EFFECTS OF LOWERING INCUBATION TEMPERATURE ON HATCH OF FERTILE AND POST-HATCH PERFORMANCE AND CORRELATION BETWEEN EGG AND CHICK WEIGHTS OF *BANABANG KALABAW* PHILIPPINE NATIVE CHICKEN

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ABSTRACT

The objectives of the study were to evaluate the effect of incubation temperature on hatch of fertile, day-old chick weight, and livability for the first seven days and establish correlation between egg weight and chick weight in 52-week old *Banabang Kalabaw* Philippine native chicken. A total of 72 fertile eggs (45 ± 2 g) were randomly distributed into two incubators with constant temperatures of 36.5°C and 37.5°C, respectively, following CRD with three replicates. Chicks were individually weighed upon hatch and group brooded for seven days. Results showed that at 52 weeks of age, *Banabang Kalabaw* native chicken had an average egg weight of 48.76 g, composed of 61.5% albumen, 30.0% yolk, 8.0% shell and 0.5% shell membrane. The two incubation temperatures had no significant effect on all variables tested. Egg weight had a very strong positive correlation (r=0.95, *P*<0.01) with chick weight. This study shows that the incubation temperature for *Banabang Kalabaw* native chicken eggs can be lowered to 36.5°C with no adverse effects on hatch of fertile and 7-day post-hatch performance. Further, egg weight can be used as direct selection criteria for chick weight.

Key words: egg size, egg weight, hatch of fertile, incubation temperature, Philippine native chicken

INTRODUCTION

One of the essential factors contributing to embryo development is incubation temperature (Decuypere and Michels, 1992; Nakage *et al*., 2003; Liu *et al*., 2015). The optimum incubation temperature for chicken ranges from 37 to 38°C (Oppenheim and Levin, 1974; Wilson, 1990) but setting incubators at 37.5°C has been widely practiced. Incubation temperatures below the optimum result in the delay of embryonic growth (Romanoff, 1936) and reduced embryonic heart rate (Oppenheim and Levin, 1974). On the other hand, exposure to incubation temperature above 37.5°C may increase embryonic mortality due to dehydration and hyperthermia (Decuypere and Michels, 1992; Nakage *et al*., 2003).

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Incubation temperature was also found to have a subsequent effect on post-hatch performance particularly chick growth and livability (Clark *et al*., 2017).

Currently, the modern artificial incubator has features such as automatic egg turning and digital control of temperature and relative humidity. Commercial chicken breeders extensively use artificial incubators to maximize production. However, modern-day chicken breeders have relatively heavier and bigger eggs as compared to native chicken breeds. Studies show that bigger eggs have higher heat production and heat transfer as compared to smaller eggs during incubation (French, 1997; Lourens *et al*., 2006; Morita *et al*., 2016). Eggshell temperature increases while the incubation period progresses (French, 1997; Joseph *et al*., 2006; Boleli *et al*., 2016).

Native chickens are the most common domesticated fowls found in small-hold farms in the countryside (PCAARRD, 2012). *Banabang Kalabaw* is one of the recognized native chicken breeds in the Philippines predominantly raised in Quezon and Batangas provinces. The hen has black plumage color, yellow laced hackle, and grey shanks. *Banaba* chickens have an average egg weight of 40 g (Lambio, 2000; Guiam, 2016). Hatchability of native chicken eggs remains low even under artificial incubation which becomes a major challenge in production. The eggs being smaller have a higher surface area to absorb heat during incubation and that the optimum temperature for incubating native chicken eggs may be lower compared to the commercial breeds. Currently, there are no studies showing the effect of incubation temperature on the hatchability of native chicken eggs. Therefore, this study aimed to evaluate the effect of lowering incubation temperature on hatch of fertile, day-old chick weight and chick livability in the first week of brooding and to establish the relationship between egg and chick weight in *Banabang Kalabaw* native chicken.

MATERIALS AND METHODS

A total of 103 *Banabang Kalabaw* native chicken hatching eggs were collected from 52-week old layers maintained at the Bureau of Animal Industry-National Swine and Poultry Research and Development Center (NSPRDC). The eggs were brought to the Poultry Laboratory of the Institute of Animal Science (IAS), College of Agriculture and Food Science (CAFS), University of the Philippines Los Baños (UPLB) for artificial incubation. The hatching eggs were individually labeled and set at a similar incubation temperature (37.5°C) for seven days. On day 7, candling was done to determine fertility and early embryonic mortality. A total of 72 fertile eggs (45 ± 2 g) were obtained and randomly assigned to two setter-hatcher incubators (AC252®, AC Ang Enterprises, Laguna, Philippines) with the temperature set at 36.5°C and 37.5°C, respectively following Completely Randomized Design (CRD). Each treatment was replicated three times, with 12 eggs per replication. The incubators have a capacity of 252 eggs and have automatic egg turning once every two hours. On day 18, fertile eggs were transferred to hatcher trays still following the experimental lay-out. Relative humidity of 60% inside the incubators was maintained until hatching. The incubation temperature from day 1 to 18 was recorded twice a day to check for any fluctuation. Upon hatching, the chicks were individually weighed and group-brooded for seven days based on the experimental assignment of the hatching eggs. Hatch-of-fertile, day-old chick weight and livability at day 7 of brooding were recorded.

An initial sample of 22 hatching eggs was collected in two consecutive days for egg quality analysis. An automatic egg tester (Egg Analyzer® ver 6.5 Egg Quality Tester, ORKA

Technology Ltd, Israel) was used to determine egg weight, commercial grade, yolk height, Haugh unit (HU) and yolk color. The yolk was separated from the albumen using an egg separator and weighed using a digital weighing scale (Kitchen Scale SF-400, Yuwei, China). Shell membrane and shell weight were measured using the digital weighing scale as well. Eggshell thickness was computed as average from three points (butt, middle, and tip) with the use of a digital caliper (Absolute Digimatic Caliper Series 500, Mitutoyo, Tokyo, Japan).

Descriptive statistics were used to analyze egg composition. All other data were analyzed using t-test on two population means with independent samples using SAS University Edition (SAS, Cary, NC, USA). Pearson correlation analysis was done to determine the relationship between egg weight and day-old chick weight. Statistical significance was set at $P \leq 0.05$.

RESULTS AND DISCUSSION

Banabang Kalabaw native chicken at 52 weeks of age had an average egg weight of 48.76 g (Table 1). *Banaba* native chicken eggs can be considered as pullet size based on the Philippine National Standard for Table Eggs (BAFPS, 2005). The observed egg weight, however, was slightly higher than the average egg weight observed by Lambio (2000) for *Banaba* Brown (39.67 g) and *Paraoakan* (41.14 g) but was comparable to the egg weight recorded by Santiago *et al*. (2015) for *Banaba* Brown (46.6 g).

In addition, *Banabang Kalabaw* native chicken eggs were composed of 61.5% albumen, 30% yolk, and 8.5% eggshell and shell membrane. A similar trend in the egg composition was reported in *Banaba* native chicken at 40 weeks of age (Santiago *et al*., 2015), in slow and fast-growing native breeds in India at 40 and 56 weeks of age (Haunshi *et al*., 2010 and 2013), and in commercial layers of different ages (Marion *et al*., 1964; Hussein *et al*., 1993; Celestino *et al*., 2012). Composition and quality of the egg is a vital pre-incubation factor to consider because the embryo obtains from the egg the nutrients required for its complete development (Mortola *et al*., 2010; Boleli *et al*., 2016).

The initial weights of hatching eggs used for the two treatments were not significantly different (Table 2). This indicates that the randomization of hatching eggs in the two treatments were effective. Egg weight is considered one of the major factors influencing the

Table1. Egg profile of *Banaba* native chicken.

Parameters	Measurement
Egg Weight, g	48.76 ± 4.20
Yolk Weight, g	15.14 ± 1.72
Shell Weight, g	4.12 ± 0.36
Shell Membrane, g	0.22 ± 0.04
Albumen Weight, g	29.29 ± 2.85
Haugh Unit, mm	56.14 ± 8.24
Shell Thickness, mm	0.31 ± 0.03
Yolk Color	8.00 ± 1.00

Table 2. Effect of different incubation temperature (Mean ± SD) on hatch of fertile and 7-d post-hatch performance of *Banabang Kalabaw* native chicken.

Parameter	36.5 °C	37.5 °C	*P*-Value
Hatching Egg Weight, g	45.39 ± 1.18	45.06 ± 2.20	0.81
Incubation, d	21	20	0.38
Hatch of Fertile, %	56.00 ± 2.83	64.50 ± 3.54	0.92
Chick Weight, g	31.59 ± 1.2731	31.90 ± 2.08	0.67
Livability d7, %	97	100	0.42

outcome of incubation (Nakage *et al*., 2003). In this study, the initial weight of hatching eggs was not a covariate, hence, no statistical adjustment was necessary for the other independent variables measured.

Moreover, in the present study, the two incubation temperatures (36.5°C and 37.5°C) did not significantly affect the length of incubation, hatchability of fertile eggs, chick weight and livability during the first-week post-hatch. Optimal incubator temperature could promote complete embryonic development (Lourens *et al*., 2007; Morita *et al*., 2016), improve egg hatchability (Collin *et al*., 2007; Piestun *et al*., 2008; Almeida *et al*., 2016) and chick quality (Hulet *et al*., 2007; Lourens *et al*., 2007; Piestun *et al*. 2008; DuRant *et al*., 2012; Van der Pol *et al*., 2014). Other factors that could increase incubator efficiency include relative humidity, O_2 and CO_2 concentration (Lourens *et al*., 2007; Tona *et al*., 2007; Boleli *et al*., 2016), and frequency of egg turning (Wilson, 1990).

Previous studies also showed that different levels of incubation temperature could affect the total length of the incubation period. An incubation temperature set at 36°C prolonged hatching of eggs by 11 hours compared to 37.5°C, but when the temperature was set at 39°C, hatching period was reduced by 7 hours (Morita *et al*., 2016). A similar trend was observed by Almeida *et al*. (2016). Decreasing incubation temperature to 36°C had slowed down embryonic heat production metabolism and development (Lourens *et al*., 2007; Morita *et al*., 2016) prolonging the incubation period. In this study, although the incubation period of eggs incubated at 37.5°C was shorter by one day compared to the other group, the difference was not statistically significant.

The effect of incubation temperature on hatch of fertile eggs was not yet fully established. Generally, the incubator temperature set at 39.5°C resulted in low hatchability (Collin *et al*., 2007; Piestun *et al*., 2008). However, some indicated improvement in hatchability when incubation temperature was increased to 39°C (Almeida *et al*., 2016). The inconsistency in results might be due to differences in the strain and age of breeders used, egg sizes, storage condition of hatching eggs prior to incubation, and incubator design and capacity. The hatchability of fertile eggs in the present study did not differ significantly between the treatments. This indicated that incubation temperature ranging from 36.5 to 37.5°C promoted complete embryonic development in *Banabang Kalabaw* native chicken.

Furthermore, studies have indicated that incubation temperature also affects post-hatch chick performance. Significant reduction in day-old chick heart weight and chick navel condition were observed when eggs are incubated at a higher temperature (Lourens *et al*., 2007; Van der Pol *et al*., 2014). Higher incubation temperature also resulted to lower body weight and poorer feed conversion in broilers post-hatch (Hulet *et al*., 2007; Piestun *et* *al*., 2008). On the other hand, duck eggs incubated at lower temperature have poorer body condition score and greater disease susceptibility post-hatch (DuRant *et al*., 2012). It is also important to monitor eggshell temperature during incubation in order to determine the physiological response of the embryo at different stages (Joseph *et al*., 2006; Lourens *et al*., 2005 and 2007; Hulet *et al*., 2007 and Van der Pol *et al*., 2014).

The present study did not find significant differences in the day-old chick weight and livability during the first week of brooding. These findings indicated that lowering incubation temperature for *Banabang Kalabaw* native chicken eggs had no adverse effects on incubation efficiency and seven-day post-hatch chick quality. Correlation analysis showed that the egg weight had a very strong positive phenotypic correlation (P<0.01) with the day-old chick weight (Table 3). This means that the weight of the *Banabang Kalabaw* native chicken at day-old could be improved by selecting for larger hatching eggs. Further studies are recommended to optimize incubation conditions for native chicken eggs considering different breeds, egg sizes and breeder age. The eggshell temperature must also be monitored to determine the relative heat production of the growing embryo throughout the incubation period.

Table 3. Correlation between egg weight and day-old chick weight of *Banabang Kalabaw* native chicken at two incubation temperatures.

	Eggs set at 36.5°C (n=27)	**Eggs set at 37.5°C (n=19)**	**Combined data (n=46)**
Correlation coefficient, r	0.93**	0.97**	0.95**

** Significant at P<0.01

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