Cooking Eggs with Chemicals Lowers its Fat-Soluble Vitamins, Proteins, Fats and Cholesterol Contents

*U.A. Ibiam[1] N. Ezeani[1] E.I. Ugwuja[2] C.A. Afiukwa[3] P.M. Aja[1] P.C. Ugwu Okechukwu[1]
1.Department of Biochemistry, Faculty of Biological Sciences, Ebonyi State University, Abakaliki, Nigeria
2.Department of Chemical Pathology, Faculty of Clinical Medicine, Ebonyi State University, P.M.B. 053, Abakaliki, Nigeria
3.Department of Biotechnology, Faculty of Biological Sciences, Ebonyi State University, Abakaliki, Nigeria
Email Address: telludu@yahoo.co.uk

Abstract
The effects of cooking eggs with chemicals on its nutritional contents were studied in eggs from four bird species (*Gallus gallus*): quail (*Corturnix delegorgei*), guinea fowl (*Numida meleagris*), local chicken (*Gallus varius*) and high-breed chicken (*Gallus gallus domesticus*). A total of 60 eggs, consisting of 15 eggs from each bird species were studied. Eggs from each bird species were divided into groups A, B, C, D and E, of three eggs per group. Eggs in groups A, B, C and D were boiled with omo, klin, table salt and alum, respectively while group E eggs were boiled with water only and served as the control. Vitamins were determined using High Performance Liquid Chromatography (HPLC, AKAPTA), while protein, fat and cholesterol were determined using standard methods. Our results showed that quail egg was superior in fat-soluble vitamins content in comparison to the other eggs species. While the chemicals prevented cracking of the shell during boiling and enhanced peeling of the shell after cooking, they significantly ($p<0.05$) lowered the concentrations of vitamins, proteins, fat and cholesterol. These were observed in eggs cooked with these chemicals in comparison to the control, with the detergents having more devastating effects than table salt and alum.
Keywords: Chemical additives, nutrient composition, food processing, denaturation, biomolecules

INTRODUCTION

Eggs are excellent source of protein, vitamins and minerals, which help to maintain essential bodily functions. Most of the fat soluble vitamins are found in the yoke (Mann and Trustwell, 2002; Combs and Gerald, 2008). Eggs are low in saturated fats but high in monounsaturated fats (Roux and Martin, 2006). They complement other food proteins of lower biological value by providing the amino acids that are in short supply in those foods (Roux and Martin, 2006; Ensminger and Esminger, 1986). About 12.5% of the weight of egg is protein and is found in both the yolk and the albumen with more protein concentrated in the albumen (Stadelman and William, 1995). Most edible eggs include birds (*Gallus gallus*) eggs such as quail (*Corturnix delegorgei*), guinea fowl (*Numida meleagris*), local chicken (*Gallus varius*) and high-breed chicken (*Gallus gallus domesticus*), to mention a few (Aurand *et al*., 1987). It is an established fact that some important nutrients in foods are lost during processing. This is more evident where foods are cooked with some chemical additives (McGee and Harold, 2004; Pomeranze and Meloan, 1994; McGuire *et al*., 2007). In Abakalili metropolis, as in many other parts of Nigeria, eggs are cooked with various chemicals such as sodium chloride (table salt), alum and detergents. This is a common practice by those who cook eggs for sale, for instances, at the motor parks, along the streets, markets and in schools. Their reason for cooking with alum (aluminium potassium sulphate) or detergents is to preserve the integrity of the egg shell by preventing cracking during cooking and hence reduce financial loss due to cracking of the shell. Alum is a white crystalline double salt used for water treatment, tanning, dyeing and as fire proof in textile industries (Greenwood and Earnshaw, 1997). Omo and detergents are chemicals that are used mainly for washing dirty materials such as cloth, kitchen utensils, etc. The chemical composition of Omo and Klin are cleaning agents (anionic and non anionic surfactants), buffering agents, stabilizers and brightening agents. Table salt is a food additive used for cooking and is made up of sodium and chlorine. Boiling eggs with either alum or detergent gives the egg a shy appearance. Eggs cooked with these chemicals are bought and consumed by the unsuspecting public with the hope that they are eating whole egg with all the nutrients intact. To the best of our knowledge, there is yet no scientific data on the possible effects of these chemical on the nutrient composition of eggs. The main goal of this research was, therefore, to compare fat soluble vitamins, protein, fat and cholesterol contents in four species of bird eggs cooked with table salt, alum and detergents (omo and klin) and to determine the effects of these treatments on these nutrients.

MATERIALS AND METHODS RESULTS

Sample collection and distribution: Guinea fowl and Quail eggs were sourced from Fidgimor Poultry Farm, Abakaliki. High-breed chicken egg samples were sourced from Ebonyi State Poultry Farm, Nkaliki, Abakaliki, while native chicken eggs were sourced from a neighbour.

A total of sixty eggs were used and consisted of fifteen eggs from each bird. Eggs from each bird species were divided into five groups: A, B, C, D and E, with three eggs in each group. Eggs in groups A, B, C and D were boiled with omo, klin, table salt and alum, respectively. Group E eggs served as the control group.

Sample preparation: All the eggs were properly washed with tap water to remove debris and dirt. Thereafter the eggs were weighed to ensure that eggs of comparable weights were selected for the study. The cooking time for the eggs was standardized at 12 min. Cooked eggs were peeled to remove the shell and the egg yolk and albumin ground together in a mortar using a pestle. The ground samples were immediately used for the various analyses.

Biochemical analysis: Fat Soluble Vitamins (A, D, E and K) and cholesterol were determined using HPLC methods (Sharpless *et al*., 2000; Nikolova-Damyanova, 1997) while total fat was determined by AOAC Official Method (2005). Total protein was determined by Kjeldahl (Mossoba, 2004). All chemicals used were of analytical grade and HPLC grade and they were purchased from Aldich Nigeria, Jos, Nigeria.

Statistical analysis: Data were expressed as mean±SD. Comparison of means were done using One Way Analysis of Variance (ANOVA). Means were accepted as significantly different at $p<0.05$.

RESULTS

Our results showed that the concentrations of the fat-soluble vitamins (A, D and K) were significantly ($p<0.05$) higher in the quail eggs in comparison with other eggs while vitamin E was significantly higher in the local-bred chicken eggs than other egg species. Generally, all the fat-soluble vitamins were significantly ($p<0.05$) lower in eggs boiled with chemicals when compared with the controls, with the effects dependent on egg species and vitamins in question (Table 1). For instance, in quail (*Cortunix delegorgei)* egg, omo and klin had the highest effect on vitamin A composition, as value was significantly ($p<0.05$) lower than that of the control and those boiled with table salt and alum. However, although alum had no significant effect on vitamin A content of quail eggs, table salt was found to have significant effect, with vitamin A value significantly ($p<0.05$) lower than those of the control eggs. While all chemicals had comparable effects on all the fat-soluble vitamins in the local bred and guinea fowl eggs, omo and klin had the highest effects on vitamin A composition of the high-bred chicken eggs (Table 1). The impact of boiling eggs with chemicals on the protein, fat and cholesterol are presented in Table 2. All the chemicals had effects on total protein content of the eggs, but effects were found to be species-dependent. While klin, table salt and alum were found to have significant effect on total protein of quail, high-bred and guinea fowl eggs, with values significantly ($p<0.05$) lower than that of the control eggs, alum did not show any significant effect on the protein of the local chicken. Again, while omo did not show any significant effect on total protein content of guinea fowl eggs, significantly ($p<0.05$) effect was observed in the local-bred chicken eggs boiled with omo when compared with controls. The guinea fowl egg was least affected species as values were significantly lower than the probably due to the thickness of its shell whereas the control. Chicken egg was the most affected due to the high effect on cholesterol contents, of quail, high-bred and porosity and the thinness of the egg shell. In addition, local bred chicken egg, with values lower than that of the alum is a complex salt with the formular (KAl(SO4). The control, all the chemicals had no effect on the potassium ion (K+) in the salt can displace (due to its cholesterol composition of guinea fowl eggs as values position in the electrochemical series) the hydrogen ion were comparable to those of the control eggs. (H) or the hydroxyl group in vitamin A (and other

Table 1: Effects of detergents, salt and alum on fat soluble vitamins in cooked eggs

		Chemicals Used				
Egg Species	Vitamins	Control	Omo	Klin	NaCl	Alum
Quail egg	A (µg/100g)	467.7±9.89	68.23±1.73^{a}	65.15±1.62^{a}	207.2±5.93^{abc}	466.8±9.61
(*Cortunix delegorgei*)	D (IU)	20.9±2.77	10.1±2.88^{a}	9.1±1.62^{a}	11.68±2.37^{a}	10.4±1.97^{a}
	E (mg/100g)	0.71±0.21	0.25±0.01^{a}	0.21±0.05^{a}	0.42±0.04^{a}	0.39±0.08^{a}
	K (mg/100g)	0.18±0.02	0.05±0^{a}	0.03±0.01^{a}	0.04±0.01a	0.06±0.01^{a}
Local Chicken egg	A (µg/100g)	305.2±5.65	150.74±2.28^{a}	155.74±3.87^{c}	122.6±2.82^{a}	152.2±3.11^{a}
(*Gallus varius)*	D (IU)	18.8±1.84	9.45±0.35^{a}	10.3±0.42^{a}	7.3±1.83^{a}	10.5±0.56^{a}
	E (mg/100g)	0.8±0.16	0.41±0.04^{a}	0.3±0.02^{a}	0.31±0.07^{a}	0.36±0.06^{a}
	K (mg/100g)	0.15±0.01	0.07±0.01^{a}	0.03±0.01^{ad}	0.02±0.01^{ac}	0.06±0.01^{a}
High-breed Chicken egg	A (µg/100g)	256.1±4.24	56.89±5.65^{ae}	56.1±1.55^{ae}	97.27±1.79^{a}	104.1±5.79^{a}
(*Gallus gallus domesticus*)	D (IU)	18.3±0.72	9.51±0.43^{a}	9.5±0.56^{a}	8.201±0.69^{a}	9.89±0.26^{a}
	E (mg/100g)	0.5±0.14	0.15±0.02^{a}	0.11±0.01^{a}	0.31±02^{a}	0.28±0.04^{a}
	K (mg/100g)	0.13±0.02	0.02±0.01^{a}	0.01±0^{a}	0.021±0.01^{a}	0.07±0.01^{a}
Guinea fowl egg	A (µg/100g)	314.4±7.07	151.0±5.02^{a}	146±2.6^{a}	95.4±4.8^{af}	113.40±8.95^{a}
(*numida meleagri*s)	vitamin D (IU)	19.9±1.98	9.7±1.04^{a}	8.8±0.28^{a}	7.1±0.55^{a}	6.3±0.42^{a}
	E (mg/100g)	0.6±0.07	0.22±0.05^{a}	0.25±0.04^{a}	0.3±0.05^{a}	0.32±0.08^{a}
	K (mg/100g)	0.17±0.01	0.09±0.01^{a}	0.08±0.01^{a}	0.06±0.01^{a}	0.05±0.02^{a}

Superscripts a, b, c, d, e and f show siginificant difference at p<0.05. Except alum on vitamin A in quail egg, all the vitamins were significantly reduced by klin, omo, table salt and alum. Superscript a = significantly different from control; b = significantly different from omo and klin; c = significantly different from alum; d = significantly different from omo; e = significantly different from table salt and alum and f = significantly different from omo, klin and alum

Table 2: Effects of detergents, salt and alum on protein, fat and cholesterol in cooked eggs

		Chemicals				
Eggs species	Parameters	Control	Omo	Klin	NaCl	Alum
Quail egg	Total protein (mg/100g)	14.06±1.04	7.95±0.16^{a}	7.9±0.06^{a}	6.45±0.24^{a}	7.04±1.47^{a}
(*Cortunix delegorgei*)	total fat (mg/100g)	9.01±0.28	4.05±0.16^{a}	4.0±0.06^{a}	4.49±0.24^{a}	4.10±1.47^{a}
	cholesterol (mg/100g)	403±14.14	130±9.89^{a}	125±4.24^{a}	115±11.31^{a}	110±12.72^{a}
Local chicken egg	Total protein (mg/100g)	12.05±2.28	7.5±0.35^{a}	7.1±0.04^{a}	7.25±0.16^{a}	8.04±2.04
(*Gallus varius*)	total fat (mg/100g)	8.85±2.13	6.23±0.11	6.15±0.15	2.51±0.02^{ab}	5.58±2.04^{a}
	cholesterol (mg/100g)	407±59.89	318±54.24^{a}	314±45.65^{a}	216±35.65^{ab}	332±37.07^{a}
High-breed Chicken egg	Total protein	10.05±1.01	6.65±0.48^{a}	6.56±0.18^{a}	4.6±0.14^{a}	6.09±0.12^{a}
(*Gallus gallus domesticus*)	total fat	21.74±2.19	8.76±0.18^{a}	7.5±0.12^{a}	9.1±0.17^{a}	9.72±1.01^{a}
	cholesterol	420±8.48	325±5.65^{a}	320±7.07^{a}	239±8.48^{a}	228±5.65^{a}
Guinea fowl egg)	Protein	13.14±3.07	9.31±2.12	8.2±3.17^{a}	4.2±0.92^{ac}	7.12±3.41^{ad}
(*numida meleagris*)	Fat	9.25±1.16	8.25±0.96	6.23±2.204	7.0±1.28	9.12±1.17
	Cholesterol	418±11.31	417±8.34	402±10.82	401±9.89	406±15.55

Superscripts a, b, c and d show significance difference (p<0.05) between the treated group and the control. Except cholesterol in guinea fowl egg, all parameters measured were significantly reduced by all the chemicals used. Superscript a = significantly different from control; b = significantly different from omo, klin and alum and c = significantly different from omo and klin; d = significantly different from table salt

DISCUSSION

This study has shown that quail eggs are superior to other egg species studied in terms of protein and vitamins A, D and K values, while the local chicken eggs were richer in vitamin E content. Also fat and cholesterol were more abundant in the high-bred chicken eggs than other species. These results are in tandem with earlier reports (Stadelman and William, 1995; Roux and Martin, 2006). It also showed the destructive effects of boiling eggs with chemicals on the nutritive value of eggs with particular reference to fat-soluble vitamins, proteins, total fat and cholesterol. Although the reasons for the observed effects are not well understood, we speculate that they are caused by a combination of physical (heat) and chemical effects. For instance, the presence of table salt, omo, klin and alum in water increases the boiling point of water thereby increasing the amount of heat applied in boiling the eggs, which will eventually lead to loss of protein via denaturation. Protein undergoes denaturation or becomes destroyed when heat is applied to it for a long time (McGee and Harold, 2004; Atkins, 1994). Another possible explanation is that the shell of the eggs are porous, which may allow water and hence the chemicals to pass through, leading to interaction between the chemicals and the constituents of the eggs. This is exemplified by the observed higher vitamins), resulting in an entirely new product with a high molecular weight. Also, Al3+ on the other hand can form coordinate bonds with the vitamins or other components of the egg. All these will result in destruction of vitamins and hence, reduce the amount that would be detected by the HPLC method used in the present study. Similarly, EDTA (ethylenediaminetetraacetic acid) which is a component of most detergents such as omo and klin forms free radicals which can attack the vitamins and results in the formation of new products. This effect might have partly accounted for the highest effects exhibited by omo and klin on most of the nutrients in the eggs observed in this study. The least effect recorded in the guinea fowl eggs and local chicken eggs boiled with the chemicals suggest that the shells of these eggs species are thicker and less porous to these chemicals. In conclusion, our results have demonstrated that these eggs were very rich in fat soluble vitamins, protein, fat and cholesterol but cooking them with detergents, salt or alum, as is currently being practiced in many towns in Nigeria, destroys these physiologically important biomolecules and hence reduce the nutritional quality of the eggs. Though this practice is economically beneficial to the egg seller, it deprives consumers of the full value for their money in terms of the nutrient derivable from each egg consumed. It is therefore suggested that this practice be discouraged.

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