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Short Communication

A method to determine the combined effects of climate change and eggshell thickness on water loss from bird eggs

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Abstract :

Differences in bird eggshell thicknesses occur due to numerous factors, including thinning due to persistent organic pollutants. Not only does thinning weaken the shell; weaker shells combined with elevated ambient temperature and changes in humidities may result in changes in water loss rates from the egg contents. Therefore, thinner eggshells raise concern of water being lost faster than normal at lower relative humidities, which may affect hatching. To investigate the combined effects, we developed and tested an effective method that measures water loss through different thickness eggshells at controlled temperatures and relative humidities to assist in ascertaining the combined effects of climate change (temperature and humidity) and changes in eggshell thickness on bird reproduction. The fastest rate of loss was at 40% RH at 40 °C (0.1 mL/cm²/day), and the slowest was at 22 °C at 80% RH (0.02 mL/cm²/day). Eggshell thickness had a significant effect on water loss at all humidity treatments, except at the highest temperature and humidity treatment (80% RH and 40 °C). Temperature explained 40% of the variance, RH explained 20%, and interactions between temperature and humidity explained 15% of the variance (repeated-measures, two-way ANOVA). Generalized linear analyses revealed that both factors temperature and humidity contributed significantly in any two-way combinations. We have laid the ground for a system to test the combined effects of temperature and humidity changes associated with climate change and eggshell thinning associated with pollutants, on water loss across eggshells.

Introduction:

Pheasant and guinea fowl are some species used in commercial poultry production for different reasons in various parts of the world. In most countries, pheasants are bred mainly as game birds as a source of animal protein (meat) for humans or are released in the wild to prevent the depletion of species' population. Guinea fowl, on the other hand, are raised both for meat and egg production and as a hobby. In Africa, guinea fowl production has cultural significance as a traditional activit and guinea fowl meat and eggs are second to chicken eggs and meat in terms of poultry products consumed.

The most important step in poultry production is incubation. In the northern hemisphere, pheasants start laying in early spring and continue until mid-summer; however, total egg production, fertility, and hatching rates vary and tend to be unsatisfactory with reported hatchability rates of fertilized eggs ranging between 41 and 79%. Similar variations have been observed in guinea fowl, with reported hatchability rates ranging between 45 and 86%. Considering the value of pheasant chicks and guinea fowl keets, together with the low egg numbers and variations in fertility and hatchability, successful incubation of all eggs is particularly desirable in these poultry species.

Studies investigating methods of improving pheasant and guinea fowl egg production have focused on nutrition and on the effects of housing system on egg production and hatching. Egg storage prior to incubation - a common practice in these species due to their relatively low egg production - has been shown to have a negative effect on hatchability.

Hatchability may also be affected by eggshell thickness; however, most studies examining the relationship between eggshell thickness and hatchability have focused on chickens, with only limited studies evaluated other poultry species, namely turkeys, geese, ostriches, and partridges, Therefore, the present study aimed at evaluating the relationship between eggshell thickness and hatchability of pheasant and guinea fowl eggs using an ultrasound gauge to measure thickness.

Conclusion:

Poultry eggshell quality and thickness are affected by numerous factors such as nutrition, stress, disease, and production system. Eggshell thickness has been reported to range between 0.30 and 0.45 mm in guinea fowl eggs and between 0.253 and 0.343 mm in pheasant eggs. The average eggshell thicknesses of guinea fowl and pheasant eggs determined in this study were 0.33 mm and 0.36 mm, respectively. In order to determine the effect of eggshell thickness on hatchability, this study grouped eggs into thin-shelled, medium-shelled and thick-shelled groups based on calculations made using fertilized eggs only. Accordingly, 16.83% of guinea fowl eggs were classified as thin-shelled, 63.5% as medium-shelled and 19.67% as thick-shelled, whereas 18.93% of pheasant eggs were classified as thin-shelled, 58.68% as medium-shelled and 22.39% as thick-shelled.

The huge differences in the reported findings regarding the relationship between eggshell thickness and hatchability may be related to the methodology used to determine eggshell thickness showed that eggshell thickness is closely related to egg specific gravity, and most studies since then have assessed eggshell thickness according to egg specific gravity. However, other studies de-

termined eggshell thickness using logarithms that rely mainly on egg weight to calculate eggshell thickness. In contrast with the direct measurement by ultrasound used in the present study, calculations based on specific gravity or egg weight all rely on indirect methods of measurement. In a study comparing various indirect methods for measuring eggshell thickness, showed that the same chicken egg could be identified as thin-shelled by one indirect method and as thick-shelled by another indirect method. These findings highlight the importance of direct measurement. Previous studies conducted using the same direct ultrasound measurement method used in the present study, but with different poultry species, namely chickens and partridges, also found hatching rates to be unaffected by eggshell thickness. Moreover, the hatching time of partridge eggs was not affected by eggshell thickness.

Conclusion:

This study measured eggshell thickness directly using an ultrasound gauge and found no significant differences in hatching rates as a function of eggshell thickness. Although these findings differ from those obtained in some previous studies using indirect measurement methods, direct measurement with an ultrasound gauge has been shown to provide more accurate results Accordingly, it may be stated that once the embryo has completed its development, even thick-shelled guinea fowl and pheasant eggs may hatch successfully. New studies need to be conducted with other poultry species, including egg weight loss during incubation, to verify these results.

Adapting the system described here will allow the simultaneous investigation of eggshell thickness, temperature, and humidity on water loss through eggshells. Long-term temperature and humidity treatments of fertilized eggs would also be possible, but the eggshell thickness then needs to be determined with ultrasonic devices or post-hatching. Our system is effective and sufficiently sensitive to measure small differences in water loss under the conditions and eggshell thickness ranges we used. An additional benefit is that we can use the same shell units repeatedly, which reduces the variability in eggshell thickness to the benefit of the statistical evaluation while changing the ambient conditions.