Effects of coating breeding eggs with different materials on quality of stored eggs and hatching results

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Abstract

The experiment was conducted to investigate the effects of coating breading eggs with different materials on the quality of stored eggs and hatching results. 400 fertile eggs were divided in a completely randomized design into five treatments, four replicates and each replicates contain 20 eggs. Experimental groups were following: 1) control (without coating egg), 2) coating egg with 50% solution of honey, 3) coating egg with 50% solution of aqueous extract of propolis, 4) coating egg with 3% solution of gelatin, 5) coating egg with 50% solution of sugar. After testing, eggs stored for two weeks and then were transferred to the hatchery. In the end of the storage, egg quality traits (egg weight, sell weight, yolk weight, albumen weight, Haugh unit and albumen pH) and at the end of the incubation period, characteristics hatchability (hatchability, weight and length of newly hatched chicks) were assessed. The results showed, coating the eggs with different materials were improved egg weight, yolk weight, albumen weight, Haugh unit and albumen pH ($p<0.05$), whereas hadn't any significant effect on shell weight. Also, coating of eggs with mentioned materials had significantly reduced hatchability percentage than to control group (without coating egg) ($p<0.05$). But the effect of experimental groups hadn't any significant effect on the weight and length of the newly-hatched chicks. The results of this study showed, coating stored eggs with honey, propolis, gelatin and sugar can improve the quality traits of the broiler breeder eggs.

Key words: Broiler breeder egg; coating materials; egg quality traits; hatching traits

Introduction

Two major important factors influencing egg quality are egg storage time and conditions (Williams, 1992). It is proven that some protection methods such as egg shell coating minimize detoriation in interior egg quality (Wong et al., 1996; Bhale et al., 2003). Previous studies have been conducted to assess egg shell coatings on increasing of interior egg quality, such as mineral oil, whey protein isolate, chitosan, shellac, soy protein isolate, wheat gluten, corn zein, and casein (Meyer and Spencer, 1973; Heath, 1977; Wong et al., 1996; Caner, 2005a, b; Caner and Cansiz, 2008).

Haugh unit is at maximum and albumen pH is at minimum when eggs are laid and their values decrease with increasing storage time (Silversides and Villeneuve, 1994; Silversides and Scott, 2001; Tilki and Inal, 2004). Haugh unit is an empirical method that determines a relationship between the weight and height of the thick albumen (Haugh, 1937; Stadelman, 1995b). When eggs age, the thick albumen breaks down into thin albumen. This break down results in a decreased height of the thick albumen, which is the primary factor in the HU equation. A higher HU value (i.e., thick albumen height) indicates a higher quality egg. The pH increases during storage due to carbon dioxide loss through the porous shell (Powrie, 1973; Heath, 1977; French and Tullet, 1991; Wong et al., 1996; Tayar, 2005). In general, eggshells are breathable material; therefore they allow moisture and carbon dioxide to permeate through the shell (Wong et al., 1996). The permeation may cause physical and chemical changes in albumen and yolk and also weight loss.

Since the egg shell coating limits water losses and gas diffusion through pores, it should be useful to coat breeding eggs shell with different materials during storage. Therefore, the objectives of this study were to investigate the influence coating stored eggs with honey, propolis, gelatin and sugar on the interior quality of eggs.

Material and method

Hatching eggs of approximately similar weights (67 ± 1 g) were obtained from broiler breeder strain (Ross 308) at 41 weeks of age. Food-grade coatings used in this study were honey, propolis, gelatin, sugar and uncoated (control). 400 fertile eggs were divided in a completely randomized design into five treatments, four replicates and each replicates contain 20 eggs. Experimental groups were following: 1) control (without coating egg), 2) coating egg with 50% solution of honey, 3) coating egg with solution of aqueous extract of propolis, 4) coating egg with 3% solution of gelatin, 5) coating egg with 50% solution of sugar. After testing, eggs stored for two weeks and then were transferred to the hatchery. Fertile eggs were incubated at 37.7 ◦C and 64 % RH.

In the end of the storage, egg quality traits (egg weight, sell weight, yolk weight, albumen weight, Haugh unit and albumen pH) and at the end of the incubation period, characteristics hatchability (hatchability, weight and length of newly hatched chicks) were assessed.

Coating Applications

Honey and propolis was collected from honey bees in Khoy and extracted according to the method suggested by Krell (1996). a 50% propolis were prepared by mixing 1600 ml 70% ethanol and 400 g of propolis. Solutions were kept in a container, sealed the top and shaken twice daily for one week. Each solution was filtered separately and was kept in a clean, dark bottle at 4°C until use. Four different food-grade coatings were applied to eggs: honey, propolis, gelatin, sugar. Propolis was melted at 60°C and eggs were dipped using a pair of tongs that made contact with the eggs with 2 small holes on the side of the eggs. When the tongs were removed from the dried eggs, the holes were filled with paraffin wax. Coating of the honey, gelatin and sugar eggs all used the same process. The pointed end of the egg was dipped into the respective coating and then placed on a small stand pointed side down. The food-grade coating was then poured over the egg until it visibly covered the surface. Care was taken to ensure that each egg had a uniform coating with no visible defects. The eggs were air-dried at ambient conditions for approximately 30 min and were then moved by hand into cartons for the rest of the storage (Biladeau and Keener, 2009).

Measuring the weight of egg, albumen, yolk and shell

Sensitivity was used for weighing the albumen, yolk and shell weights of the eggs. After the weighing process, the eggs were broken and accurately divided into three components: shell, yolk, and albumen. The yolk and albumen were weighed immediately after breaking; the shell was dried at the room temperature and weighed after water evaporation from the solid substance (Narushin et al. 2001).

HU Measurements

Haugh units were measured on 5 eggs using an Egg Multi Tester (Robotmation Co., Tokyo, Japan). This machine measures an average of the egg albumen height using ultrasound.

pH Measurements

Five of the 5 eggs measured for HU were also selected for pH analysis. The albumen and yolk were separated and albumen pH measured using a model 220 Denver Instrument pH meter (Denver Instrument, Denver, CO). Upon hatching, the number of hatchlings was determined to calculate the hatchability of fertile eggs. The weight of newly hatched chickens was determined by weighing all chickens hatched one by one.

Analyses of variance were performed using the GLM procedure of SAS Institute Inc. (2005) as a completely randomized design. Results are presented as mean ± SEM. The significantly different treatment means were investigated using Duncan's new multiple rang test. Differences were considered significant when $p < 0=05$.

Results

The effects of coating breeding eggs with different materials on weight of egg, albumen, yolk and shell are presented in Table 1. The weight of egg, albumen and yolk were significantly increased in eggs treated by honey, propolis, gelatin and sugar compared to the control group. By contrast, shell weight was not significantly altered in treated eggs. Haugh unit and albumen pH markedly improved in eggs treated with honey, propolis, gelatin and sugar compared to the control group (Table 2). As seen in Tables 3 the coating breeding eggs with different materials reduced the hatchability compared with the control group. But, the mean body weights and length of newly hatched chickens coated by honey, propolis, gelatin and sugar were not significantly altered.

Table 1. Effects of coating breeding eggs with different materials on weight of egg, albumen, yolk and shell

Groups	Egg (g)	Albumen (g)	Yolk (g)	Shell (g)
control	97.05c	58.82b	31.68d	8.54
honey	98.98a	57.86a	32.58a	8.54
propolis	98.37b	57.69a	32.14bc	8.52
gelatin	98.08b	57.61a	32.00c	8.47
sugar	98.57ab	57.81a	32.32b	8.42
SEM	0.0001	0.0001	0.0001	0.4787
P-Value	0.179	0.121	0.084	0.052

[a–e] Averages in a column with different superscript letters are significantly different.

Table 2. Effects of coating breeding eggs with different materials on Haugh unit and Albumen pH

Groups	Haugh unit	Albumen pH
control	73.31c	9.19a
honey	74.64a	8.85b
propolis	74.36ab	8.63b
gelatin	74.42a	8.71b
sugar	73.91b	8.79b
SEM	0.0001	0.0004
P-Value	0.148	0.068

[a–e] Averages in a column with different superscript letters are significantly different.

Table 3. Effects of coating breeding eggs with different materials on weight and hatchability in newly-hatched chickens

Groups	Hatchability (%)	Weight (g)	Length (Cm)
control	84.02a	43.41	19.70
honey	74.30b	43.61	19.40
propolis	69.44b	43.46	20.40
gelatin	72.22b	43.52	20.60
sugar	75.00b	43.59	20.30
SEM	0.0056	0.0647	0.1911
P-Value	2.310	0.051	0.382

[a–e] Averages in a column with different superscript letters are significantly different.

Discussion

Based on the results of the present study, coating breeding eggs with different materials can be seen as an effective tool to improve interior egg quality. The results presented agree with the study reported by Wong et al. (1996) and Bhale et al. (2003) demonstrating that some protection methods such as egg shell coating minimize deterioration in interior egg quality. The edible films, which are not detrimental to human health, have a barrier property against oxygen, carbon dioxide and humidity movement from eggs (Caner et al., 1998; Krochta and Dcmulder, 1997). Some conservation methods including oil coating (Hisil and Otles, 1997), dipping in low tem-perature, freezing, high temperature and drying (Tayar, 2005) and also the coating of egg shell with chitosan, whey protein and shellac (Caner 2005b) are used for protection of interior egg quality.

Results of the present study showed that the weight of egg, albumen and yolk were significantly increased in eggs treated by honey, propolis, gelatin and sugar compared to the control group. in agreement, Biladeau and Keener (2009) reported that the linear slope from highest to lowest is 0.28 g/wk for control, 0.24 g/wk for SPI-coated eggs, 0.23 g/wk for WPI-coated eggs, 0.03 g/wk for oil-coated eggs, and 0.002 g/wk for wax-coated eggs. Coated eggs had a lower sample variance than the control, suggesting that a food-grade coating will reduce water loss in more porous eggs. Also, Biladeau and Keener (2009) showed that the total weight (water) loss during 12 wk of refrigerated storage for control, SPI-, WPI-, oil-, and wax-coated eggs was 3.4, 2.9, 2.7, 0.35, and 0.03 g, respectively. These values are comparable to previous research. Caner (2005a) found the weight loss was 6.8% for control, 4.3% for WPI-coated eggs, 4.2% for chitosan-coated eggs, and 0.7% for shellac-coated eggs over a 4-wk study at room temperature.

The determination of albumen pH in fresh egg is more important than determination of albumen height. In general, the pH of the albumen does not differ between genetic strains, but increases with storage time (Silversides and Scott, 2001). An increase in albumen pH causes a decrease in egg quality (Scott and Silversides, 2000). Previous researchers showed the starting value of albumen pH between of 7.6-7.9 (Powrie, 1973; French and Tullet, 1991; Silversides and Scott, 2001; Senkoylu, 2001). The current study indicates that increasing storage time caused an increase in albumen pH of the egg ($p < 0.05$) (Table 2). Eggs coated with honey, propolis, gelatin and sugar exhibited lower pH ($p < 0.05$) than eggs control group. According to these results, it may be assumed that eggshell coating decreased CO2 release through the shell by acting as a barrier for CO2. In general, coatings may force some gasses to diffuse less rapidly than others through the shell. The observed values supported previous work conducted by Caner, (2005b) who found similar pH values when coating eggs with chitosan (8.83) and shellac (8.82). In general, the observed increase in albumen pH supports the conclusions of previous studies (French and Tullet, 1991; Wong et al., 1996; Tayar, 2005) that the pH increases with CO2 loss via egg shell pores during storage time. In the study of Stadelman (1995a), it was reported that the increase in albumen pH over time is related to the loss of CO2. As albumen pH increases, the bicarbonate buffering system equilibrium shifts (Heath, 1977). For coated eggs, this buffering system may not shift as quickly.

In present study, the coating breeding eggs with different materials reduced the hatchability compared with the control group. According to the past studies and our present observations, it seems that coating breeding eggs with different materials can be harmful for the internal environment susceptibility and may have negative effects on hatching.

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