue and Mirosh, 1991). Research conducted at South Dakota State University, summarized in Feedstuffs (1977), indicated no beneficial effect of probiotic inclusion in the feed of two strains of turkeys. Medium white turkeys fed probiotics incorporated into their feed from 0-16 weeks of age displayed no significant differences in body weights or feed efficiencies Egg production, daily feed intake, body weight gain, fertility and hatchability of Broad Breasted Large White turkey hens were not affected when fed diets containing 625 mg of probiotics per kilogram of feed. Bobwhite quail fed diets supplemented with probiotics did not show any significant improvement in egg production, feed consumption, growth, fertility and hatchability (Miles et al., 1981).

YEAST CULTURE AS A FEED ADDITIVE IN POULTRY

The use of antibiotics and hormones has encountered some resistance from consumers because of health concerns. Inclusion of microbial fermented products in the feeds of both livestock and poultry has been a long time practice. The products can be incorporated in the feeds in the form of living micro-organisms, inactive micro-organisms and fermentation extracts. The benefits of formulating diets supplemented with yeast cultures have been documented in several research studies. Miles et al. (1981) and Watkins and Miller, (1983), have observed subsequent effects of feeding microbial cultures to avian species as an alternative to antibiotics for growth promotion and improved feed efficiency.

Useful Effects and Mode of Action of Yeast Culture in Poultry

As it has already been stated, yeast culture is fed primarily as a digestive aid being palatable and an appetite stimulant. It also produces certain enzymes such as amylase and protease which assist animal digestion and also serve as a nutrient and stimulatory aid for digestive gut bacteria (Arambel et al., 1987). Yeast culture has an antioxidant ability which obstructs the occurrence of oxidative rancidity of the fats which occurs due to hydrogen peroxide formation. This antioxidant property of yeast cultures can prevent a loss

of energy and destruction of other nutrients (Gilliland, 1988).

Inclusion of yeast culture in the rations of poultry species has been reported to stimulate the gut microflora which resulted in improved digestive abilities. Increased microbial enzyme levels have also been suggested as a result of yeast culture dietary adjuncts and may provide unidentified growth factors which may enhance the digestion efficiency of poultry (Tonkinson et al., 1965). Enhanced phosphorous digestibility was also attributed to the increased microbial enzyme levels when yeast culture was incorporated into poultry feeds (Thayer et al., 1978). Use of feed additives like yeast culture can limit the colonization of pathogenic nature organisms. Microbial metabolism in the small intestine, exerts a significant effect on the host's mineral and vitamin supplies (Visek, 1978). Certain yeast products have indicated that chromium might be the unidentified factor responsible for the improvement of interior egg quality. In addition, the dietary adjuncts of yeast culture are suggested to be more beneficial when impaired management practices tend to stress animals, provide less nutritive diets or depressed intake (Dawson, 1990).

Yeast Culture and Poultry

The addition of 2.5 and 5.0% dried brewer's yeast to the broiler chicken diet has resulted in a reduction of leg

disorders and increased growth of the chicken. This favorable effect of yeast culture is attributed to the presence of an unidentified factor (Plavnik and Scott, 1978). Broiler chickens fed diets containing 5 and 10% fodder yeast responded with increased gain without affecting feed intake/kg gain. Inclusion of yeast culture in the diet of commercial broiler chicks brought about a significant improvement in average body weight and feed efficiency (Trammell, 1988). An addition of 1.25% yeast culture in the diet of commercial broiler chicken along with fats containing hydrolyzed animal and vegetable fats significantly elevated the growth rate and feed conversion of the chicken (Charles et al., 1985).

There was evidence for the tendency of improvement in egg weight and egg shell quality among laying hens when they were fed diets containing 5% yeast product. This beneficial performance displayed by the laying hens was attributed to a possible change in calcium metabolism (Bolden and Jensen, 1985).

DEVELOPMENT OF THE TURKEY INDUSTRY

Turkeys are now out of the era when they were highly sought after by gourmet dinners. Keeping in view the continuously increasing demand for turkey meat, economic concerns of both the producer and consumer, and the amazing productive qualities, concern regarding public health and diet, and innovative steps towards the development of further

processed products, the poultry industry has been in the process of transition to an intensive turkey growing (Scott, 1987).

Statistics of turkey production for the last few years confirm the above statement. Large production increases of over 6 percent in 1989 and 9 percent in 1990 have been observed . The increase in turkey production was as low as 2% during 1991 and will likely increase 3-4% in 1992. A slight increase occurred last year and about the same rise is expected during the current year as the result of higher feed price (Heffernan, 1991).

The major concern regarding the development of the turkey industry involves the efforts to increase their productive and reproductive efficiencies by improvement in genetics, nutrition, management, disease prevention and control, and other factors (Reece et al., 1987).

The following factors may be implicated in further development of the turkey industry.

1) Minimizing stress.

Eliminating exposure to infections and re-examining bird densities (Kumar, 1991).

2) Selection.

Selection of turkey poults on the basis of decreased total days lost from broodiness and increased average clutch

length resulted in an increase in total numbers of eggs produced.

3) Evolution of resistant Turkey Strains.

More conscientious genetics and breeding program may help in selecting and rearing pathogen free strains of turkeys. Other potential achievements by improved genetics manipulation in turkeys may be the rapid economic growth, early maturity, reduced tendency of leg weakness, improved fertility and higher hatchability (Scott, 1987).

4) Improved Husbandry.

Production of more and more clean eggs and extremely improved hatchery sanitation programs could be encountered towards the production of relatively disease-free and better quality poults (Scott, 1987; Kumar, 1991).

5) Feed Additives in The Rations For Turkeys.

Based on the past regulatory facts against drugs / antibiotics, it is quite possible the inclusion of feed additives will be minimized or banned. However, the use of yeast culture and probiotics is not even a conversation point yet (Scott, 1987; Williams, 1989).

TURKEYS AND YEAST CULTURE

The incorporation of feed additives such as yeast culture into the feeds of turkeys may serve as a vehicle in preventing the colonization of the intestine with E. coli. Therefore, turkey poult mortality due to Colibacillosis may be reduced by feeding diets supplemented with yeast cultures (Kumar, 1991).

Edible portions of turkey meat have been reported higher in protein and essential amino acids than any other meats . A comparison of the nutrient composition of flesh and skin of market chicken and turkeys indicated the presence of higher levels of B-vitamins, certain essential amino acids and minerals in turkey meat. Turkey diets based on corn and soybean meal were reported to be deficient in lysine content which could result in striking failure of plumage pigmentation (Scott, 1987; Sefton, 1989). Certain strains of Candida utilis, the most widely used yeast, has as high as 70% of the available lysine content of its protein to poultry (Bui, 1990).

Yeast culture has been reported to be effective in preventing leg problems in turkey poults. Niacin and brewer's dried yeast have shown promising response in the prevention of "hock disorders" in turkey poults and "bowed legs" in ducks (Scott, 1987). Yeast, being a dietary source of vitamins and proteins, if supplemented in turkey diets provide vitamins at a much lower cost than were they supplemented with the synthetic form (Thayer, personal communication, 1969). An

appreciable increase in both phosphorus and calcium intake were observed when yeast culture supplemented rations were fed to cage turkey breeder hens (Thayer et al., 1978). Equal amounts of fish meal were replaced with a yeast culture without effecting egg production, egg weight or feed intake (Tomova and Sudzhiiska, 1986). A significant reduction in fat content of female turkeys was observed when they were fed diets supplemented with a yeast culture and the effect was attributed to an enhanced fat mobilization activity (Savage et al., 1985).

Dietary adjuncts of yeast culture, 1.5% level, into the feed of medium white turkeys significantly increased the hatch of fertile eggs and incidence of pipped eggs (Savage and Mirosh, 1990a). Another study with a 2.5% inclusion of yeast culture indicated a significant reduction in early embryonic mortality, line by diet effect for egg weight along with a significant increase in hatch of fertile eggs (Savage and Mirosh, 1990b).

In summary, previous research (Savage and Mirosh, 1990c) has shown that genetics and yeast culture interaction on turkeys may result in:

1) Higher rates of growth and egg production
2) Lower incidences of disease and leg problems
3) Higher utilization of nutrients available in the rations
4) Higher fertility and hatchability percentage
5) Increase in percent livability

6) Appreciable reduction in stress

7) Creation of suitable intestinal environment

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CHAPTER III

REPRODUCTIVE PERFORMANCE OF TWO GENETICALLY DISTINCT LINES OF TURKEY HENS FED BREEDER DIETS WITH AND WITHOUT A .5% YEAST CULTURE[1]

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ABSTRACT

The suitability of a breeder diet containing a yeast culture as a means of improving the reproductive performance of two genetically dissimilar lines of turkey hens (designated as L and H) was investigated. A total of 200 hens of lines L and H (n=100 per line) were housed in a curtain sided breeder house (10 hens/line/pen). Starting at 31 weeks of age (WOA), the hens were fed either Corn-soy (CS) or Corn-soy+yeast (CS+Y,.5% Diamond V Mills "XP" yeast culture,Saccharomyces cerevisiae) diets. Between 33 and 45 WOA, the hens were mated inter se and from 45 to 51 WOA reciprocal line matings were established. Hen reproductive parameters measured between 31 and 51 WOA were, body weight (BW) change, feed intake, feed:per dozen eggs, egg production, egg size, fertility, embryonic mortality, and hatchability of fertilized eggs from 7 biweekly egg settings.

Yeast culture supplementation of the diet did not influence ($P>.05$) changes in BW, egg production, egg weight, embryonic mortality, and hatchability of fertilized eggs (n= 5 biweekly hatches) of either line. A significant ($P<.05$) time by diet interaction was evident only in feed intake. There was an improved ($P<.05$) hen fertility in line H as a result of feeding the dietary yeast culture.

When hens of both lines were inseminated with semen of their reciprocal line, hatch of fertilized eggs (n= 2 biweekly

hatches) was substantially improved ($P<.05$) from hens fed the yeast culture containing diet. The results of this study suggest that there is a genetic factor associated with the feeding of a diet containing a yeast culture to turkey breeder hens.

INTRODUCTION

In response to the rapidly increasing public demand for more and safer poultry products, researchers are striving to develop efficient and safe feeding programs. The use of a dietary biologic additive such as a yeast culture in poultry feeds could provide more animal protein for human consumption through enhanced poultry production. However, the magnitude of performance promoting effects of yeast cultures and the mechanism responsible for these effects is difficult to assess because of limited relevant literature available. Furthermore, a lack of consistency regarding the effects of incorporating a yeast culture into the diets for poultry is another limitation in assessing its importance. One possible source for such variation in response may be variation between poultry species and levels of yeast culture incorporated in poultry feeds (Savage and Mirosh, 1990).

Studies with broilers (Thayer and Jackson, 1975), laying hens (Tonkinson et al., 1965), market turkeys (Savage et al., 1985), and turkey breeder hens (Thayer et al., 1978; Savage and Mirosh, 1990 a,b) have shown that the incorporation of a yeast culture into the feeds resulted in enhanced performance. In addition, dietary supplementation with yeast cultures has been reported to increase feed efficiency in growing chickens and breeder turkeys (Thayer and Jackson, 1975; Day, 1977; Thayer et al., 1978). In contrast, Brewer (1983) reported a

lack of effect on live weight and feed efficiency of market turkeys fed diets supplemented with a yeast culture. Brake (1991) reported that the inclusion of a yeast culture in the diet of broiler breeders had no effect on the birds or their progeny's performance. Recently. Hayat et al. (1992) in a preliminary report indicated that a genetic factor may be involved in enhanced reproductive performance of turkeys fed a breeder diet containing a yeast culture.

The following report describes research conducted to determine the effects of a breeder diet containing .5% yeast culture (Saccharomyces cerevisiae Diamond V Mills "XP") on the reproductive performance and subsequent hatchability of fertilized eggs of genetically distinct Wrolstad Medium White turkey hens. The hens represented two lines of turkeys in which males had been divergently selected for low and high semen ejaculate volumes.

MATERIAL AND METHODS

Management Procedure

Two lines of Wrolstad Medium White turkeys from a divergent male selection program for low (L) and high (H) ejaculate semen volumes (Hales et al., 1989) were used in this experiment. Day-old poults, hatched in May 1990, from the two lines were intermingled and brooded on a floor covered with wood shavings until 8 weeks of age (WOA). The birds were then transferred to grass-covered range pens containing wood shelters that served as refuge from the summer weather. At 20 WOA, hens from the two lines were separated from the males and returned to the range pens. At 31 weeks of age, a total of 100 hens from each line were randomly assigned to 20 pens (n=10 hens/pen/line) in a curtain-sided breeder house containing wood shavings litter. The hens remained in these pens until the conclusion of the study at 51 WOA. The feeding program used to brood and rear the hens between day-old and 31 WOA is summarized in Table III.1. At 31 WOA, 5 pens of hens within each line were fed isonitrogenous and isocaloric breeder hen diets with and without the addition of .5 % yeast culture[1] (w/w) (Table III.2). Hen photostimulation to initiate egg formation was begun at 33 WOA by supplementing the natural daily light exposure to 14 L : 6 D with incandescent lights.

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[1]XP-Yeast culture, Diamond V Mills, Cedar Rapids, IA.

The males that were hatched with the hens of the 2 lines were fed a 14% CP breeder diet without any yeast culture supplementation. The management of the males was the same as described by Nilipour et al. (1987) and were the source of the semen used in the artificial inseminations. Ten days following the onset of oviposition, artificial insemination of the hens was begun.

Variables

Hen body weights were determined at 33 WOA, then repeated at 4-week intervals (periods). Egg production was recorded daily on a pen basis. The breeder feeds fed to the hens were also recorded on a pen basis and consumption was determined by periods, to calculate feed consumption per dozen eggs produced.

With the onset of oviposition, the hens were observed for the occurrence of prolapsed oviduct (blow-out). Those hens in which the condition did not resolve itself were removed from the study. Hens demonstrating a behavioral tendency towards natural incubation (broodiness) were removed from their respective pens and transferred to a single wire covered floor pen. The hens remained in this alternate location until the process of oviposition resumed. Hen-day egg production records were adjusted for days in which broody hens were absent. Hen mortality was monitored on a daily basis.

Eggs were collected, four times each day beginning the second day following the first hen inseminations. The eggs were marked with the pen number for identification, hand cleaned if necessary, fumigated with formaldehyde gas, placed on egg flats and stored at 10-13 C and 80 % relative humidity for a maximum of 14 days. Prior to incubation, bulk weights of the eggs from each pen were determined and individual egg weights calculated.

Eggs were incubated and hatched in Bionomics[2] Model T3 single stage horizontal incubators (Savage et al, 1991). Following the onset of production and prior to the first artificial insemination of the hens, the unfertilized eggs were collected and marked by pen, incubated for 10 days, and then the contents were macroscopically examined for parthenogenetic development as previously described (Savage and Harper, 1985). All subsequent eggs from inseminated hens were candled at day 10 of incubation and those eggs without embryonic formation or in which development had ceased were removed. The contents of all eggs removed were macroscopically examined to determine fertility. Following day 28 of incubation, the hatched poults were removed and the contents of all unhatched eggs were examined. The percentage of fertilized eggs, early embryonic mortality, D1 (days 0 to 10), late embryonic mortality, D3 (days 20 to 28), embryos that

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[2]Bionomics, Inc, 6565 Joseph St. SE, Salem OR 97301

pipped the egg's shell but did not hatch, and hatchability of fertilized eggs were calculated.

To evaluate the effects of maternal diets and heterosis in the two genetically dissimilar lines, incubation performance traits were examined in two consecutive experiments.

Experiment I

Between 35 and 45 WOA, the hens were inseminated weekly with undiluted semen from males of their respective line. These inseminations were conducted to evaluate the effects of the hen breeder diet containing the yeast culture on the reproductive capacity of two lines of turkeys mated inter se.

Experiment II

To determine if there was a genotype influence upon incubation performance between 46 and 51 WOA, the hens were artificially inseminated with pooled undiluted semen from the reciprocal line. During the 46th week of age the hens were inseminated twice with undiluted semen. The eggs were marked for identification and incubated.

Statistical Analysis

Data from this experiment were analyzed by analysis of variance using the General Linear Models procedure (SAS, 1988). All variables were analyzed using repeated measurements

with the exception of body weight change (31-51 WOA). In those situations in which diet by time interactions were not significant (P>.05), the data for time were pooled. All statements of significance in the experiment refer to the .05 probability level. Significant means were compared using least significant difference test (SAS,1988).

RESULTS AND DISCUSSION

Breeder Hen Performance

The breeder performance traits measured by lines for hens fed corn-soy and a corn-soy diet with .5% yeast culture from 31 to 51 WOA is summarized in Table III.3. The addition of the dietary yeast culture did not influence the change in mean body weight (BW) between 31 and 51 WOA for hens of both lines. No differences in mean hen-day-egg production and egg weights, measured between 37 and 51 WOA, between both lines with and without the dietary yeast culture were observed. Feed efficiency (expressed as kg of feed per dozen eggs) was poorer ($P<.05$) for the H line hens fed the yeast culture as compared with its control and the L line hens fed either diet. When the feed consumption of hens fed the two diets was examined by the 4-week periods, a period by diet interaction was noted (Table III.4). The H line hens fed the yeast culture containing diet consumed more feed than those H line hens fed the control diet. There was no difference in feed consumption between either group of L-line hens. The overall feed intake (4 periods) was increased by yeast culture supplementation of the turkey breeder's diet.

As measured, the BW change, egg production and egg weight, both genetic lines responded similarly to both diets fed in this study. Although the inclusion of yeast cultures in poultry diets has been reported to improve body weight (Thayer

and Jackson, 1975; and Trammell, 1988), egg production, and egg weight (Thayer et al., 1978; and Bolden and Jensen, 1985), the addition of the dietary yeast culture did not influence these parameters for either turkey line in this study. This observed response is in agreement with the previously reported observations of Savage et al. (1985). Line H hens consumed more feed than those of line L illustrating a genetic difference between the lines (Savage et al., 1984). Breeder hens of the H line fed the yeast culture supplemented diet consistently consumed more feed than the hens fed the control diet (Table III.4). A reason for this yeast culture response other than genetic line difference is unknown. A probable reason for the increased feed consumption of yeast when fed to both lines might be due to an enhanced feed palatability associated with the yeast culture (Peppler, 1982; Savage, personal communication, 1990). Since an interaction effect ($P<.05$) for feed consumption between period and diet was observed, increased feed consumption accompanied by an increase in the hen's age could be anticipated. Mean line feed conversion values of 3.5 and 4.8 kg of feed per dozen eggs for the L and H line turkey breeder hens, respectively, illustrate genetic line differences in feed conversion. With yeast culture supplementation a consistently poorer feed efficacy from both the L and H lines was observed. These results contrast those of Thayer et al., (1978), and Savage and Mirosh, (1990) who observed a relatively improved efficiency

due to feeding a yeast culture to turkey breeder hens. It is possible that different types and levels of yeast cultures used in those studies may have influenced the results. The absence of line by diet interactions for BW change, feed consumption, feed efficiency, egg production, and egg weight were observed in the present study and the response was consistent with previous reports (Savage and Mirosh, 1990)

The incidences of prolapsed oviducts and hen broodiness in both L and H line hens fed diets without (CS) and with the yeast culture supplementation (CS+Y) were observed. Due to limited data collected, no statistical analyses were performed. The incidences of prolapsed oviducts were 2.1, 0, 6.4, and 4.6 for the L-CS, L-CS+Y, H-CS, and H-CS+Y, respectively while the incidences for hen broodiness were 10.6, 16.0, 22.2, and 19.0 percent, respectively. Mean hen mortalities during the period between 31 and 51 WOA were 4.1, 0, 8.5, and 4.4 percent for the L-CS, L-CS+Y, H-CS, and H-CS+Y respectively.

Incubation Performance

The incidence of parthenogenesis observed in the two lines between 36 and 37 WOA in which the hens were fed two breeder diets (CS and CS+Y) were 7.88, 10.60, 4.29, and 3.45% for L-CS, L-CS+Y, H-CS, and H-CS+Y respectively. The data collected was insufficient for a statistical analysis. To evaluate the effects of maternal diets and potential influence

of heterosis arising from line crosses of two genetically different lines, incubation performance traits were examined in two experiments conducted using the same hens.

Experiment 1

From the first five consecutive biweekly hatches when hens were inseminated with the semen from their respective line toms, hen fertility was lower in the line L hens and higher in the H line hens both fed the dietary yeast culture (Table III.5). The dietary yeast culture did not affect the early (days 0-10) and late (days 21-28) embryonic mortality of both lines, the incidence of pipped eggs, and the hatch of fertilized eggs from the inter se matings (Table III.5).

Although hatchability of turkey breeder hen eggs of both lines was not affected by dietary treatment, there are some interesting responses of various reproductive parameters to the same dietary treatment. The H line breeder hens fed the yeast culture supplemented diet laid more ($P<.05$) fertilized eggs (83.73% vs 71.91%) than hens of the same line fed the non-supplemented corn-soy diet. In contrast, L line hen fertility was reduced ($P<.05$) when fed the dietary yeast culture then compared to unsupplemented group. The fertility responses of both lines fed the dietary treatments may be the expression of a hen genotype by diet interaction. This response to .5% yeast culture supplementation and genetic variation warrants further study. Although dietary yeast

culture did not appear to influence the embryonic mortalities and incidence of pipped eggs within the lines there were line differences due to the genome (Table III.5).

Experiment 2

The results of two additional biweekly settings of eggs from the same hens used in Experiment 1 when reciprocal line matings were conducted are also summarized in Table III.5. Hen fertility, early (days 0-10) and late (days 21-28) embryonic mortalities, and pipped eggs were not affected by the dietary yeast culture supplementation in either line. An improvement ($P<.05$) in the hatch of fertilized eggs from hens fed the yeast culture however, was observed between the control and treatment groups within both lines.

The absence of interaction effects for line, diet, and period were consistent with the results of Experiment 1. Line differences in late embryonic mortality and pipped eggs from Experiment 1 and in early and late embryonic mortalities and hatchability from Experiment 2 gave an indication of the genetic variation that exists between lines. A lack of effect on hen fertility in Experiment 2 was also observed. It appears that as the hens became older their fertility declined. There was however an improvement in hatch of fertilized eggs of the turkey breeder hens of both L and H lines fed the yeast culture supplementation when the source of male semen was changed between the lines. The response was attributed to the

genome of the heterotic embryos which enhanced their ability to develop and hatch.

The results of this study are in agreement with the reports of work done with turkey breeders (Thayer et al., 1978; Savage and Mirosh, 1990). These researchers have reported an improved feed intake and reproductive performance of turkey breeder hens fed diets containing yeast cultures. The results of this study involving a dietary supplementation of a yeast culture to the diet of turkey breeder hens of two distinct lines indicated that the genotype of the bird is a factor that should be considered in evaluating dietary supplements for their potential influence. Further, the inclusion of a yeast culture in turkey breeder hen diets can improve reproductive efficiency and warrants further investigatory studies.

Table III.1. Feeding program for Wrolstad Medium White turkeys between day-old and 31 weeks (w) of age

Feed[1]	Day-old to 8w	8 to 13w	13 to 17w	17 to 31w
Crude protein, %[2]	28.0	20.0	17.0	14.5
Metabolizable energy[2], (kcal/kg)	2712	2867	3036	3149

[1]Mash form.
[2]Calculated.

Table III.2. Composition of pelleted turkey breeder hen corn-soy diets without (CS) and with XP Yeast Culture (CS+Y)

Ingredients	CS	CS+Y
Corn, Yellow	73.79	73.40
"XP" Yeast Culture	--	.50
Soybean meal, solv., 44%	12.00	11.98
Meat and bone meal, 50%	5.07	5.00
Fish meal, 60%	2.53	2.52
Limestone flour	4.16	4.14
Monocalcium phosphate (16% Ca;21% P)	.48	.49
Salt (iodized)	.40	.40
Vitamin premix[1]	.35	.35
Trace mineral premix[2]	.10	.10
D, L methionine, 98%	.02	.02
Selenium	.05	.05
Biotin	.05	.05
Fat (blended, animal)	1.00	1.00
Calculated analyses:		
Crude protein, %	15.6	15.6
Metabolizable Energy, kcal/kg	3035	3022
Calcium, %	2.34	2.34
Avail. phosphorus, %	.51	.51
Analyzed[3]:		
Crude protein, %	15.1	15.4

[1]Supplies per kilogram of feed: Vitamin A, 5775 IU; Vitamin D_3, 1925 ICU; riboflavin, 5.8 mg; d-pantothenic acid, 9.6 mg; niacin, 38.5 mg; choline, 334 mg; Vitamin B_{12}, 9.6 mcg; Vitamin E, 1.93 IU;Vitamin K, .96 mg; folacin, .40 mg.

[2]Supplies per kg of feed: calcium, 195 mg; manganese, 120 mg; iron, 40 mg; iodine, 2.4 mg; zinc, 55 mg; cobalt, .4 mg; copper, 4 mg.

[3]Kjeldahl analysis.

Table III.3. The effect of diets containing corn-soy (CS) and corn-soy with .5% yeast culture[1] (CS+Y) on mean body weight change, egg production, egg weight, and feed efficiency by lines between 32 and 51 weeks of age

Line	Diet	Body Weight[2] Change	Egg Production[3]	Feed Per Dozen[4] Eggs	Egg Weight[5]
		Kg	%	Kg	gms
Low	CS	-0.25[a]	59.86[a]	3.41[a]	76.80[a]
	CS+Y	-0.28[a]	59.93[a]	3.67[a]	76.05[a]
	SEM	0.18	2.45	0.55	0.38
High	CS	-0.45[a]	57.06[a]	4.07[a]	74.70[a]
	CS+Y	-0.41[a]	58.82[a]	5.47[b]	75.04[a]
	SEM	0.28	2.46	1.10	0.50
Source of variation		Probability			
Line		<.05	NS	<.05	NS
Diet		NS	NS	<.05	NS
Interaction		NS	NS	NS	NS

[1]Diamond V Mills "XP" Yeast culture.
[ab]Means within columns and lines with no common superscripts differ significantly (P<.05).
[2]32 to 51 Weeks of Age (WOA).
[3]37 to 51 WOA.
[4]37 to 51 WOA.
[5]Measured at 39, 41, 43, 45, and 47 WOA.

Table III.4. Influence of dietary yeast culture (YC) on calculated daily feed consumption (kg) of the Low and High line turkey breeder hens at various periods during the breeding season

Line	Diet	4-week interval (Periods) 1	2	3	4	Overall Mean
		kg				
Low	CS	.18	.16	.17	.18	.17
	CS+Y	.17	.17	.17	.20	.18
	SEM	.02	.03	.04	.05	–
High	CS	.19	.20	.18	.22	.20
	CS+Y	.21	.24	.25	.30	.25
	SEM	.05	.07	.07	.10	–

Table III.5. Hen fertility and incubation performance of turkey breeder hens of the Low and High lines fed corn-soy diets without (CS) and with .5% yeast culture (CS+Y) between 31-51 weeks of age and mated inter se (Experiment I) and reciprocal matings (Experiment II)

Line	Diet	Incubation Performance				
		Fertility	D1[2]	D3[3]	Pipped	Hatchability
Experiment I[1]		%				
Low	CS	88.97[b]	3.17[a]	12.49[a]	23.72[a]	60.29[a]
	CS+Y	83.58[a]	4.46[a]	13.56[a]	23.88[a]	57.23[a]
	SEM	2.16	1.01	1.18	2.29	2.72
High	CS	71.91[a]	5.32[a]	20.28[a]	19.24[a]	54.41[a]
	CS+Y	83.73[b]	5.97[a]	20.62[a]	18.73[a]	53.02[a]
	SEM	4.63	1.11	2.20	2.03	2.51
Source of variation		Probability				
Line		NS	NS	<.05	<.05	NS
Diet		<.05	NS	NS	NS	NS
Interaction		NS	NS	NS	NS	NS
Experiment II[4]						
Low	CS	80.46[a]	1.79[a]	13.62[a]	15.24[a]	63.56[a]
	CS+Y	78.47[a]	0.85[a]	12.08[a]	12.63[a]	69.73[b]
	SEM	2.93	0.62	2.03	2.59	3.59
High	CS	75.03[a]	3.43[a]	19.27[a]	17.70[a]	54.46[a]
	CS+Y	72.87[a]	6.40[a]	14.14[a]	13.82[a]	59.72[b]
	SEM	5.71	2.04	3.43	2.09	3.60
Source of variation		Probability				
Line		NS	<.05	<.05	NS	<.05
Diet		NS	NS	NS	NS	<.05
Interaction		NS	NS	NS	NS	NS

[ab]Means in columns within lines with no common superscripts differ significantly (P<.05).
[1]Incubation performance of hens mated inter se. [2]Early embryonic deaths (days 0-10 incubation).
[3]Late embryonic deaths (days 20-28 incubation). [4]Incubation performance of hens after reciprocal cross.

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CHAPTER IV

GENERAL DISCUSSION

The present study demonstrated that yeast cultures could be used as a potential feed additive in the turkey breeder hen diet to enhance reproductive performance specifically hatchability of fertilized eggs. Three major considerations should be taken into account however, when the feeding of a yeast culture to poultry is considered: 1) the type of bird 2) the strain of yeast 3) level of yeast culture into the feed.

Different avian species may utilize the same feedstuffs in dissimilar manner (Slinger et al., 1964). Growing chicks (Thayer and Jackson, 1975), laying hens (Tonkinson et al., 1965) market turkeys (Savage et al., 1985), and turkey breeders (Thayer et al., 1978; and Savage and Mirosh, 1990) have shown improvement in different performance traits when fed diets containing yeast cultures. For example, an improved fat digestibility in layers, improved phosphorus utilization in broilers, reduced fat content in market turkey hens but not males, and improved reproduction performance traits in breeder turkeys have been documented. In a preliminary report by Hayat et al. (1992) the genotype of the turkey hen was also suggested to have an important impact on the reproductive performance responses when a breeder diet containing a yeast culture was fed. In the study reported here, fertility of both

the L and H lines was influenced in Experiment 1 by the yeast culture supplementation while no effect was observed in Experiment 2. However, a differential response was observed for the hatch of fertilized eggs in the two experiments. Although both the genetic and nutritional factors influenced the responses measured in the experiments, there was an interrelationship between these variables (genetics and nutrition) affecting fertility and hatchability. The precise mechanism is unclear but could be the subject for a future investigation. The increased hatchability of fertilized eggs when the males were changed might be a result of a negative heterosis of undesired traits (Darden et al., 1988). Additionally, the differential responses of two genotypes (Inter se mating and line crosses) to dietary treatments (without and with yeast culture) in both experiments indicate a possible genotype by experiment effect. This interaction however, was not tested because the data were not collected at the same age in two experiments.

Different strains of yeast vary in their nutritional constituents. Yeasts from genus Saccharomyces and Rhodotorula, for example, have high protein contents while yeast of the genus Candida are rich in vitamins (Perlman, 1973; Atkinson et al., 1983; and Ratledge et al., 1985). The lack of effect on some performance parameters in poultry may be an indication of inappropriate levels of a yeast culture's incorporation into the feeds or the selection of a yeast culture that is

unsuitable for poultry. Savage and Mirosh, (1990) demonstrated that turkey breeder hens responded differently with two different levels of same yeast culture supplementation.

Though the data from the present study does not offer a possible mechanism for the yeast culture action, it does suggest that it has possible role in the improvement of turkey breeders performance that can not be overlooked. Since Thayer et al. (1978) reported that yeast culture supplementation could reduce ration costs, yeast culture incorporation into turkey diets might be cost effective and warrants further study.

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APPENDICES

APPENDIX 1

THE INFLUENCE OF MATERNAL CORN-SOY DIETS WITHOUT (CS) AND WITH .5% XP YEAST CULTURE (CS+Y) ON THE INCIDENCES OF PARTHENOGENSIS IN EGGS LAID BETWEEN 36 AND 37 WOA.

Unfertilized eggs from the virgin hens were collected for a 10 day period between the weeks 36 and 37 then incubated in Bionomics incubator for 9 days. The eggs were subsequently removed and the contents of all eggs were macroscopically examined for indication of parthenogenetic development, unorganized embryonic tissues or the presence of blood islands. The incidence of parthenogenesis was increased by feeding the yeast culture to hens of the L line while slightly reducing the incidence in H line. A numerical increase in parthenogenesis of the L line and a slight decrease in H line associated with dietary treatments did not provide sufficient data to assess the importance of the dietary inclusion of yeast culture, Table A1.1.

Table A1.1. The effects of hen diets on the incidence of parthenogenesis

Line	Diet	Number of Eggs Examined	Parthenogenesis[1](%)
Low	CS	165	7.88
	CS+Y	161	10.60
High	CS	210	4.29
	CS+Y	174	3.45

[1]No statistical analysis was performed.

APPENDIX 2

THE INFLUENCE OF MATERNAL DIETS ON THE INCIDENCES OF PROLAPSED OVIDUCTS OBSERVED AT THE ONSET OF EGG PRODUCTION (37 WOA) AND HEN BROODINESS BETWEEN 36 AND 51 WOA.

Appendix Table A2.1 summarized the observed incidences of prolapsed oviducts and broodiness in both L and H line hens illustrating that yeast culture supplementation may reduce this reproductive problem in hens beginning to lay. Dietary treatments demonstrated an inconsistent effect on hen broodiness of both L and H lines. Hens from line L fed the diet containing yeast culture exhibited an increased incidence of hen broodiness, while the reverse response was observed in the hens from line H. These observations complement a previous study (Savage and Mirosh, 1990).

Table A2.1. Influence of diets on percentage of turkey hens experiencing prolapsed oviducts at the onset of egg production and broodiness during the production period

		Prolapse[1]		Broodiness[2]	
Line	Diet	Number of Hens	%	Number of Hens	%
Low	CS[3]	1/47	2.1	5/47	10.6
	CS+Y[4]	0/50	0	8/50	16.0
High	CS	3/47	6.4	10/45	22.2
	CS+Y	2/44	4.5	8/42	19.0

[1]Blow-outs.
[2]Hen demonstrating non productive behavior (chronic occupancy of the nest without egg production).
[3]Corn-soy control diet.
[4]Corn-soy with .5% "XP" yeast culture.

APPENDIX 3

THE INFLUENCE OF MATERNAL DIETS ON THE INCIDENCES OF DROOPY NECK AND BUTTON NAVELS BETWEEN 37 AND 51 WOA.

Appendix Table A3.1 summarized the effects of maternal diets on certain incubation associated parameters within both L and H lines. Incidence of droopy neck was considerably reduced in the poults from the hens of both L and H lines fed dietary yeast culture in Experiment 1 while the incidence was increased in H line in Experiment 2. There were fewer poults with button navels from H line hens fed dietary yeast culture in Experiment 1 and same trend was observed in Experiment 2 in both the L and H lines. A consistent reduction in droopy neck and button navel incidences in genetic lines related with yeast culture supplemented diet may predict an improvement in reproductive efficiency of the turkey breeder hens, which ultimately can have a substantial economic benefit.

Table A3.1. The influence of breeder hen diets without (CS) and with .5% XP yeast culture (CS+Y) on the incidences of poults at the time of hatch exhibiting "droopy neck"[1] and "button" navels[2]

Line	Diet	Number of poults	Droopy Neck	Button Navel
Experiment 1				
Low	CS	1024	4.19	3.96
	CS+Y	971	2.89	5.34
High	CS	656	1.50	33.50
	CS+Y	742	0.83	26.91
Experiment 2				
Low	CS	359	2.35	13.71
	CS+Y	400	2.14	10.21
High	CS	272	3.46	25.31
	CS+Y	283	2.13	20.57

[1]Droopy neck described poults at hatching whose neck and heads were extended laterally suggesting of a cervical paralysis as described by Scott, (1987).
[2]Button navel is a defect that is associated with incubation condition.

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APPENDIX 4

THE EFFECT OF MATERNAL CS OR CS+Y DIETS ON SUBSEQUENT POULT LIVABILITY WITHIN L AND H LINES.

The potential influence of the hen's diet on subsequent early poult mortality after hatching (days 0-7) was examined in 3 separate hatches. The following appendix Table A4.1 summarizes an inconsistent effect of dietary treatments on poult mortality (days 0-7).

Table A4.1. The effects of the hen diets (without (CS) and with XP Yeast (CS+Y)) on percent early poult mortality (0-7 days) in the brooder house

Line	Diet	Trial 1[1]	Trial 2[2]	Trial 3[3]	Overall Mean
Low	CS	0	0	0	0
	CS+Y	0	0	0	0
High	CS	3.33	3.33	0	2.22
	CS+Y	0	0	2.0	0.67

[1]30 Straight-run poults per maternal diet (Hatch date 3-12-91).
[2]30 Straight-run poults per maternal diet (Hatch date 4-9-91).
[3]50 Straight-run poults per maternal diet (Hatch date 4-23-91).