International Journal of Electrical Electronics & Computer Science Engineering
Volume 6, Issue 4 (August, 2019) | E-ISSN : 2348-2273 | P-ISSN : 2454-1222
Available Online at www.ijeecse.com

Non Destructive Evaluation of Trace Elements in Quail (Coturnix Coturnix) Eggs using Color Image Analysis

Ousman Boukar[1], Abdoul Yaya Yayafanta[2], Alban Ngatchou[3], Gamraïkréo Djaowe[4], Laurent Bitjoka[5]
[1-5]Laboratory of Energy, Signal, Imaging and Automation (LESIA), The University of Ngaoundere, Cameroon
[1, 5]National School of Agro-Industrial Sciences, P. O. Box 455, Ngaoundere, Cameroon
[1]boukarousman@gmail.com, [2]fantayayaabdoul@yahoo.fr, [3]ngatchou_alban@yahoo.fr, [4]djaowegamraikreo@gmail.com, [5]lbitjoka@gmail.com

***Abstract:** This paper introduces the nondestructive prediction of the concentration in trace elements of the quail Coturnix coturnix eggs by color image processing. First, the evaluation of zinc, chrome and magnesium elements of quail eggs was done by atomic absorption spectroscopy. Secondly, algorithms for the determination of the color co-occurrence matrix and Haralick attributes extraction were implemented. Then, eggs were classified according to these attributes and their concentration in trace elements. The obtained results showed that quail Coturnix coturnix eggs are grouped in three distinct classes. They have been determined by evaluating the aspect of the eggshell (Haralick attributes) to deduce the concentration in trace elements of the egg. The attributes f5 (homogeneity), f7 (variance of sums), and f12 (correlation information) are respectively strongly correlated to the zinc, chrome and the magnesium concentrations. Eggs with different shells have shown a different composition in trace elements.*

***Keywords:** Quail Eggs (Coturnix Coturnix), Trace Elements, Digital Color Image Processing.*

I. Introduction

The quail belongs to the family of Phasianidae, the order of Galliformes, the class of birds. The species or subspecies of the genus Coturnix live in all continents. There are subspecies among which the most important are Coturnix coturnix and the Asian or Japanese species, Coturnix japonica. They are bred for their flesh and, particularly, their eggs which are appreciated for their high nutritional value [1] and therapeutic value. Actually, it is in 1967 that Truffier, a French physician, showed that quail eggs have a profitable action against conjunctivitis, gastric acidity, high blood pressure, gout, diabetes and asthma for which the recovery rate for children is of 90% and of 75% for adults. At the end of his investigations, he proposed treatments made up of quail eggs at the rate of six (06) raw eggs taken on an empty stomach during nine (09) days, break for 09 days then resumption for 09 other days and so on until the end of the treatment, based on 240 eggs for diabetes, asthma and hypertension and 180 for gastric acidity. The very great quantity of consumed raw eggs provoked nauseas, lack of appetite, and then difficulties in following the treatment. To solve that problem, American laboratories have put in place sublingual drugs of a quail eggs homogenate. It is a homogenous mixture of eggs, cellulose and lactose, all frozen.

However, before using eggs, they are selected. Eggs non-destructive selection techniques up to now mentioned in the literature evaluate in a general manner egg (chicken) quality parameters like the detection of spots of dirtiness [2-4], the shell rigidity and the presence of cracks [5-6], the detection of undesirable inclusions like blood spots [7]. Considering that quail eggs, unlike chicken eggs, are used for therapeutic goals, the noninvasive evaluation of their physicochemical composition appears to be necessary. Relying on the fact that the color of the eggshell depends on the bird feeding and of its environment [8], we formulate the assumption that the quail eggshell could be the reflect of its chemical composition and of its content.

This work aims to predict the concentration in trace elements of quail Coturnix coturnix eggs from the image analysis of its shell. In order to achieve this objective, we are going to implement the following steps:

- Evaluation of the trace elements content of quail eggs;
- Classification of eggs according to the attributes of Haralick;
- Classification of eggs according to their concentrations in trace elements;
- Correlation of image attributes to the concentration in trace elements.

The next section (section II) describes the material used and the methodology adopted. Section III presents the results obtained. We conclude in section IV.

II. Material And Methods

1. Quail Eggs:

Quails which eggs are used in this study are from the species Coturnix coturnix. Their nutrition is made up of seeds of maize, soybean and shell. The prepared samples have been selected and grouped in three classes of 10 eggs according to the following criteria:

- *White:* eggs are white, looking like pigeon eggs.
- *Bright:* these eggs have big, brown or black spots.
- *Green:* in this class, eggs have small, brown or black spots almost uniformly distributed.

Figure 1 presents these empirical classes.

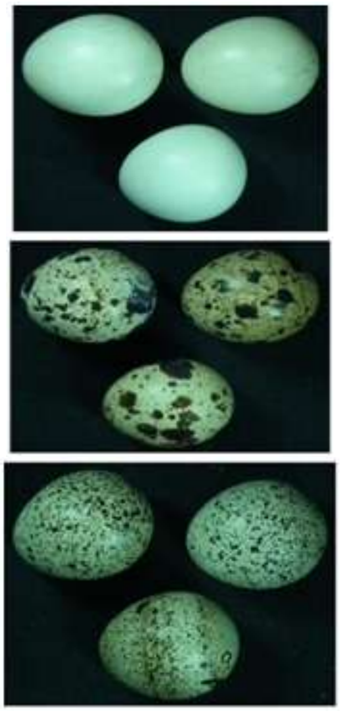

Fig. 1. Empirical classes of quail eggs. From the top to the bottom, we have the white class, the bright class and the green class

The eggs samples used have the average physical characteristics presented in Table 1 below.

Table 1. Physical Characteristics of Quail Eggs

Whole Egg (g)	Egg Content (g)	Water Content (%)	Dry Matter (g)	Ashes content (g)
11.03 ± 1.37	9.45 ± 0.81	75.74	2.49 ± 0.32	2.15 ± 0.25

2. Images Acquisition Setup:

The imaging system used in this work, the camera (Fujifilm FinePix F480) and a light box (Silvania 50-60Hz, 220V, 36W), was previously described by Bitjoka et *al.* [9].The box dimensions and the different positions and locations of lamps are chosen in such a way that the observation angle proposed by the International Commission of Illumination (abbreviated CIE for its French name, Commission international de l'Eclairage) is respected.

3. Biochemical Methods:

The zinc (Zn), chrome (Cr) and magnesium (Mg) concentration of quail eggs is determined by atomic absorption spectroscopy. For each element, multiple range tests are carried out with Statgraphics® to determine which class of eggs means are significantly different in the 95% confidence level from each others.

4. Image Analysis and Trace Elements Evaluation:

First of all, the egg image is separated from the background, by implementing in Matlab® the color image segmentation algorithm developed by Kang & Sabarez[10].Then, the color co-occurrence matrix is computed for the green component in four directions (0°, 45°, 90°, 135°), with the Manhattan distance of one pixel, and13 Haralick attributes (f1, f2, … f13) are extracted. The evaluation of the concentration is obtained by discriminant function analysis.

III. Results And Discussion

1. Trace Elements Content of Quail Eggs:

1.1 Comparison of the Chrome Content in Eggs:

Table 2 shows that the three classes of eggs are different. Differences in means are presented in table 3.

Table 2. Multiple Ranges Test of Chrome Absorbance Per Class

Class	Count	Mean	Homogeneous Groups
White	10	0.0	X
Bright	10	0.0022	X
Green	10	0.0043	X

Table 3. Difference in Means of Chrome Absorbance

Contrast	Sig.	Difference of Means	+/- Limits
White - Bright	*	-0.0022	0.0012
White - Green	*	-0.0043	0.0012
Bright - Green	*	-0.0021	0.0012

1.2.Comparison of the Zinc Content in Eggs:

Table 4 shows that the three classes of eggs are different. Differences in means are presented in table 5.

Table 4. Multiple Ranges Test of Zinc Absorbance Per Class

Type	Number	Mean	Homogeneous Group
Bright	10	0.1358	X
White	10	0.1409	X
Green	10	0.1806	X

Table 5. Differences in Means of Zinc Absorbances

Contrast	Sig.	Difference of Means	+/- Limits

International Journal of Electrical Electronics & Computer Science Engineering
Volume 6, Issue 4 (August, 2019) | E-ISSN : 2348-2273 | P-ISSN : 2454-1222
Available Online at www.ijeecse.com

White - Bright		0.0051	0.0092
White - Green	*	-0.0397	0.0092
Bright - Green	*	-0.0448	0.0092

1.3. Comparison of the Magnesium Content in Eggs:

Table 6 shows that the three classes of eggs are different. Differences in means are presented in table 7.

Table 6. Multiple Ranges Test of Magnesium Absorbance Per Class

Type	Number	Mean	Homogeneous Group
Bright	10	0.0116	X
White	10	0.018	X
Green	10	0.0226	X

Table 7. Differences in Means of Magnesium Absorbances

Contrast	Sig.	Difference of Means	+/- Limits
White - Bright	*	0.0064	0.00303207
White - Green	*	-0.0046	0.00303207
Bright - Green	*	-0.011	0.00303207

The concentration in trace elements (zinc, chromium, magnesium) determined after calibration are presented in table 10. Eggs of the « green » class are richer in these elements.

Table 8. Trace Elements (Chrome, Zinc and Magnesium) Content of Quail Eggs

Samples	Chrome Content (mg/g)	Zinc Content (mg/g)	Magnesium Content (mg/g)
Bright	4.53a ± 0.18	17.22a ±0,.73	0.78a ± 0.14
White	4.16b ± 0.00	17.86a ±1.64	1.18b ± 0.20
Green	4.88c ± 0.33	22.82b ±1.22	1.45c ± 0.28

2. Classification:

2.1. Classification of Eggs According to Haralick Attributes:

After extracting the Haralick attributes from the co-occurrence matrix for each egg, we have done a discriminant analysis in order to verify the observations that allowed us to differentiate the three samples. Two statistically significant discriminant functions were evaluated. The classification table (Table 9) and the graph of the discriminant functions (Figure 2) show that among the 30 eggs used to adjust the model, 26, that is 86.67% have been correctly classified, which proves that the formed classes of eggs depend on the Haralick attributes.

Table 9. Classification Table

Observed Type	Group Size	Planned Type		
		White	Bright	Green
White	10	10	0	0
		(100.00%)	(0.00%)	(0.00%)
Bright	10	0	8	2
		(0.00%)	(80.00%)	(20.00%)
Green	10	0	2	8
		(0.00%)	(20.00%)	(80.00%)

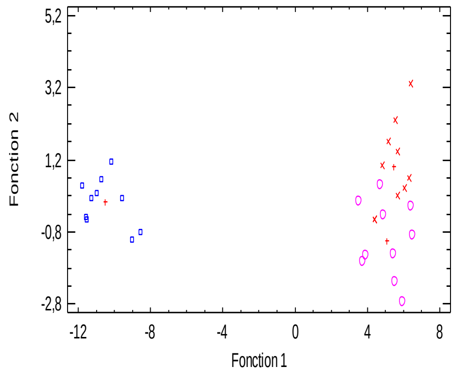

Fig. 2. Graph of Discriminant Functions

2.2. Eggs Classification According to their Content in Trace Elements:

Here, we still do a discriminant analysis and also the two discriminant functions in order to prove that the content in trace elements depends on the type of egg. The classification table (Table 10) and the discriminant functions graph of figure 3 show that 29 of the 30 eggs, that is 96.66%, have been well classified. We can notice the discriminant functions graph that an egg of class « green » is considered as belonging to class « white ». This explains that classes of eggs are 96.66% dependent on their trace element content.

Table 10. Classification Table

Observed Type	Group Size	Planned Type		
		White	Bright	Green
White	10	10	0	0

		(100.00%)	(0.00%)	0.00%)
Bright	10	0	10	)
		(0.00%)	(100.00 %)	0.00%)
Green	10	1	0	)
		(10.00%)	(0.00%)	90.00%)

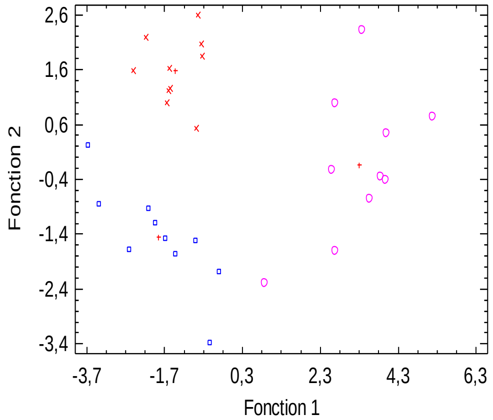

Fig. 3. Graph of Discriminant Functions

Contrary to [11] who asserts that the colour of the shell has no influence on the nutritional value of the egg, but that it corresponds to particular preferences of the consumer and to [12] according to whom, the colour of the shell can be influenced by a poor breeding practice, we see, given the results of classification that the colour of the shell is not a factor to be neglected when estimating the nutritional value of the quail egg. The shell of the quail Coturnix coturnix is a reflection of its content.

Since the different classes of eggs are a function of the Haralick attributes on the one hand and of the trace elements content on the other hand. What are the Haralick attributes that describe the concentration in trace elements in a quail eggs. To address this concern, we will identify Haralick attributes that are strongly correlated by simple to different concentrations.

3. Correlation of Haralick Attributes to Trace Element Content:

After having examined all the calculated attributes, we realize that attributes f5, f7, f12 are better correlated respectively to zinc, chrome and magnesium.

3.1. f7 Simple Regression According to Cr:

Here, we show in table 11 the results of the linear model adjustment to describe the relationship between f7 and Cr. The equation of the adjusted model is:

$$f7 = 9.48 + 2088.39 \times Cr$$

The graph of figure 4 presents the adjusted model off 7 depending on the chrome. The R-square statistic indicates that the adjusted model explains 94.68% of the variability in f7. The correlation coefficient is 0.97; indicating a strong relationship between f7 and chromium variables. The mean absolute error of 0.88 is the average value of the residues.

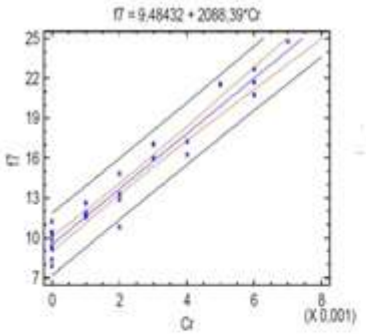

Fig. 4: f7 Adjusted Model Graph According to Chrome

Table 11. f7 Chrome Regression Parameters

Correlation Coefficient	R-Square	Mean Absolute Error
0.97	94.68 %	0.88

3.2. f5 Simple Regression According to Zn:

We show here the results of adjustment of a linear model in order to describe the relation between f5 and Zn. The equation of the adjusted model is:

$$f5 = 0.64944 + 2.08457 \times Zn$$

The graph of figure 5 presents the adjusted model f5 depending on the zinc. The R-square statistic indicates that the adjusted model explains 81.60% of the variability in f5. The correlation coefficient is 0.90; which indicates a strong relation between f5 and zinc variables. The mean absolute error of 0.01 is the mean value of residues. Figure 5 graph presents the adjusted model.

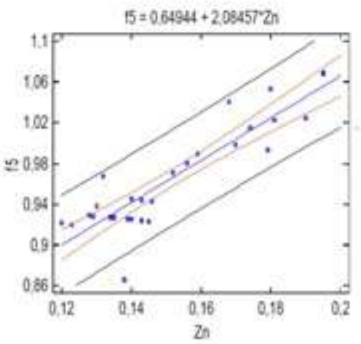

Fig. 5. f5 Adjusted Model Graph Depending on Zn

Table 12. f5 Zinc Regression Parameters

Correlation Coefficient	R-Square	Mean Absolute Error
0.90	81.60%	0.01

3.3. f12simple Regression According to Mg:

We present here a linear model adjustment results to describe the relation between f12 and Mg. The adjusted model equation is:

$$f12 = -02.05863 + 62.0128 \times Mg$$

The graph of figure 6 presents the adjusted model f12 depending on the magnesium. The R-square statistic indicates that the adjusted model explains 85.83% of the variability in f12. The correlation coefficient is 0.92; which indicates a strong relation between the variables. The mean absolute error of 0.08 is the mean value of the residues. Figure 5 presents the adjusted model.

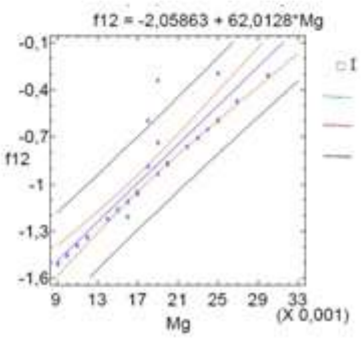

Fig. 6. f12 Adjusted Model Graph According to Mg

Table 13. f12 Regression Parameters

Correlation Coefficient	R-Square	Mean Absolute Error
0.92	85.83	0.08

IV. CONCLUSION

The main object of this study was to implement a nondestructive model to evaluate the trace elements in quail eggs. To achieve these results, we have used the co-occurrence matrix to extract Haralick attributes from the RGB color images. The results obtained show on the one hand that the types (classes) of quail Coturnix coturnix eggs were determined knowing the 13 attributes of Haralick. For 30 eggs used to build this model, 26, that is 86.67% have been well classified. On the other hand, the types of eggs have been determined knowing the different concentrations in trace elements. Again, for 30 used eggs, 29, that is 96.67% were well ranked.

Since egg types depends on both shell appearance (Haralick attributes) and micronutrient concentrations (zinc, chrome, magnesium), we have identified the attributes that best correlate with these concentrations. The results we obtained show that there is a strong relation between f7 attribute (variance of sums) and chrome concentration, between f5 attribute (homogeneity) and the zinc concentration, between f12 (correlation information) and magnesium concentration.

ACKNOWLEDGMENT

The authors gratefully acknowledge Prof. Njintang Nicolas and Dr. Beka Robert Germain of Biophysics and Food Biochemistry Laboratory for the technical assistance in physico-chemical analysis. We would like to express our gratitude to Dr. Kamla Corneille Vivient who contributed to develop the statistical analysis study. The work presented in this paper was supported by the National School of Agro-Industrial Sciences and the Cameroon Ministry of Higher Education.

V. REFERENCES

[1] R. Ibrahim, Z. Mohd Zin, N. Nadzri, M. Z. Shamsudin, and M. Z. Zainudin, “Egg’s Grade Classification and Dirt Inspection Using Image Processing Techniques”, in Proceedings of the World Congress on Engineering (WCE2012), London, U.K., July 4 - 6, 2012, Vol II, pp. 1179-1182.

[2] M.C. Garcia-Alegre, J. Ensico, A. Ribeiro and D. Guinea, “Towards an automatic visual inspection of eggshell defects”, Proc. Intern. Workshop on Robotics and Automated Machinery for Bio-Productions, Gandia, Spain, 1997, pp. 51-56.

[3] K. Mertens, B. De Ketelaere, B. Kamers, F. R. Bamelis, B. J. Kemps, E. M. Verhoelst, J. G. De Baerdemaeker, and E. M. Decuypere, “Dirt detection on brown eggs by means of color computer vision”, Poultry Science, 84(10), 2005, pp. 1653–1659.

[4] S. Arivazhagan, R. Newlin Shebiah, Hariharan Sudharsan, R. Rajesh Kannan, and R. Ramesh, “External and internal defect detection of egg using machine vision”, Journal of Emerging Trends in Computing and Information Sciences, Vol. 4, No. 3, 2013, pp. 257-262.

[5] M. C. Garcıa-Alegre, A. Ribeiro, D. Guinea, and G. Cristobal, “Color index analysis for automatic detection of eggshell defects”, in Proc. SPIE 3966, Madrid, Spain, 2000, pp. 380-387.

[6] H. R. Pourreza, R. S. Pourreza, S. Fazeli, and B. Taghizadeh, “Automatic detection of eggshell defects based on machine vision”, Journal of Animal and Veterinary Advances 7 (10), 2008, pp. 1200-1203.

[7] V. C. Patel, R. W. Mcclendon, and J. W. Goodrum, “Color computer vision and artificial neural networks for the detection of defects in poultry eggs”, Artificial Intelligence Review, 12, 1998, pp. 163-176.

[8] H.-C. Liu and W. T.-K. Cheng, “Eggshell pigmentation: a review”, Journal of the Chinese

Society of Animal Science, 39 (2), 2010, pp. 75-89.

[9] L. Bitjoka, O. Boukar, D. Tenin, M. F. C. Mbofung, and E. Tonye, “Digital camera images processing of hard-to-cook beans”, Journal of Engineering and Technology Research, 2(9), 2010, pp. 177–188.

[10] S. P. Kang and H. Sabarez, “Simple colour image segmentation of bicolour food products for quality measurement”, Journal of food engineering, 94(1), 21-25, 2009.

[11] R. Wei and J. J. Bitgood, “A new objective measurement of eggshell color 1. a test for potential usefulness of two color measuring devices”, Poultry Science, 69(10), 1990, pp. 1775-1780.

[12] Gary D. Butcher and Richard D. Miles, “Factors Causing Poor Pigmentation of Brown-Shelled Eggs”, University of Florida, retrieved June 7, 2019, from https://edis.ifas.ufl.edu/pdffiles/VM/VM04700.pdf.