

**GENETIC STUDIES FOR DETERMINING GENES
RESPONSIBLE FOR HEAT TOLERANCE IN
SOME LOCAL STRAINS OF CHICKEN**

By

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B. Sc. Agric. Sc. (poultry production), Ain Shams University, 2013

A Thesis Submitted in Partial Fulfillment

Of

The Requirements for the Degree of

**MASTER OF SCIENCE
in**

**Agricultural science
(Poultry Breeding)**

**Department of poultry production
Faculty of Agriculture
Ain Shams University**

2018

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ABSTRACT

HABIBA HASSAN REZK. Genetic Studies for Determining Genes Responsible for Heat Tolerance in some Local strains of Chicken. Unpublished Master of Science dissertation, Ain Shams University, Faculty of Agriculture, Department of Poultry Production, Egypt, 2014.

This experiment was designed to evaluate some productive traits of some local breeds (Fayoumi, Dandarawi and Sinai) under heat stress condition, It is important in genetic studies in order to determining genes responsible for heat tolerance to local strains of chicken and estimated relationship between heat tolerance and gene expression of heat shock protein for three Egyptian strains before and after introducing Naked neck gene. And also to compare some productive traits for three local strains under heat stress conditions.

Main results could be summarized as follows:

- Growth characteristics (mainly body weight and body measurement) indicated that Fayoumi breed recorded significantly heaviest body weight and higher body measurements at different ages in this study compared to Sinai and Dandarawi ones in parent stock. After, introducing the Na genes the results indicated that the heterozygous Naked neck genotypes (Fayoumi and Sinai) had significantly heavier body weights compared with residual genotype at 2,4 and 6 weeks of age. it could be noticed that normal Fayoumi and heterozygote naked neck Fayoumi genotypes had increased body measurements at 4 weeks of age.
- Maturation characters (body weight and body measurements) showed that Sinai female reached sexual maturity earlier than Fayoumi and Dandarawi breed by about 3 days, but the

difference was not significantly between breeds. However, found that Fayoumi breed was high significant keel length trait compared to Dandarwi and Sinai breeds. But, and that Sinai breed was significant in shank length, tibia length, body length and wattle and comb length compared to Fayoumi and Dandarwi ones.

- Production traits (egg weight, egg mass, egg number and egg production percent) showed that significant difference between breeds.
- Internal and external egg quality indicated that Fayoumi breed significantly increased both all traits comparable to Dandarawi and Sinai ones. But, Sinai breed slightly increased Haugh units compared to Fayoumi and Dandarawi ones.
- Heat stress measurements (Respiratory rate and rectal temperature) were no significant effect of the breed and also showed a significant effect of age and treatment for parent stock. But, in genotype offspring found that Fayoumi Nana and Sinai Nana and Dandarawi Nana were high significant compared with normal breeds.
- Gene Expression of Hsp70 was highly significant for Dandarawi breed followed by Fayoumi and Sinai ones for groups subjected to heat stress.
- Gene Expression of CPT-1 was high significant Dandarawi breed when compared with Fayoumi or Sinai ones under heat stress circumstances.

Key words: Heat Tolerance, Hsp70, CPT-1, gene expression, Naked Neck, local strains.

ACKNOWLEDGMENTS

Firstly, I wish to express my prayerful thanks to **ALLAH** for everything.

I wish also to express my deepest gratitude to **Prof. Dr. H. Ayoub** professor of Poultry Breeding, Poultry Production Department, Faculty of Agriculture, Ain Shams University for his constructive guidance, valuable advice, revising the manuscript and continues supporting during this study. And, his valuable feed during this breeding.

My deepest gratitude and sincere thanks are extended to **Prof. Dr. A. Galal**, professor of Poultry Breeding, Poultry Production Department, Faculty of Agriculture, Ain Shams University for supporting me in many ways during this study.

Special acknowledgments and deep grateful to **Dr.Lamiaa. M. Radwan**, Associate Professor of Poultry Breeding, Poultry Production Department, Faculty of Agriculture, Ain Shams University for supporting me in all things during this study and spirit supporting throughout the course of the study. Also, her valuable inputs and estimated of gene expression during this study.

I wish to express my sincere gratitude to **Prof. Dr. A. Zein EL-Dein**, professor of Poultry Breeding, Poultry Production Department, Faculty of Agriculture, Ain Shams University, encouragement, valuable advice, interest and remote revising the manuscript.

My thanks are due to **Abdelhay Gaber Abuhussrin**, Cairo University Research Park for help in technique of Real Time PCR.

I would like to express all my sincere gratitude and unlimited love to my **father, mother, sisters** and **brothers** for their patience, continual encouragement and love.

INTRODCTION

In recent years, a great global climatic changes occurred, the elevated temperature and the increase occurrence of heat waves cause a marked stress on poultry. These changes resulted in reducing in productivity and increasing mortality rate (**Turnpenny et al., 2001**). High environmental temperatures had also negative impacts on poultry health. According to recent surveys, the heat stress is a major problem facing poultry production because poultry does not have sweat glands and also they have fatty subcutaneous layer causing difficulty in getting rid of high temperatures. As a result, mortality rate become higher and causing a great economic loss for both laying and broiler stocks. Moreover, the heat stress affected negatively egg and meat quality. On the other hand, there were some mendalin genes had an important role in improving the productivity (such as growth rate, meat yield, egg production, and increase average egg weight) and heat tolerance of birds such as naked neck gene .

Heritable background plays an important role in a bird's response to heat stress. Many researcher in recent years, showed that birds under heat stress conditions produced upper levels of heat shock protein 70 (HSP70) in the livers. Other researcher, had the same results but in another different tissues (heart, liver and kidney).

These present studies were carried out on the most important Egyptian native strains (Fayoumi , Dandarawi and Sinai) in order to determining genes responsible for heat tolerance before and after introducing the naked neck gene into them and also before and after subjecting birds to heat stress conditions. Also we put in studying the relationship between gene expression responsible for heat shock protein and naked neck one (Nana).

REVIEW OF LITERATURE

Numerous studies have been conducted on the productive performance (growth and egg production traits) of Egyptian strains (Sinai , Fayoumi and Dandrawi) under Egyptian conditions. But till now, there is no study carried out on the Genetic studies for determining genes responsible for heat tolerance to local strains of chicken and estimated gene expression of responsible for heat stress for local strain. In general, all traits of Sinai and Fayoumi and Dandrawi strains will be discussed later in details.

1. Local strains

The local chicken is the main source of meat and eggs in more than 80% of the rural and poor households in developing countries **Tchoumboue et al. (2002)**. **Pedersen (2002)** and **Guèye (1998)** studied have generated information on local breeds production, their functions to rural households and demonstrated that the system is complex with many constraints such as low productivity of meat and eggs and high mortality because of little or no investment into the system. Moreover, the production of local chickens is distinguished low cost, makes use of by-product resources and is thus more efficient. The performance of local chickens was variable under traditional production system **Aini (1990)**. On the other hand, the Local breed, particularly at family level, still represent an appropriate system for supplying the fast.growing human population of high.quality protein and providing additional income (**Iraqi et al., 2002**). **Khalil et al. (1999)** and **Iraqi et al. (2000)** recorded that, the Egyptian strains of chickens were not subjected to thorough selection program and consequently, high additives and non.additive genetic variations appear between them. The Egyptian strains studied exhibited higher intrapopulation genetic diversity than European

fancy and purebred commercial lines, but lower diversity than local chicken populations of Vietnam, Malawi and Zimbabwe **Hosny (2006)**. **Gueye (2003)** said that While Egypt owns varieties of chickens including several local types. Two of them, Fayoumi and Dandarawi, are native breeds, while Sinai, a mongrel chicken breed with its origins in the Sinai desert, goes back to crosses of old local breeds and exotic types. In particular, Fayoumi chickens were used for the development of synthetic breeds by intercrossing them with high-producing lines of Europe and the United States in order to increase productivity and to maintain their ability to adapt to local conditions. Increasing expansion of the commercial chicken industry and intermixing of commercial hybrids with local strains on rural backyards is eroding the genetic uniqueness of native breeds and their potential to adapt to local conditions.

1.1. The productive performance under heat stress of (Fayoumi and Sinai and Dandarawi) strains:

Granevitze et al. (2007) stated that temperatures fluctuating in a very wide range of commercial laying hen houses that are located in hot climatic regions pose a serious threat to health, productive performance, and egg quality of modern layer hybrids, commercial poultry production is associated with various stresses affecting productive and reproductive performance of birds and their health status. **Surai and Fislain (2016)** and **Rekawt et al. (2016)** found that the inherited groups significantly influenced the egg weight, egg length, and egg shape and earlobe color. They recorded that the Black with Brown Neck and White significantly had heavier egg weight (62.095 and 62.258g) compared with Pure Black and Isa Brown (58.40 and 57.62g) respectively, Local chickens were significantly superior in egg length than Isa Brown, whereas egg shape significantly higher in Pure Black than other Groups.

El.Gendy (2009) suggested that the improvement in its productivity will be highly beneficial to the relief from the socio.economic and nutritional status of the farmers. Unfortunately, the global warming and climatic changes is particularly deleterious to tropical agriculture in general and to the local genetic resources, hence impairing their sustainable management initiatives. The ambient heat of the tropical zones constitutes a major constraint on the development of poultry production of these areas, because it induces considerable economic losses in their breeding by leading to fall in productivity and increase from mortality. To limit the harmful effects of heat, several technical solutions including nutritional or environmentally oriented actions are possible. To date, none of these techniques could restore the zoo technical performances close to those obtained in temperate climate, reason for which the genetic approach from solutions should be envisaged. The local chicken genetic resources are theoretically better adapted to their environment. Knowing that the response to chickens to thermal waves is based on their genetic constitution, the use of the crossings between hypothetical thermo tolerant local chicken and the highly productive exotic standard breed is sometimes recommended for the improvement in the breeds, strains or lines for better yielding poultry production of tropical environment **Yahav (2000)**.

1.1.1. Sinai strain under heat stress

Arad and Marder (1982) stated that the Sinai desert.inhabiting breed was found to be significantly more heat resistant compare to the Leghorn. This superiority was expressed in its longer survival time, its efficient regulation of body temperature and its high lethal body temperature, the superior heat resistance of the Sinai breed might reflect physiological adaptations to the extreme conditions in its ecological habitat. Also, The Sinai desert.inhabiting breed was

found to be significantly more to heat resistant than the Leghorn. This superiority was expressed in its longer survived time, its efficient regulation of body temperature and its high lethal body temperature, the superior heat resistance of the Sinai breed might reflect physiological adaptations to the extreme conditions in its ecological habitat. For example, Jungle fowl survive heat stress more successfully than do normal commercial strains of chicken, as do Bedouin fowl in the Sinai desert **Marder (1973)**. While, **El.Gendy et al. (2006)** studied genetic background for Egyptian native breeds they found that more variability, less band distribution and more heterozygosis were observed in Fayoumi compared to the other breeds. An average genetic distance index, overall primers, of 0.42 was calculated between White Baladi and each of Fayoumi and Sinai Bedouin. Whereas, the genetic distance between White Balad and commercial boilers was slightly further with an average of 0.45. Fayoumi was genetically the furthest from Sinai Bedouin with an average genetic distance from 0.53. The phylogenetic tree formed three distinct branches, They could reflect the genetic locality interaction, where White Baladi and Fayoumi are locals to the hot climate and Sinai Bedouin is local to the desert climate.

1.1.2. Fayomi strain under heat stress

Ying et al. (2016) researched for Physiological characteristics of Hy.Line and Fayoumi birds. They found that more diverse and altering directions or magnitudes of these measurements were mostly opposite to Fayoumi breeds. This study provides basic genetic information about resistant heat stress in local chickens and the biomarkers of physiological responses could serve as potential candidates for predicting heat tolerance. **Essa (2010)** and **Essa and Madion (2009)** studied effect Casein for productive traits for Fayoumi under heat stress. They recorded that diet by 0.2% Casein with 0.05% Vit.C in consumption water improved most of the

productive traits, egg quality, economic efficiency and egg contents percent as compared with those of the other treatments. Also, performance traits were improved when diet Fayoumi laying hens were supplemented with casein, they related this influence to improve calcium and protein utilization by feeding casein.

1.1.3. Dandarawi strain under heat stress

The Fayoumi lines and Dandarawi were genetically distinct, they exhibited high kinship relationships. This could reflect their ancient common ancestry, as confirmed by their common clustering up to $K = 4$. In addition, gene flow may have occurred among Fayoumi and Dandarawi because of their geographical origins in Upper Egypt **Muchadeyi et al. (2007); Bodzsar et al. (2009)**. In many developing countries, the local birds are mainly used in the subsistence and small scale sector, supplying most of the eggs and meat consumed. Both Fayoumi and Dandarawi strains are most widespread native breeds of chickens in Egypt. Since these local strains are expected to be more adapted to the unfavorable local conditions, they could be utilized in the process of establishing a local hybrid for egg production **Saleh et al. (1994); Mahmoud (2000); El-full et al. (2005); Zaky (2006)**.

Khairy et al. (2011) observed that which declined embryonic mortality during hatching process of eggs of Dokki4 and Dandarawi strains without adverse effects, decline embryonic mortality and caused retardant in hatching time for eggs of Dokki4 and Dandarawi strains. The Dandarawi strain was inferior in incubation traits compared to Dokki4 strain so more breeding selection plans are required for enhancing the performance of Dandarawi breed. While, **El.Sagheer (2007)** The recommendation of the present study is raising Dandarawi laying hens during the period from 32 to 44 weeks of age under 24 to 26°C to obtain higher productive and reproductive

performance, so, this study designed objected to evaluate productive and reproductive performance for Dandarawi laying hens under different ambient temperatures to find out the more appropriate one for its performance. **Sheikhmous and Hussein (2002)** studied effect Na and Cr genes for Dadarawi breed. They recorded that the correlation coefficients of egg breaking strength with egg weight, specific gravity and shell weight were more pronounced for crested Dandarawi naked neck genotype; this may reflect the interaction between Na and Cr genes which may reduce calcium carbonate accumulation in the eggshell **Sheikhmous and Hussein (2002)**.

In the poultry houses of laying hen , Dandarawi breed laying hens for optimal temperature is required up to 19. 22°C **Charles (2002)**. Environmental temperature was correlated with many measures of performance including feed and water consumption, body weight, egg production, shell quality, feed conversion, and egg weight **Sterling et al. (2003)**. The reduction of egg production of high temperature may have been related to the altered respiratory pattern. Such condition is one of the main causes of low productivity of chickens under Upper Egypt conditions where the prevailed ambient temperature fluctuates from lower than 10⁰C in winter to higher over 40⁰C in summer months. In case of reduction of environmental temperature, the laying hens consume much feed in order to maintain their body heat and also decrease egg production, nutrient digestibility and feed conversion **Ensminger et al. (1990); Spinu and Degen (1993)**. Temperature was found to have significant effect on body weight, fertility and hatchability percentages of chickens **Balat (1990); Saleh et al. (1991)**. Intensive poultry production of Egypt depends not only on commercial hybrids but also on local strains of chickens. Recently in Egypt, a considerable attention has paid to improve the productive performance of these local strains, especially Dandarawi. Although many researches have

been carried out to determine the optimal requirements of different local strains on different locations in Egypt, the available data regarding their requirement of optimum ambient temperatures are still insufficient. Therefore, this study aimed to evaluate productive and reproductive performance for Dandarawi laying hens under different ambient temperatures to find out the more suitable one for its performance.

1.2. Economic importance of local strains under heat stress

The value of animal genetic resources conservation is generally underestimated, as the current indirect values are often neglected **Philipsson et al. (2006)**. The conception of adaptability revolves around fitness describing relation ability of an individual to survive and reproduce next generation to ensure continued survival of the population and is the result of natural selection of many generations. Current trend in genetic selection has severely eroded the genetic base ignoring the diversity of the production milieu, significance of adaptation, production of multiple products and social value of the livestock **Naskar et al. (2012)**. local birds are a vital reservoir of gene resources and their conservation has a technical role related to the future improvement in the productive system as well as a social.cultural role **Camacho.Escobar et al. (2008); Ajayi et al. (2012)**. In Nigeria, poultry production enjoyed a boom in the early 1980s due to the government subsidies on day.old chicks and feed. This was followed by a downward trend in the industry due to subsidies removal but in recent times, the industry is again experiencing growth due to the current regime's effort in encouraging the citizenry to invest in the industry, many economic and agricultural policies reforms and removal of import duties on agricultural products **Fasina et al. (2007), Anonymous (2012)**. Turkey production is both an important and a profitable agricultural

industry, with a rising global demand for its products **Ironkwe and Akinola (2010); Anandh et al. (2012)**. Local strains are about 1.05 million in Nigeria, being the smallest when compared with other poultry species **FAO.stat (2010)**. Free range system of rearing is the most popular with rearing the local stocks of turkey **Peters et al. (1997)**. These birds are natural foragers and scavengers and always range farther. **Singh and Sharma (2012)**. Development in performance of indigenous stock or populations' overtime can arise throughout improvement in management and feeding conditions and through genetic improvement by use of genetically superior animals **Yakubu et al. (2012)**. The characters traditionally considered as criteria for selecting breeding stock are important to describing the adaptive attributes and genetic merits of the indigenous birds and in identifying farmers' choice of genetic stock used **Dana et al. (2010); Ilori et al. (2011)**. An issue that has received little attention to the tropics is the improvement in relevant breeding objectives for smallholder production circumstances. Design of sustainable genetic improvement schemes for smallholder situations requires indigenous knowledge on traditional breeding practices which is structured differently from scientific knowledge **Duguma et al. (2010)**. Lack of such knowledge leads to the setting up of unrealistic breeding goals and the effect of which can put in danger the conservation of indigenous animal genetic resources **Gizaw et al. (2011)**.

Family poultry is defined as small.scale poultry keeping by households using family labour and, wherever possible, locally available feed resources. The poultry may range freely from the household compound and find much of their own food, getting supplementary amounts of the householder. Participants at a 1989 workshop for Ile.Ife, Nigeria, defined rural poultry as a flock of less than 100 birds, of unimproved or improved breed, raised in either extensive or intensive farming systems. Labour is not salaried, but

drawn from the family household **Sonaiya (1990)**. Family poultry was additionally clarified as “small flocks managed by individual farm families in order to obtain food security, income and gainful employment for women and children” (Branckaert, as cited in **Sonaiya (1990)**). Family poultry is quite distinct from medium to largescale commercial poultry farming.

2. Thermo regulation and resistance to heat stress

Numerous studies have been conducted on the Thermo regulation and resistance to heat stress in chickens. But, little studies on role genetic of heat stress resistance or heat tolerance. The naked neck gene (Na) was decreased feather covering has been shown to be associated with resistance to acute heat stress, **Merat (1986) and Touchburn et al. (1980)** suggested that reduced feathering, associated with the Na gene, results in increased flexibility in the regulation of body temperature at high ambient temperature. Also, **Hanzl and Some (1983)** studied the potential usefulness of naked neck broilers at high ambient temperature, but its importance became more apparent to the 1990s, **Lou et al. (1992); Cahaner et al. (1993a); Eberhart and Washburn (1993)** From these studies, the advantage of naked neck broilers over their normally feathered counterparts, when reared at constant high ambient temperatures (above 30 C) was well demonstrated. It has been shown that the high in body temperature in high ambient temperatures were increased from normally feathered compared with naked neck broilers, due to the low feathering of the latter. Consequently, the naked neck broilers exhibited higher feed intake, growth rate, and meat yield than their normally feathered counterparts **Deeb and Cahaner (1994)**.