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Research Article
Ability of Yeast Based Post Biotic to Alleviate the Negative Effects of Broilers Exposed to Prolonged Heat Stress

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Abstract

Background and Objective: The use of feed additives to mitigate the detrimental effects of heat stress is a method beyond environmental management that may be a useful tool in poultry production. A study was conducted to evaluate the effect of a yeast-based postbiotic product's ability to reduce the detrimental effects of prolonged heat stress on performance and yield of broiler chickens. **Materials and Methods:** Day-old Cobb 708 male broiler chicks were randomly allocated to one of two dietary treatments: T1, control (CON); T2, yeast-based postbiotic product (YPB, 0.45 kg/MT all phases). From day 28-35 ventilation was reduced to increase litter temperatures to 29-32°C for 16 hrs a day. Ventilation was returned to normal 2 hrs before lights off until 2 hrs after lights on, for a total of 8 hrs a day. All birds were weighed on d14, 28, 35 and 42 to obtain performance parameters: Body weight (BW), feed consumption (FC) and feed conversion ratio (FCR). On d43, five birds of a pen were processed to determine carcass, breast, tenderloin and leg quarter weights and yield. **Results:** Differences ($p>0.05$) in bird weights were observed until d42 at that time YPB treatment weighed more ($p<0.05$) than the CON treatment. At end of the trial, the YPB treatment also had lower ($p<0.05$) FCR than CON treatment. No differences ($p>0.05$) were observed in uniformity of pen weights or carcass part weights or yield. **Conclusion:** The results demonstrated that supplementing broiler diets with YPB can alleviate the detrimental effects of prolonged heat stress on growth and FCR. Utilizing such a product in the feed could mitigate extreme final losses caused by heat stress and improve animal health and welfare.

Key words: Postbiotic, heat stress, broiler chicken, growth, carcass

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

One of the greatest stressors and risks to broiler production is heat stress. Extreme temperatures can have catastrophic effects on the production goals and the welfare status of a flock. When extreme changes in housing environmental temperatures or even those that exceed the thermoneutral zone it can result in distress which will activate the hypothalamic-pituitary-adrenal axis (HPA) increasing plasma corticosterone levels[1-4] in the blood. When exposed to heat stress, increased concentrations of reactive oxygen species (ROS) are observed which leads to increased intestinal permeability. This can lead to an increase in pathogenic bacteria in the intestinal tract[5]. Stressful conditions can lead to increased mortality, decreased feed intake, lower body weight, decreased feed conversion and decreased meat quality[6,7] all of which are detrimental to profitability and animal welfare. Furthermore, heat stress can negatively affect meat quality by altering fat deposition within meat in broiler chickens[8]. Heat stress can alter the proportion of breast meat to thigh meat[9]. Zhang *et al.*[9] also concluded that heat-stressed birds produced meat with lower protein content and higher fat deposition.

The inclusion of postbiotic metabolites from fermentation with *Saccharomyces cerevisiae* either in the feed or water have been shown to be beneficial in reducing the negative effects onset by exposure to acute heat stress[10-15]. The inclusion of these metabolites has shown positive effects on gut health by increasing villus length along with villus/crypt ratio in heat-stressed Pekin ducks, allowing for increased nutrient absorption[11]. Other species have also observed positive impacts by feeding products containing postbiotic metabolites from fermentation with *Saccharomyces cerevisiae.* Nde *et al.*[16] observed increased feed intake and feed efficiency in sheep and Ponce *et al.*[17] observed positive effects on heifer performance during heat stress.

This experiment was conducted to determine if a post biotic product that utilizes fermentation with *Saccharomyces cerevisiae* could alleviate the detrimental effects of heat stress on growth, FCR and yield in broiler chickens exposed to prolonged heat stress during the late stages of growth. It is hypothesized that the supplementation of these compounds into broiler diets will decrease the heat stress susceptibility of broilers reared under heat stress improving their growth, FCR and yield.

MATERIALS AND METHODS

Study area: The study was conducted in July and August, 2022 at the Department of Poultry Science, Teaching, Research and Extension Center, Texas A&M University, Texas, United States. The area is located at Latitude 30°N and Longitude 96°W and an Altitude of 100 m above sea level.

Animal husbandry, diet and experimental design: All procedures were carried out in accordance with the guidelines established by the Texas A&M Institutional Animal Care and Use Committee (AUP # IACUC 2019-0056) and the birds were managed according to the guidelines described in the Guide for the Care and Use of Agricultural Animals in Research and Teaching[18]. For the experiment, Ross 708 male broilers were acquired from a commercial hatchery (n = 960). At placement, all chicks were vaccinated with a Coccidiosis vaccine (COCCIVAC-B52, Merck) and then were randomly allocated to one of 24 pens, measuring 0.9×1.8 m. Treatments can be found in Table 1.

All birds were provided with *ad libitum* access to both feed and water throughout the duration of the project. The birds were fed a three-phase diet consisting of a starter (d1-14, crumble), grower (d15-28, pellet) and finisher (d29-42, pellet) and diets were mixed at the Texas A&M Poultry Research Center Feed Mill.

The barn was equipped with LED lights throughout. A photoperiod of 24 L: 0D was maintained until 10 days of age and then reduced to 20 L: 4D for the remainder of the study. Barn temperature was set to 35°C for 7 days and was then decreased to 31°C for 8 days after the arrival of chicks. Week 2 house temperatures were maintained at 29°C. Beginning at week 2, barn temperature was decreased by 5°C each week until ambient temperature of approximately 23°C was met. From day 28-35 ventilation was reduced to increase litter temperatures to 29-32°C for 16 hrs a day. Ventilation was returned to normal 2 hrs before lights off until 2 hrs after lights on, for a total of 8 hrs a day. The final week ventilation was returned to normal.

Performance parameters: Mortalities were collected and weighed daily so that feed conversion could be adjusted. At feed phase changes pen weights were recorded and on d35, 42 individual birds were weighed. Feed addition was recorded and the remaining feed was weighed on feed phase transition days so that the total feed intake could be calculated. The feed conversion ratio (FCR) was calculated by dividing the total feed intake per pen by the total body weight gain per pen and corrected for mortality weights.

Table 1: Treatment description including abbreviation and inclusion rates used in the study

Treatment	Treatment details
Control (CON)	Standard diet all diet phases
Yeast based postbiotic (YPB)	0.45 kg/metric ton in all diet phases

Uniformity was determined on d35 and 42 by two methods. First, by calculating the coefficient of variation (% CV). Secondly, by calculating the percent of individual weights that occur outside of 10% of the pen average. At the conclusion of the study, on d43, five birds per pen were processed and carcass and part weights and yield were determined.

Statistical analysis: All data was analyzed via one-way ANOVA using the GLM model (Minitab software) with treatment means deemed significantly different at $p \leq 0.05$. Treatment means that were determined to be significant were further separated using Fisher LSD test.

RESULTS

Body weight: Body weight data is presented in Table 2. There were no differences in body weight observed between treatments at d14 or 35 (p>0.05). At d28, the CON treatment weighed more (1.80 kg) than the YPB treatment (1.71 kg, p = 0.02). At the conclusion of the study on d42, the YPB treatment weighed more (2.72 kg) than the CON treatment (2.54 kg, p = 0.02).

Feed conversion ratio: Feed conversion ratio (FCR) data is presented in Table 3. There were no differences (p>0.05) observed between treatments on d0-14 or d0-28. There were differences (p<0.05) between treatments observed in d0-35 FCR. The YPB treatment had a lower (1.58, p = 0.03) FCR than the CON treatment (1.66) at the d35 timepoint. The YPB treatment had a lower (1.63, p<0.001) FCR compared to CON treatment (1.80) at the d42 timepoint.

Uniformity and coefficient of variance: Uniformity Score and coefficient of variance (CV)data are presented in Table 4. There were no observed differences (p>0.05) between treatments in uniformity percentage at d35 or d42.

Processing weight: Final processed weights can be observed in Table 5. No differences between treatments were observed in WOG, breast, leg, tender or wing weight (p>0.05).

Processing yield: Yield of breast, leg and tenderloin to carcass weight are presented in Table 6. There were no differences (p>0.05) observed between treatments on processing yield percentages.

Table 2: Average bird weight (kg) of broilers fed control (CON) diet or diet containing a yeast based postbiotic (YPB)

Treatment	d14 wt	d28 wt	d35 wt	d42 wt
CON	0.56	1.80	2.13	2.54
YPB	0.56	1.71	2.18	2.72
SEM	0.003	0.007	0.012	0.021
p-value	0.98	0.02	0.14	0.02

wt: Weight

Table 3: Feed conversion ratio (FCR) of broilers fed control (CON) diet or diet containing a yeast based postbiotic (YPB)

Treatment	FCR (0-14)	FCR (0-28)	FCR (0-35)	FCR (0-42)
CON	1.10	1.42	1.66	1.80
YPB	1.10	1.43	1.58	1.63
SEM	0.004	0.006	0.007	0.009
p-value	0.95	0.27	0.03	<0.001

Table 4: Uniformity score and coefficient of variance (%) of broilers fed control (CON) diet or diet containing a yeast based postbiotic (YPB)

Treatment	Uniformity (d35)	CV (d35)	Uniformity (d42)	CV (d42)
CON	74.65	9.45	68.18	10.65
YPB	77.63	8.96	70.54	9.82
SEM	1.19	0.23	1.16	0.23
p-value	0.27	0.47	0.54	0.21

Table 5: Processing part weights (kg) of broilers fed control (CON) diet or diet containing a yeast based postbiotic (YPB)

Treatment	WOG weight	Breast weight	Leg weight	Tender weight	Wing weight
CON	2.05	0.54	0.11	0.67	0.22
YPB	2.05	0.54	0.10	0.66	0.22
SEM	0.01	0.004	0.002	0.003	0.001
P-value	0.94	0.67	0.69	0.49	0.25

WOG: Weight of carcass without giblets

Table 6: Processing yield (%) of broilers fed control (CON) diet or diet containing a yeast based postbiotic (YPB)

Treatment	WOG yield	Breast yield	Leg yield	Tender yield	Wing yield
CON	77.82	25.62	5.05	32.32	11.33
YPB	77.77	25.43	5.02	31.67	11.16
SEM	0.10	0.16	0.11	0.13	0.11
P-value	0.81	0.41	0.58	0.32	0.11

WOG: Weight of carcass without giblets

DISCUSSION

The heat stress in this current study lasted from d28-35 and this caused an effect on final bird weights and FCR in the CON treatment but the YPB was able to mitigate those negative effects. At the end of the study, all supplemented birds weighed more than the control birds illustrating that the supplementation mitigated the effects of the heat stress. The results of this current study conformed similarly to previous research by Sobotik *et al.*[15], which observed that birds fed a YPB produced increased body weights and reduced FCR following a short-term heat stress. Haldar *et al.*[19] also saw increased body weights and improved FCR of heat-stressed broiler fed similar products. However, this current study is the first to examine utilizing YPB to alleviate long-term heat stress effects. Additionally, following the heat stress period the YPB birds had better FCR and this continued through the end of the grow-out period. The improved body weights and FCR following the heat stress demonstrated that the YPB allowed birds to withstand the heat stress. This could be related to the ability of these products to stimulate digestive enzymes resulting in improved immune response and as a result, improved performance[20]. The previously observed reduction in stress susceptibility[10-15] when broilers consume postbiotic metabolites could also have contributed to the improved weights and FCR despite the week-long heat stress they experienced. Either of these possibilities or a combination of them could be the cause but further research is needed to confirm.

No differences in part weights or yield were observed but this could be related to the fact the biggest birds were not selected to be processed but the median birds. This was done to equalize things but this may have removed the part weight advantage supplemented birds should have had due to larger overall average live weights at d42. If all birds had been processed, then maybe this effect would have been detected but that requires future research.

The livestock/poultry industry has reported $2.4 billion in annual economic loss as a result of heat stress[21]. Heat stress occurs as a result of animals being reared in conditions that are beyond the animal's thermal neutral zone. Losses observed from heat stress can be seen through increased mortality and decreased performance and reproduction. Individual animals react differently to stress as stress can alter animals physiologically, physically, or chemically[22]. Because of this, it can be hypothesized that a flock of broilers subjected to heat stress will have difficulty maintaining group homeostasis resulting not only in production losses but flock uniformity. Utilizing postbiotic metabolites has been shown to improve production[16,17] and reduce stress susceptibility[10-15]. Therefore, it was thought that providing these compounds during a grow-out with a prolonged heat stress period would mitigate the negative effects. The results of this current study demonstrated for the first time that a YPB could help mitigate the effects of long-term cyclic heat stress. All previous studies have only looked at acute heat stress or the lack of any stressor.

Mitigating the effects of heat stress is a constant challenge in the poultry industry. Extreme ambient temperatures have the ability to compromise the immune systems of broilers and increase susceptibility to disease which can alter growth rate[23]. The effects of postbiotic metabolite products in this study have been strongly demonstrated to improve the performance of broilers subjected to heat stress.

CONCLUSION

It has been demonstrated from this study that chickens supplemented with YPB during prolonged periods of heat stress had better growth and feed efficiency than those not supplemented. While there was no effect on yield or bird uniformity it was concluded that this YPB could be used to mitigate the negative effects of prolonged heat stress on broiler performance. Thus, it can be used to reduce economic losses and improve bird welfare during times of prolonged heat stress. Utilizing this post biotic in poultry feed during heat stress is a possible tool for producers to reach these goals.

SIGNIFICANCE STATEMENT

The goal of this study was to determine if a yeast based post biotic could be used to mitigate the effects of prolonged heat stress in broiler chickens. Previous studies have demonstrated that this post biotic reduced stress susceptibility to acute and typical production stressors, however, it was unknown if it would be effective during prolonged heat stress. The results of this current study indicate that this post biotic could be used to mitigate the production losses observed as a result of prolonged heat stress. This not only demonstrates the use of this post biotic as a means to lessen economic losses but also improves bird health and overall welfare.

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