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The efficacy of peanut oil and palm oil in preserving chicken eggs in a tropical environment

SM Atabo[1]*, AA Umar[2], SA Shehu[2], J Abdullahi[3] & YA Yabo[4]

[1.] *Department of Animal Health and Production Technology, College of Agriculture and Animal Science, Bakura, Zamfara State, Nigeria*

[2.] *Department of Veterinary Anatomy, Usmanu Danfodiyo University, Sokoto, Nigeria*

[3.] *Department of Theriogenology and Animal Production, Usmanu Danfodiyo University, Sokoto, Nigeria*

[4.] *Department of Veterinary Physiology and Biochemistry Usmanu Danfodiyo University, Sokoto, Nigeria*

*Correspondence: Tel.: +2348069728062; E-mail: mohakosh@yahoo.com

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Abstract

The study was undertaken to compare the effect of different storage methods on external and internal quality of Isa Brown eggs obtained from Rufai Poultry Farms Bakura, Zamfara State. Ninety (90) eggs were collected from the Rufai farms sales office at Talata Mafara, Zamfara State. The eggs were divided into three groups (A, B and C) of 30 eggs each. The mean weight of the eggs in each of the groups was determined. Group A was left uncoated in a crate, while groups B and C were coated with peanut oil and palm oil respectively, and stored for four (4) weeks at room temperature. The egg shell, mean egg weight, egg yolk, egg white (albumen) and volume of each individual eggs were evaluated. The average percentage whole egg weight loss for all the groups showed significant difference ($p<0.05$) after preservation, with group A having the highest average percentage egg weight loss of 64.16±5.00%, although, group B had heavier weight compared to group A before preservation. Eggs coated with palm oil had better internal quality compared to peanut oil coated eggs and non-oil coated eggs, as it was seen to have intact internal content. A significant difference ($P< 0.05$) was also seen in the volume of group B and C with group C having the highest volume of 67.67±10.79ml. In conclusion this study showed that all palm oil coated eggs had good external and internal quality and longer shelf-life than non-oil coated and peanut coated eggs. It was therefore recommended that eggs should be preserved by coating with palm oil, so as to extend their shell-life.

Keywords: Chicken egg, Egg Albumen, Egg Yolk, Palm oil, Peanut oil, Preservation

Introduction

Chicken eggs are among nature's most nutritional and cheapest foods. As a source of high quality animal protein, they are classified as being alternatives to meat (Cook & Briggs, 1986). Each egg is composed of internal yolk and albumen contents sealed within a hard shell. The calcium carbonate shell makes up about 11% of total egg weight while the yolk and albumen form 31% and 58%, respectively. The proportions of these egg constituents remain relatively constant regardless of the egg's quality or size (MSUES, 2017).

Yolk and albumen contribute about 40% and 60% to the total protein of the egg respectively. Eggs contain 12 of the 13 vitamins that are required by man: they lack only vitamin C (ascorbic acid) (Shenstone, 1968). Chickens, like most birds and mammals, can synthesize vitamin C from glucose, and therefore it is not necessary for it to be present in the egg for the development of the chick (Shenstone, 1968).

According to USDA (2004), the fat-soluble vitamins (A, D, E, and K) are also present only in yolk where they associate with the lipoproteins of yolk. The remaining vitamins and 12 important minerals are present in both yolk and albumen.

Poor egg quality has been of major economic concern to commercial egg producers (Roberts, 2004). Physical factors such as egg shell appearance and strength, egg size, weight and physical appearances of internal structures have direct effects on the prices especially when the eggs are graded (Seidler, 2003). As soon as an egg is laid, the internal quality of eggs begins to deteriorate due to loss of moisture, carbon dioxide and entrance of bacteria via the eggshell pores (Nongtaodum *et al.,* 2013).

The quality of the egg once it is laid cannot be improved, so efforts to maintain its quality must start right at this moment. There are six main factors affecting egg quality: disease, egg age, temperature, humidity, handling, and storage. High temperatures cause a rapid decrease in internal quality (Marion *et al.*, 1964). Tumova *et al.* (2007) also reported that external and internal characteristics of an egg mainly depend on the breed and its duration of storage. Most commercial and backyard poultry farms in Nigeria produce eggs all year round and face challenges during the hot months as high temperature during the hot months causes a rapid decrease in the quality of eggs (Dauda *et al.*, 2006).

Shin *et al.* (2012) reported that refrigeration preserve egg for a long-term. However, considering the epileptic power supply and economic challenges in Nigeria, there is therefore the need to establish an alternate and inexpensive means of preserving eggs. Although, mineral oil has been reported to improve the shelf-life of eggs (Torrico *et al.,* 2011), however it is not as cheap and readily available as peanut oil and palm oil in Nigeria. Hence there is the need to study the efficacy of peanut oil and palm oil as preservatives of eggs in the study area. The current study aimed to establish cheaper and readily available means of preserving the external and internal quality of chicken eggs.

The information established in this research will be useful to the egg producers, sellers, consumers and livestock officials on how to improve the shelf-life of eggs so as to safeguard the public health and profitability in egg production especially during the hot months.

Materials and Methods

Ninety (90) commercial eggs of Isa Brown chickens obtained from Rufai Poultry Farms, Bakura, Zamfara State-Nigeria were used for this study. The eggs were collected in April, 2017, and transported to the General Laboratory Unit; College of Agriculture and Animal Science, Bakura, Zamfara State-Nigeria. The climatic condition of Zamfara is tropically warm with temperature ranging from 23.8-40.6^{0}C with relative humidity ranging from 21-34% between March to May. Rainy season starts in late May to September while the cold season (Harmattan) lasts from December to February (WMO, 2017).

The shell of each egg was smooth, clean, free of cracks and brown in colour. The freshness of the eggs and storage quality was evaluated by deeping the eggs into a bowl of water to check for floating eggs and candling to check the space and visibility of the yolk as described by David *et al*. (1997). The eggs were numbered with a permanent marker, and divided into three (3) different groups (A, B and C) each comprising of thirty (30) eggs All the eggs from each group (A, B and C) were weighed. Groups A had no oil coating (control group). Group B and C were coated by immersing the eggs into peanut oil and palm oil respectively. All the three (3) groups were stored at average room temperature 38.30^{0}C for four weeks.

In the month of April, 2017, the quality of the eggs in each group were determined as follows:

i. Egg shell: The shell of the eggs of each of the groups were physically examined with the naked eyes for defects (Nonga *et al*., 2010).
ii. Whole egg weight (g): The eggs were weighed on daily basis for four (4) weeks using an electronic digital balance (Mettler Toledo PL1501-S Precision Scale) with a sensitivity of 0.01g to 1000g, and the percentage weight loss after four (4) weeks was calculated (Anon, 1988).
iii. Egg yolk: Each egg was carefully broken to release the albumen and yolk on a smooth flat plate taking care not to rupture the vitelline membrane. The shape, firmness of yolk and colour were physically evaluated with the naked eye using the normal description of Nonga *et al.* (2010) and Shenstone (1968) as a guide
iv. Egg white (albumen): The relative viscosity was determined by gently rotating the plate and colour of albumen was evaluated with the visualizing with the naked eyes (Nonga *et al*., 2010; Shenstone, 1968).
v. Volume (ml): The volume of the albumen and yolk was measured using a measuring cylinder (JayTec United Kingdom BS. 604).

The data obtained were summarized into means and standard deviation of the means, and presented in tables and chat. One-way ANOVA using GraphPad InStat version 3.05 32 bit for Win, 95/NT, was used to compare the means between groups, and p values of less than or equal to 0.05 were considered statistically significant.

Results and Discussion

After four (4) weeks of preservation, it was observed that all the eggs stored in groups A, B and C had brown egg shell surfaces with no defect (Plate I, II and III), and eggs preserved with peanut oil and palm oil (group B and C) had a glossy shell cuticle (Plate II and III).

The mean egg weight of the eggs before preservation were 63.71g, 65.52g and 64.64g for groups A, B and C respectively (Figure 1). The mean egg weight of groups A, B and C at week 1-4 of preservation is as shown in Figure 2 and the mean percentage whole egg weight loss for groups A, B and C were 64.16g, 23.33g and 35.83g respectively (Table 1).

Plate I: A photograph of group A eggs stored at room temperature with non-oil coating (control group) showing the intact egg shell at week four (4)

Plate II: A photograph of group B eggs coated with peanut oil showing the intact egg shell with a glossy cuticle at week four (4)

Plate III: A photograph of group C eggs coated with palm oil showing the intact egg shell with a glossy cuticle at week four (4)

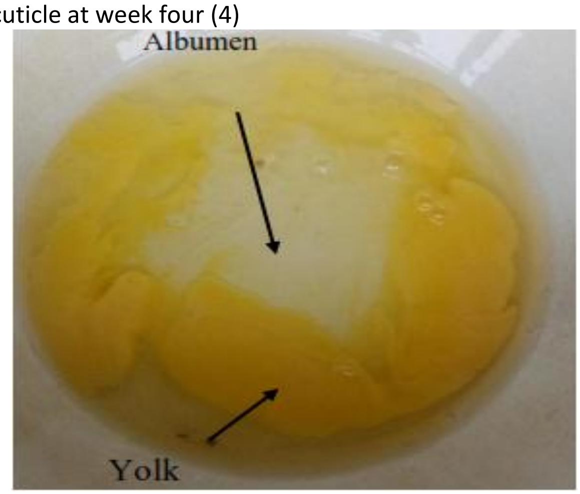

Plate IV: A photograph of the internal content of a non-oil coated egg stored (group A) stored for a period of four (4) weeks, showing the pale and broken yolk and the cloudy albumen

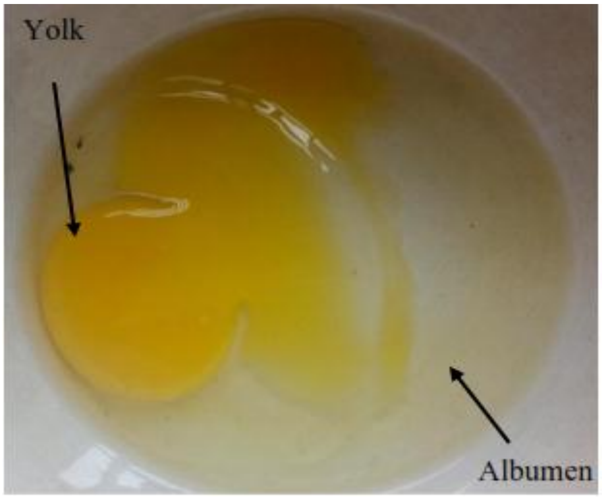

Plate V: A photograph of the internal content of a peanut oil coated egg (group B) stored for a period of four (4) weeks, showing a yellow, flat and broken yolk and a cloudy albumen

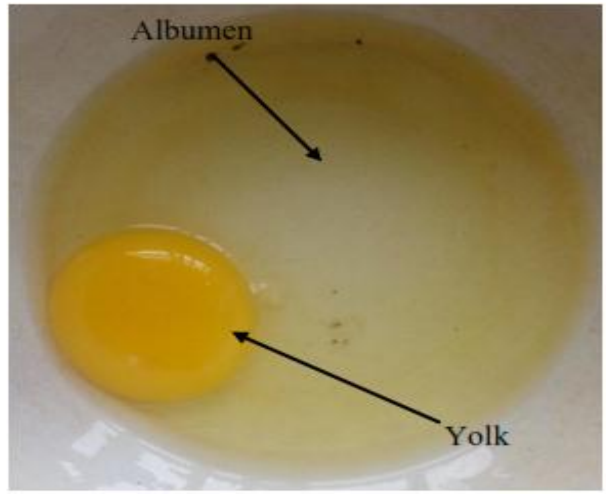

Plate VI: A photograph of the internal content of a palm oil coated eggs (group C) stored for a period of four (4) weeks, showing a yellow egg, rounded, compacted egg yolk that is high up above the albumen level and a cloudy albumen

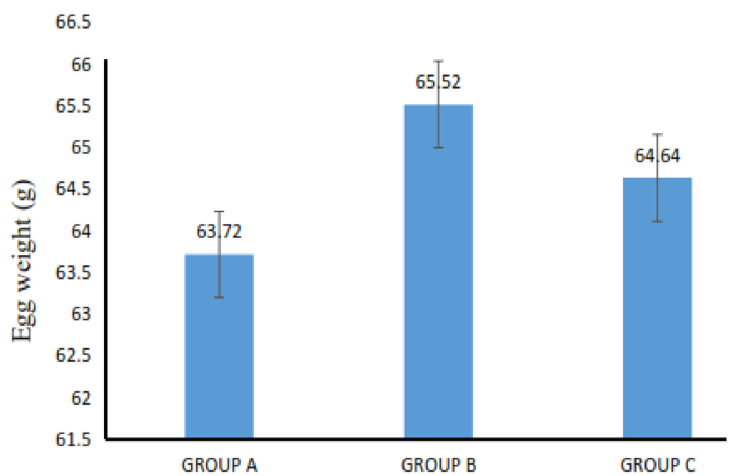

Figure 1. Mean egg weight (g) in group A, B and C before preservation

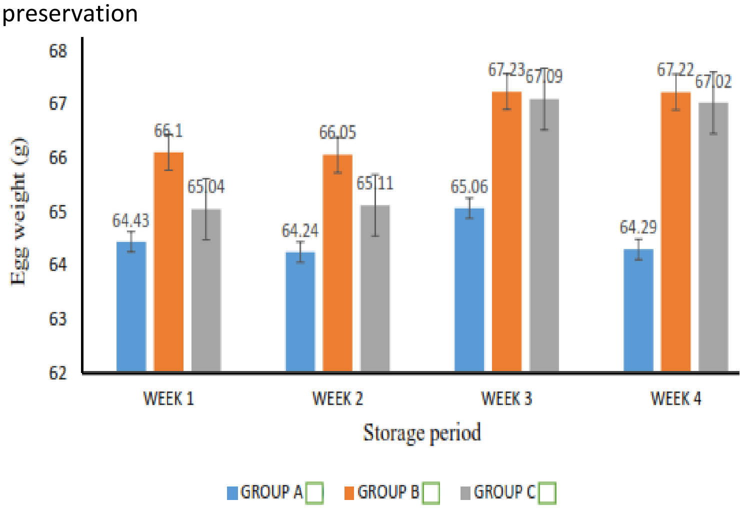

Figure 2: Average egg weight of groups A, B and C at 1-4 weeks of preservation

In all the groups, the internal component of each egg comprised of yolk and albumen contents sealed within a hard shell and no pungent smell was observed after four weeks of preservation, The control group (group A) had a pale, flat and broken yolk (Plate IV), and the eggs stored in peanut oil (group B) had a yellow, flat yolk that breaks easily (Plate V) and the yolk in eggs stored in palm oil (group C) was yellow in colour, rounded, compacted and high up above the albumen level (Plate VI). The egg white (albumen) in group A appeared cloudy and watery, group B and C also had a cloudy albumen with relative viscosity. The mean albumen and yolk volume for group A, B and C were 52.67ml, 61.00ml and 67.67ml, respectively.

Egg shell color does not affect the quality, taste, nutritional value, or cooking quality of eggs, and the shell color is determined by the breed of hen laying the egg and cannot be altered except in disease conditions (MSUES, 2017). The egg cuticle (bloom) is a natural protective coating of the eggshell that seals the pores/air cells (microscopic openings on the eggshell). The bloom helps to prevent bacteria from getting inside the shell and reduces moisture loss from the egg. In nature, the bloom dries and flakes off (AEB, 2017). The glossy cuticle of egg shell seen in group B and C of this study was due to the oil coating.

Table 1: Total mean percentage of egg weight loss and albumen and yolk volume of group A, B and C at storage temperature of 25^{0}C N=90

Group	Whole egg weight loss (%)	Volume (ml)
Group A (Crate n=30)	64.16±5.00^x	52.67±6.43^x
Group B (Peanut oil n=30)	23.33±2.72^y	61.00±7.00^y
Group C (Palm oil n=30)	35.83±5.00^z	67.67±10.79^z

Means in the same column with different superscripts (xyz) differ significantly (P< 0.05)

Nongtaodum *et al.* (2013) reported that the whole egg weight and internal quality of eggs begins to reduce and deteriorate after they have been laid due to loss of moisture, carbon dioxide and entrance of bacteria via the eggshell pores. In this study, as the eggs in all the groups ages, a progressive increase in the average whole egg weight was seen in 1-3 weeks of preservation and a subsequent decrease in the average whole egg weight was noted at week 4 (Figure 2). The increase in the egg weight seen from week 1-3 could be due to the absorption of the egg white into the egg yolk due the permeability of the vitelline membrane of the egg yolk, leading to the expansion and subsequent rupture of the egg yolk as seen in groups A and B (Benton & Brake, 1996). Eggs in all the groups had their highest average whole egg weight (65.06±91g, 67.23±4.18g and 67.09±5.73g for group A, B and C respectively) at the third week of storage (figure 2). However, the average percentage of whole egg weight loss for all the groups (group A, B and C) at week four (4) of this study showed significant difference (p<0.05), with group A having the highest average percentage egg weight loss of 64.16±5.00% (Table 1), which could be due to the evaporation of the internal egg content through the egg shell pores. This study demonstrated that oiling of eggs could have replaced the natural protective coating on the eggshell, hence maintaining the egg weight by preventing the evaporation of the internal content. Wahba *et al*. (2014) also noted that bad or very old eggs are extremely light in weight due to evaporation of the internal content via its eggshell pores (air cells). Furthermore the significant difference observed in the percentage whole egg weight loss and volume of non-oil coated eggs reported in this work agrees with. Wahba (2014), Nongtaodum *et al.* (2013), Torrico *et al.* (2011), and Heath (1977) who stated that mineral oil coatings minimized egg weight loss and preserved the albumen and yolk quality of eggs for a longer period than those observed for non-oil coated eggs at 25^{0}C.

The rupturing of the egg yolk observed in non-oil coated eggs and peanut oil coated eggs reported in this work might be due to the enlargement and weakness of the vitelline membrane of the yolk resulting from the absorption of albumin water into the yolk (Jones & Musgrove, 2005; Wahba *et al*., 2014).

Both peanut oil and palm oil are known to contain vitamin E, which is a lipid soluble antioxidant, which maintains the integrity of the egg shell and vitelline membrane of the egg yolk by protecting them from harmful oxygen-free radicals that causes egg yolk cholesterol oxidation and egg spoilage (Yang & Chen, 2001; Wolf, 2005). The vitamin E in peanut and palm oil are tocopherol and tocotrienol respectively (FITDAY, 2017), furthermore, the tocopherol in peanut oil has lower anti-oxidative capacity than palm oil (FITDAY, 2017). Hence the differences seen in the egg volume and egg yolk quality between the palm oil and peanut oil coated eggs. The general observations made from this study showed that all oil coated eggs had longer shelf life than non-oil coated eggs. However, eggs coated with palm oil had better internal quality compared to peanut oil coated eggs. It was therefore recommended that eggs should be preserved by coating with palm oil, so as to extend their shell-life and further chemical analysis of such coated eggs should be evaluated.

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