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Effect of *Salix babylonica, Populus nigra* and *Eucalyptus camaldulensis* Extracts in Drinking Water on Performance and Heat Tolerance of Broiler Chickens During Heat Stress

Abdur-Rahman Al-Fataftah and Anas Abdelqader

Department of Animal Production,
Faculty of Agriculture, the University of Jordan, Amman 11942, Jordan

Abstract: The effects of some plant extracts which had antipyretic property and synthetic acetylsalicylic acid were studied. Broiler chicks were grown to 35 days of age under normal conditions, then placed in environmental chambers maintained under constant heat stress (35 ºC) conditions for three weeks. During the period of heat stress exposure, birds were allocated into 5 treatments with 30 birds per treatment. Treatment 1 was provided with 100 ml/day of *Salix babylonica* extract, Treatment 2 was provided with 100 ml/day of *Populus nigra* extract, Treatment 3 was provided with 100 ml/day of *Eucalyptus camaldulensis* extract, Treatment 4 was provided with 100 ml/day of 0.1% acetylsalicylic acid solution. Treatment 5 was provided with blank water (the control group). The experiment was conducted for 3 weeks during the period from April 21 to May 11. Treatments provided with extracts of *Salix babylonica* and *Populus nigra* showed similar performance and heat tolerance to that provided with acetylsalicylic acid but higher than that exhibited by the control group. Treatment provided with *Eucalyptus camaldulensis* exhibited lower ($P<0.05$) performance and heat tolerance than *Salix babylonica* and *Populus nigra* treatments but higher ($P<0.05$) than the control. The maximum heat stress mortality was observed in the control group (33.3%) while the minimum heat stress mortality was observed in the *Salix babylonica* group (14.4%), with no significant differences between acetylsalicylic acid, *Salix babylonica* and *Populus nigra* groups. In conclusion, *Salix babylonica* and *Populus nigra* leaf extracts improved heat tolerance, feed intake, body gain, feed conversion rate and reduced mortality of heat stressed broilers. Extracts of *Salix babylonica* and *Populus nigra* leafs can be used as a natural alternative to replace the synthetic acetylsalicylic acid and control body temperature of heat stressed broiler chickens.

Key words: Salix · Populus · Eucalyptus · Heat Stress · Broiler Chicken

INTRODUCTION

Heat stress is one of the main limiting factors of production efficiency in hot regions [1]. It is well documented that heat stress affects performance of broiler chickens. High ambient temperatures depress feed intake, body growth and feed efficiency [2]. Cooling poultry buildings is very expensive. Therefore different approaches were employed to alleviate the effect of high environmental temperature on broiler performance, for example, the use of different feed additives like sodium chloride [3]; carbonated drinking water [4], ascorbic acid [5], potassium chloride [6] and acetylsalicylic acid [7]. However, there is a growing demand on using animal products free of chemical residues and synthetic pharmaceuticals. Phytogenic feed additives have been gaining considerable attention in livestock feeding in the last few years, particularly after the European ban on many synthetic pharmaceuticals [8]. To achieve this goal, similarly to organic agriculture, the animal feed industries have to reduce the application of synthetic chemicals and turn towards the more healthy natural ways and means of production for which phytogenic feed additives can offer a solution. Phytogenic feed additives are of plant origin, as compared to synthetic feed additives, have the advantage that they are readily accepted by the consumers since they are considered to be safe and not a 'chemical'. One promising alternative method is the supplementation of the diet with natural plant extracts that contain bioactive compound that reduce the negative

Corresponding Author: Abdur-Rahman Al-Fataftah, Department of Animal Production, Faculty of Agriculture, University of Jordan, Amman 11942, Jordan. Tel: +962 65355000.

impacts of heat stress on broiler performance. Acetylsalicylic acid (Aspirin) is a well known antipyretic drug, which inhibits prostaglandin synthesis and "resets the hypothalamic thermostat" [9]. Recent works showed that synthetic acetylsalicylic acid improved the productive and reproductive performance of different poultry species [7, 10, 11]. Different trees from the family *Salicaceae* have abundant watery leafs which is heavily charged with acetylsalicylic acid [12].Therefore, the objective of the present study was to determine if adding the extracts of leafs obtained from three species of trees or synthetic acetylsalicylic acid to heat stressed broilers would improve heat tolerance and increase overall performance.

MATERIALS AND METHODS

Leafs Extracts: Leafs of three trees species were collected from healthy trees grown in Zai Natural parks, Jordan. The trees species were *Salix babylonica, Populus nigra and Eucalyptus camaldulensis*. The leafs were dried at room temperature (20±2 °C) for 3 days. The dried leafs were ground to 5 mm size particles. From each species, 250 g of ground leafs were mixed with 5 litters of hot water (1:5 w:v). The mixtures were placed in sealed glass bottles at room temperature for 24 hours. The mixtures were then filtered through #1 Whatman filter paper. The resulted extracts were individually mixed with drinking water to produce a final concentration of 5 ml extract/100 ml water for each species.

Birds Management and Experimental Design: This experiment was conducted at the Environment and Animal Physiology Lab, Faculty of Agriculture, The University of Jordan. One-day-old Arbor Acres broiler chicks were obtained from a commercial hatchery and reared under routine management practice. At 35 d of age, birds were allocated into 5 treatment groups of 30 birds per treatment. Treatment groups were moved to climate-controlled chambers equipped with metal slatted battery cages. Each bird was tagged, kept in individual cage (dimensions: 37×30×40 cm) and provided with feeder and a cup drinker. Birds were kept at the climate-controlled chambers under ambient temperature of 35±2 ºC and 55±2 % RH. Throughout the experimental period, Treatment 1 was provided with 100 ml/day of *Salix babylonica* extract, Treatment 2 was provided with 100 ml/day of *Populus nigra* extract, Treatment 3 was provided with 100 ml/day of *Eucalyptus camaldulensis* extract, Treatment 4 was provided with 100 ml/day of 0.1% salicylic acid solution. Treatment 5 was provided with blank water (the control group). The experiment was conducted for 3 weeks during the period from April 21 to May 11, 1988. The heat tolerance of all treatments was evaluated under heat stress conditions by daily measurements of rectal temperature, respiratory rate (panting), mortality, feed intake and body weight gain. Standard grower and finisher rations based on maize and soybean meal were balanced to meet the nutrient requirements for broiler chickens [13] and offered ad libitum.

Measurements: Body weight and average daily feed intake were measured for each bird every morning at 08:00. Rectal temperature was measured 3 times a day at 09:00, 12:00 and 16:00. Rectal temperature was calculated and expressed as the average of daily measured rectal temperatures. A digital thermometer (±0.01 °C accuracy) was used to measure rectal temperature that was connected to a very fine probe and inserted for a distance of 3 cm inside the rectum of each bird. Respiratory rate (RR) was visually monitored 3 times a day at 10:00, 13:00 and 17:00 by counting number of breathes per minute depending on shank movement. Mortality was recorded in each treatment throughout the experimental period. Air velocity was not controlled, but daily periodical measurements at different sites around birds indicated that it did not exceed 0.15 m/s.

Statistical Analysis: The effects of different treatments on rectal temperature, respiratory rate, mortality, feed intake, body weight gain and feed conversion were analysed with one-way Anova implemented in the proc GLM procedure of SAS. All the statistical analyses were performed with SAS [14]. Mortality data were transformed by using a natural logarithm (ln) function [ln(y)= Log(y+10)] to correct heterogeneity of variance and produce an approximately normally distributed data set. When significant treatment effects were noted, differences among treatments were separated by Duncan's multiple-range test. The accepted level for significance was $P = 0.05$.

RESULTUS AND DISSCUSSIONS

The results of the present investigations indicated that the performance of heat stress broiler birds (the control) is significantly ($P<0.05$) impaired by exposure to high ambient temperature of 35ºC (Table 1). However, providing acetylsalicylic acid had significantly ($P<0.05$) improved the performance and heat tolerance of heat

Table 1: Performance and physiological parameters measured on broiler birds during the experimental period.

	Treatments				
Parameters	*Salix babylonica*	*Populus nigra*	*Eucalyptus camaldulensis*	Acetyl-salicylic acid	Control (blank water)
Final body weight (g)	1575.3±41[a]	1437.7±43[a]	1257.0±22[b]	1574.0±39[a]	1209.7±33[c]
Average daily gain (g/day)	99.1±18[a]	91.4±13[a]	82.0±16[b]	98.7±19[a]	74.6±11[c]
Average daily feed intake (g/day)	197.4±22[a]	194.2±29[a]	190.4±21[b]	198.3±27[a]	185.6±24[c]
Feed conversion ratio (kg feed/kg body weight)	2.0±0.82[c]	2.1±0.82[c]	2.3±0.82[b]	2.0±0.82[c]	2.5±0.82[a]
Rectal temperature (°C)	41.2±2.7[c]	41.4±2.2[c]	42.3±1.9[b]	41.2±2.4[c]	43.2±2.1[a]
Panting rate (breath/minute)	102.2±11[c]	107.5±16[c]	119.6±8[b]	98.3±14[c]	137.1±18[a]
Mortality (%)	14.4±1.3[c]	16.5±1.1[c]	24.8±1.7[b]	16.7±1.4[c]	33.3±2.8[a]

[a,b,c] Means±standard errors of the means (SE) in the same row with different superscripts are significantly different, (Duncan, P<0.05).

stressed birds under hot conditions as compared to the control. The most interesting results of this experiment was that performance and heat tolerance of treatments provided with extracts of *Salix babylonica* and *Populus nigra* were similar to that of treatment provided by acetylsalicylic acid. This indicated that the bioactive compounds in these extracts perform similar function to that of acetylsalicylic acid. However, treatment provided with *Eucalyptus camaldulensis* exhibited lower (P<0.05) performance and heat tolerance than *Salix babylonica* and *Populus nigra* treatments but higher (P<0.05) than the blank water treatment (control). Broiler birds provided with acetylsalicylic acid, *Salix babylonica* and *Populus nigra* exhibited the maximum final body weight and average daily gain compared with other groups. The acetylsalicylic acid, *Salix babylonica* and *Populus nigra* treatment appeared to suffer the heat stress conditions less than other treated groups, as these treatments showed lower rectal temperatures and respiratory rates than other groups. This also was reflected on heat stress mortality as the acetylsalicylic acid, *Salix babylonica* and *Populus nigra* treated groups showed the least mortality during the period of exposure to heat stress conditions. The *Eucalyptus camaldulensis* treated birds showed higher performance and heat tolerance potentials than the control group but lower than that exhibited by acetylsalicylic acid, *Salix babylonica* and *Populus nigra* groups. It is obvious in the current investigation that the heat stressed birds could increase their daily feed intake upon supplementation with acetylsalicylic acid, *Salix babylonica* and *Populus nigra* compared with other groups (Table 1). It clear also that daily weight gain and feed conversion improved in these groups which were reflected on the higher and final body weight compared to other groups. The rate of weight gain of meat-type chickens has increased significantly due to intensive genetic selection of fast-growing broiler chickens [15]. High growth rates are associated with high metabolic heat production. However, adjusting physiological systems that support energy balance and heat tolerance were not considered among selection factors in breeding programs. Broilers consume large quantities of feed in order to attain maximal growth rate. However, the intake and metabolism of feed have thermogenic effects and at high ambient temperatures this heat increment aggravates the problem by adding more heat to the already-heat-stressed birds. The bird, therefore, reacts by lowering its voluntary feed intake and its metabolic rate. This explains the poor feed conversion efficiency and body growth of blank water group compared with other treatment groups. Under these circumstances, supplemental extracts of *Salix babylonica* and *Populus nigra* offers the potential to control body temperature and thus stimulate body growth and feed efficiency under heat stress conditions.

In our experimental conditions, it is apparent that *Salix babylonica* and *Populus nigra* supplementation offers a feasible way to reduce the losses in body growth, feed efficiency and mortality due to heat stress. This was explained by the improved heat tolerance as indicted by the efficient control of body temperature and lower panting under hot conditions. A likely mechanism for the antipyretic activity of *Salix babylonica* and *Populus nigra* is due to its content of natural salicylates which has inhibitory effect on prostaglandin synthesis [12]. The *Salix babylonica* treated bird exhibited higher body weight and average daily gain than the acetylsalicylic acid group. In the same trend the *Salix babylonica* showed lower body temperature, panting rate and mortality rate than acetylsalicylic acid group. These differences were numerically but not statistically different. However, this trend in variation may indicated that using synthetic acetylsalicylic acid as a feed additive to improve heat tolerance under heat stress conditions might not be efficient like using the whole extract of *Salix babylonica*

due to the potential influence of other bioactive components in *Salix babylonica*, which may modulate the major component and exert an additional activity. Furthermore, these bioactive components may work together in a synergism action. The antipyretic property of *Salix babylonica* and *Populus nigra* represents a promising alternative solution to replace synthetic pharmaceuticals and thus avoid chemical residues. This would be of great importance for peri-urban poultry produced in free-range or organic farming systems which will contribute in sustainable agriculture. Furthermore, the active principles in plants are diverse and stable natural compounds with low molecular weight which can prevent the occurrence of toxicity. Salicylate, as an example of phenolic compounds, has been shown to perform low oral toxicity (LD50 > 1000 mg/kg) and has been generally recognized as safe [16]. Therefore, the used doses of *Salix babylonica* and *Populus nigra* in this study had no negative effects on performance. These results agree with observations of Oluyemi and Adebanjo and Al-Mashhadani *et al*., [17, 18] who noted that adding acetylsalicylic acid to the diet (from 0.05 to 0.3%) resulted in increased body weight. Our finding of the influence of acetylsalicylic acid on body temperature confirms other previous studies. The positive effects of adding acetylsalicylic acid to drinking water during summer season on improving laying hens performance and enhancing the physiological responses was also confirmed [11]. The beneficial effect of supplemental acetylsalicylic acids in the maintenance of body temperature under heat stress conditions has also been reported in Japanese quail [7].

CONCLUSION

The present results suggest that *Salix babylonica* and *Populus nigra* leaf extracts improved heat tolerance, feed intake, body gain, feed conversion rate and reduced mortality of heat stressed broilers. Extracts of *Salix babylonica* and *Populus nigra* can be used as a natural alternative to replace the synthetic acetylsalicylic acid. However, further investigations are needed to determine proper doses and their mode of action under different productions systems.

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