Summary of my PhD Dissertation

Title: Comparative studies on performance and physiological responses of Ethiopian indigenous (Angete-Melata) chickens and their F1-crosses to long-term heat exposure

Two different experiments were conducted under two temperature regimens (warm: 30-32 °C; normal: 18-20 °C) at Martin-Luther University Halle-Wittenberg, Germany between April 1997 and September 1999. The objectives of the first experiment were to identify layer chicken breeds with better performance under heat stress conditions and to test the suitability of physiological parameters as indicator of chronic heat stress. To this effect, a total of 240 female chickens consisting of the Lohmann Brown (LB), Lohmann White (LW), New Hampshire (NH), White Leghorn selected for improved feed efficiency (LW-FE) and White Leghorn with dwarf gene (WL-dw) were randomly divided into control (normal temperature) and experimental (warm temperature) groups and tested up to 56 weeks of age. Finally, on the basis of their performance and adaptability to heat exposure, both LW and NH breeds among the five chicken breeds were identified and eventually crossed with male cocks of Angete-Melata (Na) chicken breed to produce the F1 crossbred chickens (experiment 2). To this effect, fertile eggs of Angete Melata chicken breeds were collected from Ethiopia and transported to Germany where they were incubated and hatched. Consequently, a total of five genotypes were produced including the two F1 crosses and the three pure breeds. In experiment 2, a total of 240 female chickens consisting of 5 genotypes [LW, NH, Na, LWxNa and NHxNa) were randomly divided into control (18-20 ^{0}C) and experimental groups (30-32 ^{0}C) and tested under two ambient temperatures up 68 weeks of age. The objectives of the 2nd experiment were to investigate the productive adaptability of the F$_1$ crosses; to identify suitable crossbreed combinations for improved performance; and to test the suitability of various physiological parameters as indicators of heat stress.

The following most common physiological heat stress indicators were determined: the activities of enzymes [Creatin Kinase (CK), Alanine Aminotransferase (ALAT), Aspartate Aminotransferase (ASAT), Lactate Dehydrogenase (LDH)]; the levels of hormones (T$_3$ and corticosterone) in plasma; differential leucocyte counts in chicken's blood; and level of heat-shock protein 70 (HSP70) in mononuclear blood cells. Moreover, performance traits and egg quality traits were thoroughly investigated.

The main results of the study can be summarized as follows:

1. In the first phase experiment, the average depression due to heat stress in egg shell quality was lower for LW, WL-dw and NH chicken breeds, but larger for LB and FE chicken breeds. Despite considerable losses in some performance traits due to heat stress, the LW breed with the highest performance index proved to be the best line under heat stress conditions. Moreover, the NH breed demonstrated low heat stress response in egg weight, egg mass, feed intake and feed efficiency which indicates improved tolerance against chronic heat exposure.

2. In general, the effect of heat exposure on sexual maturity was not significant, except for local chicken. Age at sexual maturity for F_1 crosses was considerably earlier than Angete-Melata breed but same as to the average of standard chicken breeds.

3. The body weight of F_1 crosses in warm environment was generally larger than Angete-Melata and closer to the average of standard chicken breeds.

4. Percentage hen-day and hen-housed egg production as well as total egg number of F_1 crosses did not differ significantly from control group. The effect of heat stress on daily egg mass output was generally significant except for Angete-Melata and their crosses with LW genotypes.

5. The F_1 crosses at high temperature were superior to local chickens for body weight, egg production, egg mass output, egg weight and feed efficiency. Long-term heat stress did not significantly affect feed efficiency.

6. Some egg shell quality traits (deformation, breaking strength, shell thickness, percentage shell and egg specific gravity) in heat stressed F_1 crosses did not differ significantly from control group. On the contrary, the effect of heat stress on the egg shell quality traits of standard chicken breeds was most of the cases highly significant. Shell thickness, breaking strength, shell percentage and deformation for F_1 crosses improved considerably compared to the average of standard chicken breeds under heat stress conditions.

7. The NaxLW cross in warm environment was superior to NaxNH for egg fertility, hatchability, egg weight, age at sexual maturity, body weight at 20th weeks old and daily egg mass out put. The NaxLW cross was also better than NaxNH in some shell quality as well as albumen and yolk quality traits with lower mortality during the laying period.

8. The average depression in thyroid gland hormone triiodothyronine (T_3) concentration due to heat stress was higher for experiment 1 but lower for experiment 2. The lower rate of T_3 is due to the inclusion of the local Na and its F_1 crosses in the latter experiment. The Na

local chicken in warm environment showed the highest corticosterone level followed by NH and NaxNH genotypes. An elevated level of plasma corticosterone was found during the peak egg production between 22 and 38 weeks of age and declined thereafter. The heterophil/lymphocyte (H/L) ratio and basophils increased as a result of heat stress in NH and NaxNH genotypes, whereas the monocytes increased in Na and LW genotypes.

9. The CK activity was higher in both experiments just after sexual maturity. The plasma activities of ALAT, ASAT, CK and LDH were generally higher for WL-dw and local Na genotypes exposed to long-term heat stress. Similar tendency was also noted in T_3 concentration, being the lowest for both WL-dw and Na genotypes.

10. The HSP70 level increased due to heat stress in NaxNH crosses. The HSP70 level notably increased at 51 and 65 weeks of age and was exceptionally higher for all genotypes at the latter age. The total HSP70 was also variable between genotypes with different genetic back grounds.

11. The correlation between performance traits (except sexual maturity) and some enzymes showed an inverse relationship. Conversely, the relationship of performance with T_3 was positive. A positive relationship was also noted between T_3 and feed intake. A negative correlation of HSP70 with feed intake, feed efficiency and body weight was found.