Nutritional Strategies to Reduce Heat Stress in Broilers and Broiler Breeders

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Introduction

The poultry industry has for some time occupied a leading role among agricultural industries in many parts of the world. Poultry meat production has shown much higher growth than any other type of meat during the past decade. The potential for growth is obvious in view of the value of this kind of meat in modern day human diets. Chicken meat production has been on the increase in all continents with the highest increases in Asia and South America. The rate of increase in chicken meat has averaged 5.7% per year since 1990 (Daghir, 2008). The hot regions of the world have probably the greatest potential for further growth since the level of consumption is still very low. Asia now leads the world in poultry meat production, followed by North and Central America which had the lead until 1990. In 2005 Asia and South America contributed 50% to global poultry meat production (Daghir, 2008). The rapid expansion of the industry in these regions is very evident in countries like Brazil in South America, Morocco and Nigeria in Africa, and Saudi Arabia in the Middle East. Shane (2006) presented data indicating that there will be an increase of 12.5% in consumption of poultry meat during the present decade. According to this author, the highest increase will be in Asia, Africa and South America, the main warm regions of the world.

There are several constraints to the future development of the poultry meat industry in the hot regions of the world. The first and foremost is the availability of capital. With the exception of the oil-rich countries, these regions are in general poor and have low per capita income. The availability of adequate supplies of grain and protein supplements necessary for the production of feeds is another major constraint for development. A third constraint on future development in these areas is the need to develop the various supporting industries for commercial production such as equipment, pharmaceuticals, packaging materials, housing materials, etc.. The lack of poultry-skilled people for middle management positions in these areas is a real hindrance to further growth in the industry as well as lack of adequate disease diagnosis and control facilities. Finally, the most obvious constraint to high production in these regions is climate. High temperature, especially when coupled with high humidity, imposes severe stress on birds and leads to reduced performance. During the past two decades there has been a great deal of research and development on ways and means of reducing heat stress of birds subjected to high temperature. By far the most effective have been developments in housing practices for hot climates. This paper will deal mainly with certain nutritional manipulations and feeding practices that have been found to be helpful in reducing heat stress in broilers and broiler breeders.

General Temperature Effects

There is considerable disagreement as to what is the ideal temperature range for different classes and age groups of poultry. This is probably due to the fact that many factors influence the reaction of poultry to temperature changes. The most important are humidity of the atmosphere, wind velocity, and previous acclimatization of the birds. Birds perform well within a relatively wide range of temperatures. Whether they are broilers, layers or turkeys, this range extends between 10 and 27° C. Kampen (1984) found that the highest growth rate of broilers occurs in the range of 10-22° C while maximum feed efficiency is at about 27° C. Charles (2002) reviewed the literature on the optimum temperature for performance and concluded that for growing broilers it is 18-22° C. It is known, however, that what is ideal for growth is not ideal for feed efficiency. The overall optimum range mainly depends on the market value of the product produced, relative to feed cost. As the price ratio widens, the best temperature falls, and vice versa.

The most important factor affecting performance in broilers subjected to high temperature is reduced feed intake. However, only part of the reduced performance of broilers is due to reduced feed intake and the rest is due to high temperature per se. Dale and Fuller (1979) showed that 63% of the reduction in broiler growth is due to reduced feed intake. More recently, we conducted some paired-feeding as well as forced-feeding studies on broilers raised at high temperature and found that 67% of the reduction in growth rate in these birds is due to reduced feed intake (Daghir and Hussein, unpublished data).

The response of broilers at high temperatures differs with different relative humidity. High temperature accompanied by high humidity is more detrimental to broiler growth than high temperature with low humidity. At the same time, constant high temperature of 30-32° C is more deleterious to broilers than cyclic or alternating temperatures of 30-32° C by day and 25° C by night. Feed conversion in broilers is subject to marked fluctuations because of seasonal as well as ambient temperature changes. All studies indicate that high temperatures reduce the efficiency of utilizing feed energy for productive purposes. Broilers not only eat less at high temperature, but also gain less per unit of intake, especially at temperatures above 30° C. Feed conversion in broilers is subject to marked fluctuations because of seasonal as well as ambient temperature changes. Poultry producers in the state of Florida found that 0.09 kg more feed was required to produce a unit of gain in broilers during the hot months June to August compared to the period November to April.

It has been known for some time that chickens can adapt to climatic changes. Attempts have therefore been made at reducing heat-stress mortality in broilers by acclimatization. Raising house temperature prior to the onset of a heat wave has been shown to reduce mortality. This is partly due to the reduction in feed intake in response to the stress. Arjona *et al.* (1990) observed that exposure to 35-38° C for 24 hours at 5 days of age reduced mortality when these birds were heat stressed for 8 hours at 44 days of age. It has been suggested that a temperature of 36-37.5° C at three days of age is optimum for early conditioning of broilers (Yahav and McMurty, 2001). Incubating eggs at high temperature has also shown to improve the tolerance of fast-growing broilers to heat stress (Yalcin *et al.,* 2008). Although this practice of acclimatization is still in the experimental stage, it has strong potential for the broiler industry.

Broiler Nutrition in Hot Climates

Environmental temperature is the most important variable affecting feed intake and thus weight gain of broilers. Several authors have shown that increasing the energy content of the diet can partially overcome this growth depression. It is common practice now in formulating broiler feeds for hot regions to boost the energy level of these diets by adding fat. This practice not only increases the energy intake but also reduces the specific dynamic effect of the diet, which helps birds to cope better with heat stress. Ghazalah *et al.* (2008) showed that high fat diets (5%) helped in reducing the detrimental effect of heat stress in broilers raised at 29-36° C. High fat content of the diet helps to reduce heat production, since fat has a lower heat increment than either protein or carbohydrate. The addition of fat to the diet also appears to increase the energy value of other feed constituents (Mateos and Sell, 1981) and has been shown to decrease the rate of food passage in the GI tract and thus increase nutrient utilization (Mateos *et al.,* 1982).

Besides energy, consideration must be given to the amino acid balance of the diet during heat stress. If the energy content of the diet is increased, all other nutrients must be increased proportionally. Minimizing excess amino acids usually improves feed intake. During hot periods, lower protein diets supplemented with limiting amino acids (mainly methionine and lysine) give better results than high-protein diets. Several workers have tested low protein diets supplemented with the most critical amino acids or simply protein levels higher than what is recommended by NRC (1994) for broilers raised at high temperatures. Filho *et al.* (2006) found that at 32° C, low protein diets (18-16.6-15%) for broilers impair performance. These protein levels were obviously too low for our modern broiler strains. Cheng *et al.* (1997) reported that feeding low protein diets to broilers partially ameliorates the negative effects of high temperature. Rahman *et al.* (2002) evaluated different levels of protein on broilers raised in a hot and humid environment and found that there were no significant differences in performance between groups receiving 23 vs. 21% protein. Temim *et al.* (2000) studied the effect of chronic heat exposure (32° C) on broilers fed different levels of protein and concluded that raising the protein level above 20% is not helpful to broilers to withstand high temperature conditions.

Most research has shown that temperature changes neither increase nor decrease the protein requirement of birds per unit gain. Some work shows that there is decreased protein synthesis and increased breakdown under heat stress (Lin *et al.,* 2006) and that this decreased protein synthesis can not be restored by increasing the dietary protein level. Part of this decreased performance is due to the increased heat production, since protein has a high heat increment. Therefore heat increment is lowered by decreasing dietary protein. Gonzalez-Esquera and Leeson (2005) found that the length of exposure to heat stress may affect the response of birds to dietary protein. Short term exposure has a different effect from long-term exposure. Reduction in crude protein levels in heat-stressed birds as a means to reduce heat production may not always be justified. Amino acid requirements as affected by temperature have been studied for many years and the response to amino acid supplementation at high temperature has varied a great deal.

Several factors therefore may be involved in differing responses to amino acid supplementation at high temperature. Chen *et al.* (2005) reported that the response to crystalline amino acid supplementation is affected by dietary electrolytes such as sodium chloride. Brake *et al.* (1998) confirmed this and reported that increasing the Arg:Lys ratio in Australian diets fed to broilers raised at 31° C improved weight gain and feed conversion when the diets contained low levels of NaCl. Balnave and Brake (2001) found that sodium bicarbonate improved broiler performance with high Arg:Lys ratio. Gonzalez-Esquera and Leeson (2006) concluded that the Arg:Lys ratio, methionine source and time of exposure to heat stress all altered protein utilization in hyperthermic birds. This brings us to the conclusion that the ideal amino acid balance for broilers raised at high temperature may vary with different dietary conditions.

The supplementation of essential amino acids to a diet with poor quality protein or unbalanced amino acid profile helps performance by reducing heat increment and the harmful effects of high temperature. The industry therefore has followed the practice of adjusting the dietary levels of protein and amino acids in order to assure an adequate intake of these essential nutrients as house temperature and thus feed intake vary. This is based on the assumption that temperature does not affect the efficiency with which amino acids are utilized for growth. Some nutritionists recommend to increase amino acid levels as a percentage of the diet up to 30° C, but beyond that temperature further increases are not justified because growth will be depressed.

Several acid-base imbalances occur in heat-stressed broilers. The occurrence of alkalosis in heat-stressed birds has been known for a long time and the addition of ammonium chloride, potassium chloride and/or sodium bicarbonate have improved performance of broilers by improving water and feed intake (Ahmad *et al.,* 2008). Mineral therapy and manipulation appear to be effective means of reducing detrimental effects of heat stress in broilers. The dietary electrolyte balance (DEB) also known as acid-base balance is probably more critical at high temperature than at normal temperature, and different results have been reported on the most appropriate DEB for birds under high temperature conditions. Ahmad and Sarwar (2006) reviewed the literature on this subject and concluded that differences in response depend on ambient temperature, age of bird, and length of exposure to high temperature. Very high (360 mEq/kg) and very low (0mEq/Kg) DEB can result in metabolic alkalosis and acidosis, respectively. In diet formulation very high and low DEB should be avoided. These authors concluded that birds under heat stress perform best at a DEB of 250 mEq /Kg. At the same time, excesses or deficiencies of any specific mineral should be avoided. Based on their recent study, Mushlag *et al.* (2007) concluded that the dietary requirements are 0.20-0.25 % Na and 0.30 % Cl during the finishing period (29-42 days) at temperatures ranging from 32 to 40° C.

Since heat stress always depresses appetite and therefore reduces nutrient intake, the use of a vitamin and electrolyte pack in the drinking water for 3-5 days during a heat wave has been shown to be helpful in most cases. Vitamin C supplementation is probably the most beneficial among vitamins, and several nutritionists recommend the administration of 1 g ascorbic acid / liter drinking water throughout heat periods. In addition, a vitamin pack of A, D, E and B complex supplementation of drinking water is beneficial for both performance and immune function of heat–stressed broilers.

Since many countries in hot regions import their vitamin and trace mineral mixes, and since there are often delays in transport of ingredients, the problem of vitamin stability is of primary concern. Temperature, moisture, and oxidation by polyunsaturated fatty acids, peroxides and trace minerals are the most critical factors affecting vitamin stability in both complete feeds and vitamin-trace mineral premixes. Therefore, vitamin activity in feeds should be preserved by the incorporation of antioxidants, selecting gelatin-encapsulated vitamins, appropriate storage conditions, adding choline separate from the vitamin and trace mineral premix, delaying the addition of fats until just before the use of the feed and using feeds as soon as possible after mixing.

Temperature and Body Composition of Broilers

Today's broilers are selected and managed with the aim of increasing meat yield and decreasing fat deposition. Several studies have shown that environmental temperature has an effect on carcass composition and meat yield. At high temperature, meat yield, particularly breast meat yield, is reduced (Yalcin *et al.,* 1997, 2001). Akit *et al.* (2005) studied the effect of temperature on meat quality and found that high temperature had an adverse effect on meat quality.

Cahaner and Leenstra (1992) found that males were more affected by high temperature than females.

Lu *et al.* (2007) found that abdominal fat deposition of Beijing You (BYJ) chickens was enhanced by heat exposure, while fat deposition in Arbor Acres broilers was decreased in heat-exposed and pair-fed chickens. They concluded that the impact of heat stress was breed dependent and that the BYJ chickens showed higher resistance to high temperature, which could be related to their increased feed efficiency and deposition of abdominal fat under heat exposure. Although there is a lot of research on breed and strain differences in resistance to heat stress, very little has been done in relation to breed and strain responses to different nutritional states at high temperatures. Havenstein (2007) reported in a study on turkeys that strains and sexes reacted very differently to an old (1966) vs. a modern (2003) dietary regime in response to high temperature and high humidity. Birds on the 1966 diet (high protein, low energy) performed better during the summer than those on the modern high energy diet (see figures 1 through 4). Birds on the modern high energy diet reduced their intake as an adaptive measure to minimize heat stress. This author agreed with Veldkamp *et al.* (2002) who concluded that turkeys modulate feed intake when exposed to high ambient temperature in relation to the caloric density of the diet.

Fig. 1: Body Weight Males

(G1 = generation 1966, G2 = generation 2003;
F1 = feed 1966, F2 = feed 2003)

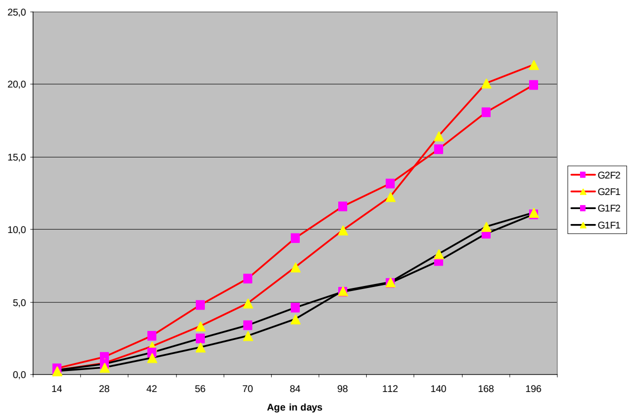


Fig. 2: Body Weight Females

(G1 = generation 1966, G2 = generation 2003;
F1 = feed 1966, F2 = feed 2003)

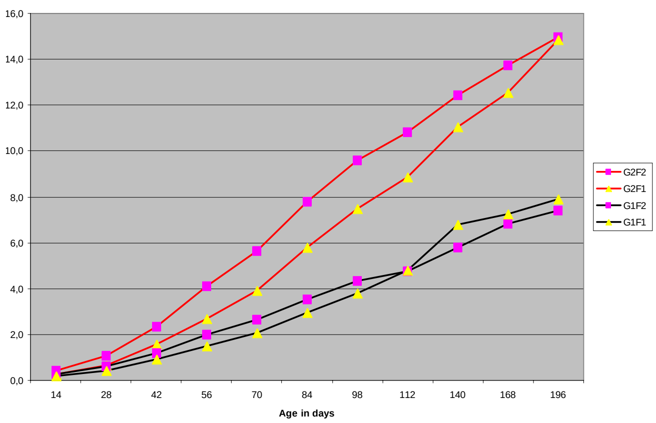


Fig. 4: FCR Males

(G1 = generation 1966, G2 = generation 2003; F1 = feed 1966, F2 = feed 2003)

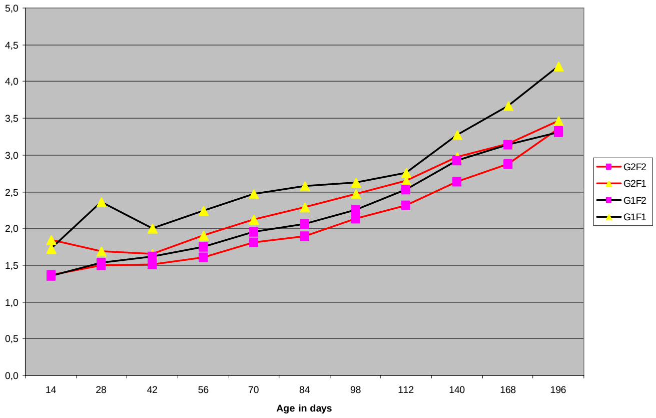
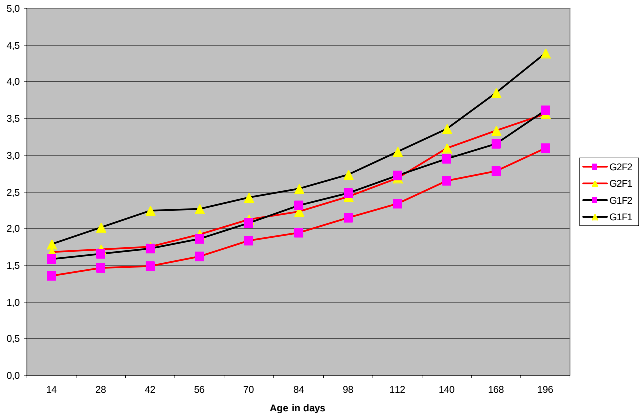


Fig. 3: FCR Females

(G1 = generation 1966, G2 = generation 2003; F1 = feed 1966, F2 = feed 2003)



Broiler Feeding Recommendations

For hot climates, the author recommends that protein levels be about 1-2 % lower than usually recommended for temperate regions because of what has been presented above. Energy levels should be adjusted to protein levels, but kept higher than currently used in many hot regions. The potassium level should be increased to 0.6 % in contrast to 0.4% normally recommended in cool climates. Levels of critical amino acids should be about 5-10% higher than normally used at the same protein level.

In many cases, straight-run broilers are fed a starter diet for the first three weeks of age; a grower diet from three to 6 weeks of age; and a finisher diet from 6 weeks to market weight. If the growth rate is depressed due to hot climate, it may be necessary to feed the grower to 7 weeks. In hot and humid climates, slight increases in dietary protein late in the broiler cycle may be beneficial for growth and feed efficiency. These increases in dietary protein are also helpful in reducing abdominal fat content.

Broilers are usually fed either crumbles or pellets. In hot climates, broilers prefer feed with larger particle size and therefore it may be beneficial to start pellet feeding earlier than usual. Intermittent feeding programs have been used in some broiler operations. This method could have possible applications in hot climates since the hours of darkness provide minimum activity on the part of the birds and therefore reduced heat production.

Fasted animals produce less heat than fed animals. Feed withdrawal has been shown to reduce heat production, leading to a decrease in body temperature and mortality of broilers (Francis *et al.,* 1991; Yalcin *et al.,* 2001). Feed withdrawal during the hottest hours of the day has therefore become a common practice in many broiler-producing areas. One suggested practice during a heat wave is not to feed between 8:00 a.m. and 8:00 p.m. Fasting will probably result in reduced weight gain, a longer growing period and thus a delay in marketing age, but also reduced mortality. Therefore the producer has to weigh the benefits of a faster growth rate vs. a greater mortality risk. Another concern about feed withdrawal is that alterations in intestinal morphology and depletion of intestinal mucosa due to fasting may reduce the integrity of the intestine (Thompson and Applegate, 2006).

Water plays an important role in cooling broilers. The cooler the drinking water, the better the birds can tolerate high environmental temperature. Growers usually provide broilers with approximately 25% more drinker space than the standard cool climate recommendation. Where possible, wide and deep drinkers, permitting not only the beak but all the face to be immersed, should be used. In case chlorinated water is being used on the farm, it is recommended to discontinue chlorination on extremely hot days.

Nutritional manipulations, such as the addition of fat and the reduction of excess protein and amino acids as described above are recommended. Birds should be fed during the cool hours of the day. Maintenance of both carbon dioxide and blood pH is critical to the heat-stressed broiler and the addition of ammonium chloride and potassium chloride to the drinking water to maintain this balance is advised. The addition of extra vitamins and electrolytes to the drinking water is helpful under most situations and the use of ascorbic acid in the feed or in the drinking water is a common practice in many hot regions of the world.

Broiler Breeder Nutrition in Hot Climates

Nutrition for meat-type breeders differs from egg-type chickens because the former tend to become obese and decline in egg production. Boren (1993) presented some basic rules on broiler breeder nutrition and pointed out that nutritional strategies in use today are to help balance the lower potential for egg production against the economic necessity of maximizing viable hatching egg production and minimizing costs. There are very few studies on the feeding of broiler breeders in hot climates. We know that males are more susceptible to heat stress than females, and that younger females experience a more severe drop in egg production when heat stressed.

Broiler breeder pullets are placed under feed restriction starting at about 14 days of age. Two methods of quantitative restriction are used for pullets. Birds can be fed either restricted amounts daily or on a skip-a-day program. For hot climates, the heat production of birds on every-day feeding is about 10% lower than those on a skip-a-day feeding (Leeson and Summers, 1991).

In cool climates, the effect of using high-protein pre-breeder rations has been studied on reproductive performance of the broiler breeder hen and the results have not always been positive. This practice, however, may be useful in certain warm regions where poor-quality protein is used and where breeder pullets may be underweight at onset of production.

The energy requirement of the broiler breeder hen is considered to be the most limiting nutrient. Rostagno and Sakamoura (1992) studied the effects of environmental temperature on feed and ME intake of broiler breeder hens. Daily feed intake, nitrogen corrected ME, and nitrogen corrected true ME decreased linearly as environmental temperature increased. Hen body weight and rectal temperature were not affected. A rise in temperature by 1° C resulted in a decrease of feed intake by 2.43 g per hen, 2.10 kcal MEn/kg body weight and 2.20 kcal TMEn/ kg body weight. Egg production, egg weight, egg mass and feed conversion were not affected by environmental temperature.

The use of vitamin supplements to improve performance of breeder flocks in hot climates has been studied by few workers. It is fairly well established that fertility in hot climates can be improved in breeder flocks by the addition of extra amounts of vitamin E if breeder rations contain the usual level of 15-20 mg/kg of diet. The addition of ascorbic acid to breeder rations of both chickens and turkeys has yielded positive responses in many cases. Supplementation of broiler breeder feeds with 300 ppm ascorbic acid during hot summers in the Eastern Mediterranean region improved performance (Cier *et al.,* 1992).

The calcium requirement of the breeder hen increases with age. Birds require slightly more phosphorous at high than at moderate or low temperatures. Breeders need a minimum daily intake of about 700 mg of total phosphorous. For breeder hens maintained in cages, the requirements of both calcium and phosphorous are significantly higher than for those kept on litter floors. The daily sodium requirement of broiler breeders has been estimated to be about 170 mg per hen (Harms, 1987).

Feed allowances for breeder hens are usually determined by egg mass output, body weight and changes in time to consume feed by the breeder. Egg mass output usually continues to increase after peak egg production has been reached. Therefore, peak feed, which is usually started from about 40 to 50 % of production, should be maintained for 3-4 weeks after maximum egg production has been reached. Changes in consumption time are good indicators of over- or underfeeding. Several stressors have been shown to affect the time required to eat the daily allowance, high environmental temperature being one of the most important. McLeod and Hocking (1993) compared two lines of breeder hens divergently selected for fatness and leanness for susceptibility to heat stress. Their results showed that fat line birds were more susceptible to heat stress; this susceptibility was not related to increased heat production, but to a decreased ability to lose heat.

Feeding broiler breeders once vs. twice daily was studied by Samara *et al.* (1996) to determine the effect of feeding time and environmental temperature on performance. High temperature caused a significant reduction in egg weight, specific gravity and shell thickness as expected. Changing the feeding time from 7:00 a.m. to 6:00 p.m. did not improve eggshell quality in heat-stressed hens.

Broiler Breeder Feeding Recommendations

The nutrition of meat-type breeders is critical in hot climates because of the feed restriction used and differences in maintenance requirements as well as quality of feeds available in many hot regions. The use of a high-protein pre-breeder ration may be useful in those areas where breeder pullets are underweight at onset of production. Broiler breeder pullets should not be severely restricted early in their life cycle in hot climates since a moderate restriction at that age is less stressful. This allows for better uniformity and proper fleshing, both of which contribute to good hatching egg production. Feed allowances for growing meat breeders should be determined on the basis of ME requirements per bird per day and these should be adjusted in relation to body weight and condition and uniformity of the pullets. Lack of uniformity may be due to insufficient feeder space and/or inadequate feed quality.

The daily energy requirement of the meat breeder hen increases from about 300 kcal ME at 20 weeks to about 400 kcal ME per bird at 28 weeks of age. This early part of the production cycle is critical, and calculations based on flock averages ignore the fact that individual needs differ between hens before and after onset of lay. Therefore, feed allowances during this period should exceed the average requirements to provide a safety margin for hens already producing. The daily protein requirement of the meat breeder has been estimated to be about 20 g per bird and less protein intake of individual birds will reduce egg weight and body weight.

A feeding program is recommended which consists of an 18% protein chick starter with 2850 kcal/kg, a 15% protein grower with 2750 kcal/kg, a 16% protein female breeder with 2750 kcal/kg and a 12% protein male breeder with 2750 kcal/kg. When it is difficult to use a specific male diet, the grower diet can be used for feeding males separately throughout the breeding period, provided that it is supplemented with the breeder vitamin and trace mineral premix rather than the grower premix.

Nutritional manipulations stated above for both broilers and broiler breeders can reduce detrimental effects of heat stress but can not fully eliminate them.

Summary

One of the most important constraints for the development of the poultry meat industry in the hot regions of the world is climate. This paper deals with certain nutritional manipulations and feeding practices that have been found to be helpful in reducing heat stress in broilers and broiler breeders. The most important factor affecting performance in broilers subjected to high temperature is reduced feed intake. High temperature accompanied by high humidity is more detrimental to broiler performance than high temperature with low humidity. Nutritional manipulations, such as the addition of fat and the reduction of excess protein are recommended. During hot periods, lower protein diets supplemented with limiting amino acids give better results than high protein diets. Responses to amino acid supplements differ with different dietary factors at high temperature; dietary electrolytes being one of them. Maintenance of both carbon dioxide and blood pH is critical to heat-stressed broilers and the addition of ammonium chloride and potassium chloride to the drinking water to maintain this balance is advised. The dietary electrolyte balance (DEB) is more critical at high temperature than at normal temperature. The addition of extra vitamins and electrolytes to the drinking water is also helpful and the use of ascorbic acid in the feed or in the drinking water has become a common practice in hot regions. Environmental temperature has an effect on carcass composition and at high temperature, meat yield, particularly breast meat is reduced.

The nutrition of meat-type breeders is critical in hot climates because of the feed restriction used and the differences in maintenance requirements and in the quality of feeds used. Broiler breeder pullets should not be severely restricted early in their life cycle in hot climates. The use of a high-protein pre-breeder ration is useful in those areas where breeder pullets are underweight at onset of production. Specific energy and protein requirements are presented in the paper for both female and male breeders in hot regions.

Nutritional manipulations used for broilers and broiler breeders are useful in reducing the detrimental effects of high environmental temperatures, but what is more effective is controlling house temperature such as the use of environment controlled housing.

Zusammenfassung

Richtige Ernährung von Broilern und Broilerelterntieren als Beitrag zur Minimierung von Hitzestress

Der wirtschaftliche Erfolg der Haltung von Broilern und Broilerelterntieren hängt in vielen Regionen vom Klima bzw. der Effektivität von Maßnahmen zur Optimierung der Stalltemperatur ab. Diese Arbeit gibt einen Überblick über bewährte Praktiken der Futteroptimierung und Fütterungstechnik an heißen Standorten bzw. bei saisonal erhöhten Temperaturen.

Broiler reagieren auf hohe Stalltemperatur vor allem durch reduzierte Futteraufnahme, vor allem bei gleichzeitig hoher Luftfeuchtigkeit. Um die dadurch verringerte Nährstoffaufnahme auszugleichen, sollte man das Futter durch Fettzusatz energiereicher machen, den Proteingehalt absenken und limitierende Aminosäuren entsprechend erhöhen.

Die Wirkung erhöhter Aminosäurengehalte hängt von verschiedenen Faktoren ab, u.a. von den Elektrolyten im Futter. Der Zusatz von NH4Cl und KCl zum Trinkwasser ist zu empfehlen, um einen ausgeglichenen CO_2 Gehalt und pH-Wert im Blut der Broiler bei Hitze zu unterstützen. Ausgewogene Elektrolyten sind bei hohen Stalltemperaturen wichtiger als im optimalen Temperaturbereich. Erhöhte Vitaminzusätze im Futter und Elektrolyten im Trinkwasser sind zu empfehlen, Ascorbinsäure wird üblicherweise in heißen Regionen im Futter oder Wasser zugesetzt.

Erhöhte Temperaturen wirken sich auf die Schlachtkörperzusammensetzung aus: unter Hitze leidet der Ausschlachtungsgrad, und vor allem der Anteil Brustfleisch ist niedriger als bei optimaler Stalltemperatur.

Die richtige Fütterung von Broilerelterntieren ist eine besondere Herausforderung im heißen Klima wegen der notwendigen und üblichen Mengenbegrenzung. Während der Aufzucht sollten Mastelterntiere nicht zu scharf im Futterverzehr begrenzt werden. Wenn die Junghennen bei Legebeginn untergewichtig sind, sollte eine proteinreiche Prestarter Ration gefüttert werden. Detaillierte Empfehlungen für den Energie- und Proteingehalt im Futter für Hennen und Hähne in heißen Regionen werden gegeben.

Angepasste Ernährung von Broilern und Mastelterntieren ist eine sinnvolle Maßnahme, um den Hitzestress zu mildern, es ist jedoch kein Ersatz für die noch wichtigeren Maßnahmen zur Kontrolle der Stalltemperatur.

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