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A Model for Promoting Poultry Industry Development in Togo: Part 1. Management Practices and Incubation Conditions

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Abstract: In commercial poultry husbandry practice, the hatchery takes over the incubation of bird eggs in order to provide as many day-old chicks as needed at any time to farmers. The main bottleneck for poultry industry development in Togo is the lack of day-old chick supply. Indeed, there is no proficient hatchery which can cover the needs of the farmers because of lack of information about hatchery management or people trained as hatchery managers. Also, there is lack of information about management practice aspects, etc. With the aim to promote poultry industry in Togo, an interuniversity project [Catholic University of Leuven (KUL) and University of Lome (UL)] as a model of poultry industry development was implemented. Specific objectives of the current project are to implement research and development activities on better conditions of incubation and adapted management practices focusing mainly on (1) Effect of early transferring of layer breeders hatching eggs on embryo parameters and hatchability, (2) Comparison of different chicken genotypes in Embryo Physiology, (3) Effects of heat conditioning at d 16 to 18 of incubation or during early broiler rearing on embryo physiology, post-hatch growth performance and heat tolerance, (4) Effect of low albumen quantity on chick embryo and post-hatch parameters, (5) Effects of In ovo-administration of L-carnitine on hatching events and juvenile performance of layer-type chick, (6) Interaction effects of mixing hatching eggs of differential embryo growth trajectory and incubator CO_2 concentration on embryo physiological parameters, (7) Effect of delayed feed access on production and blood parameters of layer-type chicks and (8) Induced moulting of layer chickens.

Key words: Poultry development, incubation, delayed feeding, carnitine, moulting, temperature treatment

INTRODUCTION

Livestock, especially poultry, make a substantial contribution to household food security by providing income, quality food, fertilizer and assets in over 80% of rural households in developing countries (Bebay, 2003). Constraints faced by the rural producer in resource-poor areas include: lack of access to markets, goods and services; weak institutions; and lack of skills, knowledge and appropriate technologies. As results, both production and productivity remain below potential and losses and wastage can be high. However, imported breeds can be adapted and local feed resources are available, along with proven technologies that include preservation and value-added product processing which could substantially improve productivity and income generation.

Togo is a primarily agricultural country. The rural population is estimated at 80% of the total population. In the 1970's, new livestock development policies with development of short-cycle animals, especially poultry, as key elements were launched. However, the species with short cycle are faced with many constraints in particular husbandry techniques and health thus limiting the socio-economic role of this activity for rural population. Although family poultry production is still an important activity and helps preservation of within species biodiversity, its commercial impact is decreasing every year whilst commercial poultry production is increasing. But, breeding of high productive chickens is dependent on external inputs such as day-old chicks, prophylactic measures and special food components. Among these inputs, only day-old chicks are scarcely available so that besides capital availability, supply of day-old chicks remains the major problem for the farmers. With the aim to promote poultry industry in Togo, an interuniversity project [Catholic University of Leuven (KUL) and University of Lome (UL)] as a model of poultry industry development was implemented. The main thrust of this project is to improve poultry industry in Togo and its neighboring

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countries through adapted mechanisms that will allow different chickens' lines to perform well under local environmental conditions in order to improve the economics of production. More precisely, this project was dealing with adapted incubation conditions in order to produce day-old chicks of optimal quality which can cope with hot and wet climatic conditions. Also, the current project focused on development of new technologies in poultry production and implementation of research on better conditions of incubation and management practices. The research and development activities focused on (1) incubation conditions of hatching eggs and rearing managements of hatchlings and (2) evaluation and description of the effects of delayed feed and water access on post-hatch performance. More precisely, the project provided relevant information about:

- Several aspects of incubation conditions of hatching eggs and rearing managements of hatchlings
- Evaluation and description of the effects of delayed feed and water access on post-hatch performance
- Induced molting of layer chicken

Incubation conditions of hatching eggs and rearing managements of hatchlings

Effect of early transferring of layer breeders hatching eggs on embryo parameters and hatchability: Besides temperature and relative humidity, the turning requirements are also important for incubation. It may affect the physiological development of the embryo and hence the hatchability. Wilson (1991) pointed out that turning involves several variables such as frequency, axis of setting and turning, turning angle, planes of rotation and stage of incubation. In practice, it is common to turn and transfer the eggs from incubator turning trays to hatcher trays during the 18th day of incubation. However, due to management practices in hatcheries, incubated eggs transferring can take place between 15 to 18 days of incubation. Studying broiler hatching eggs, Tona *et al.* (2001) concluded that transfer time has to be considered in order to optimize hatchability and chick quality, especially if the eggs from older flocks are incubated. To our knowledge there is no information about the effects of layer breeder eggs transferring on hatching performance. Investigations in our laboratory focused on the effects of transferring layer hatching eggs at 15 days of incubation on hatching parameters. Hatching eggs produced by Hisex Brown layer breeders provided by Levrau Hatchery (Belgium) were incubated in forced draft incubators (Petersime incubators 96) at standard incubation conditions. At d 15 of incubation, three replications of 150 eggs each were transferred from turning trays to hatching baskets. At day 18 of incubation another three replications of 150 eggs each were also transferred. Sample of eggs were used for embryo wet and dry weights recording at day 15 and 18 of incubation. At the end of incubation (21 days), number of hatched chicks were recorded according to their sex and weighed. Unhatched eggs were opened for macroscopic analysis in order to classify them as "infertile eggs" or egg containing dead embryos. Eggs with dead embryos were classified as early (0 to 15 days) or late dead embryos (15 days onward). Late dead embryos were classified as pipping dead or malpositioning dead embryos. Embryo wet and dry weights increased with incubation stages in a similar way, for both incubation treatments. Eggs transferred at 18 days of incubation had higher hatchability of female chicks (45.1% for female chicks vs. 42.2% for male chicks) while for those transferred at 15 days hatchability of male chick was higher (44% for male chicks vs. 42.1% for female chicks) ($p<0.01$).

Comparison of different chicken genotypes in embryo physiology: Chicken post-hatch performance is known to be related to embryonic developmental parameters. However, strain or genotype differences with regard to embryo physiological parameters have received little attention. Two different studies were conducted to compare chicken genotypes in embryo physiology and/or post-hatch juvenile growth. In a first study, a total of 1,200 hatching eggs produced by Lohmann Brown (LB) and Lohman White (LW) breeders of the same age were studied. Between 62 and 150 h of incubation, embryo development was monitored by acoustic resonance analysis as described previously by Coucke *et al.* (1997). Briefly, the method involved the mechanical excitation of the egg by a mechanical impactor. The impactor hit the egg at its equator and the noise of the vibrating egg was recorded by a microphone positioned at the equator at an angle of 90° to the impacter. The recorded signal was then sent to a data acquisition card and transformed by fast Fourier transformation to obtain the resonant frequency for the first spherical mode of the vibrating egg. In this experiment, four instantaneous excitations with a phase shift of 90° were applied at the equator zone of the eggs. Also, albumen pH was measured between setting and d 8 of incubation. From 10 to 18 days of incubation, remaining albumen and embryos were weighed. During the last days of incubation, hatching occurrences were monitored after every four hours and hatched chicks were recorded. Results indicate that RF of LW eggs were lower than that of LB eggs ($p<0.01$) and starting time point of RF decrease occurred 4 h earlier in LB eggs than in LW eggs. Albumen pH of LB eggs was lower than that of LW eggs at day 8 of incubation. Remaining albumen weight at 14 and 16 days of incubation was lower in LB than in LW ($p<0.05$) while embryo weights increased more rapidly in LB strain than in LW strain (Fig. 1). The faster growth of LB embryo compared with LW embryo

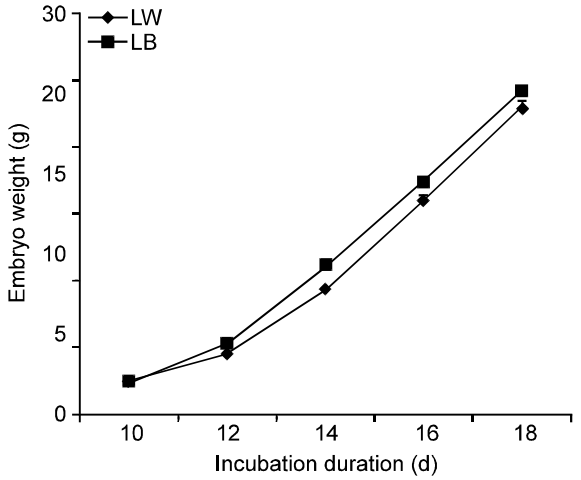

Fig. 1: Embryo growth in relation to post-hatch stage and according to strains (LW: Lohmann White and LB: lohmann Brown). At each incubation day, *indicates difference between albumen weights

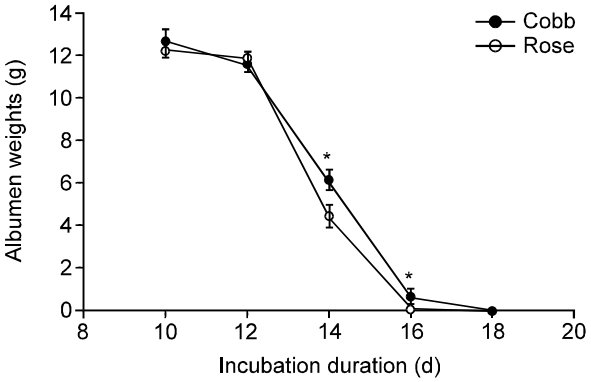

Fig. 2: Remaining albumen weights according to incubation day and strains. At each incubation day, *indicates difference between albumen weights (Tona *et al*., 2010)

observed up to d 16 of incubation lasted until end of incubation. As result, incubation duration was 7 h shorter for LB eggs than that of LW eggs. This delay in hatching of LW eggs was related to a delay in the initiation of embryogenesis (Becker *et al*., 1968; Mclaury and Insko, 1968; Mather and Laughlin, 1976) and in a decrease in rate of embryo development.

The second study compared embryo physiology and post-hatch juvenile growth of two broiler lines. A total of 1,200 hatching eggs produced by Cobb and Ross broiler breeders of the same age were studied. At setting for incubation and between 66 and 130 h of incubation, egg Resonance Frequency (RF) was measured as an indicator of the formation of sub-embryonic fluid. Also, eggs were weighed before setting and at d 18. From d 10 to 18 of incubation, remaining albumen was weighed. During the last days of incubation, hatching events such as internal pipping (IP), external pipping and hatch were monitored every 2 h. Hatched chicks were recorded and weighed. At IP stage, gas partial pressures in the egg air chamber were measured. Hatched chicks were reared for 7 d and weighed. Results indicate that RF of Ross eggs were lower than those of Cobb eggs ($p<0.01$) and starting time point of RF decrease occurred 4 h earlier in Cobb eggs than in Ross eggs. This difference in RF suggests that Cobb embryo initiation was faster than that of Ross embryo. Between d 12 and d 16 of incubation, remaining albumen weight was lower in Ross strain than in Cobb strain (Fig. 2) indicating that during this stage Ross embryo utilize albumen faster for growth. Relative egg weight loss up to 18 d of incubation was lower in Cobb than in Ross ($p<0.05$). At IP, partial pressure of CO_2 was higher in Cobb than in Ross ($p<0.05$) with shorter incubation duration in Cobb suggesting that conducting through egg shell is lower for probably due to differential shell characteristics. Between 6 and 60 h post-hatch, heat production was higher in Cobb than in Ross ($p<0.05$). At 7 d post-hatch, Cobb chicks were heavier than Ross chicks ($p<0.05$). More details about Cobb and Ross comparison are published in Poultry Science (Tona *et al*., 2010).

Effects of heat conditioning at d 16 to 18 of incubation or during early broiler rearing on embryo physiology, post-hatch growth performance and heat tolerance: This study was designed to test the effect of pre- and post-hatch temperature conditioning or a combination of both, on the acquisition of heat tolerance during the adult life of broiler chickens. Nine hundred hatching eggs produced by Cobb broiler breeders were incubated at standard incubation conditions until d 16. Half of the eggs were subjected to temperature conditioning for 3 h/day (39.5°C, 65% relative humidity (RH)) at d 16, 17 and 18 of incubation (T group) while the other half Control group (C group) were kept at standard incubation conditions. From the end of d 18 until the end of incubation, embryo heat production (HP), gas partial pressure in the air chamber at IP and blood parameters (T_3 and corticosterone) were measured. Also, hatching time for individual chick, body temperature (Tb) and body weight (BW) and the number of hatched chicks were recorded. Hatched chicks were raised under regular conditions. At the age of 3 d, the chicks of each incubation condition group were divided into 2 groups: half of the chicks of each group (C and T) were subjected to thermal conditioning (41.0°C for 6 h). The other half of the chicks was used as control. The 4 groups of broilers (Fig. 3) were reared until 42 d of age. During post-hatch period, Tb, blood parameters and BW were again measured. At 42 d all broilers were heat challenged at 35°C for 6 h. After heat challenge, mortality

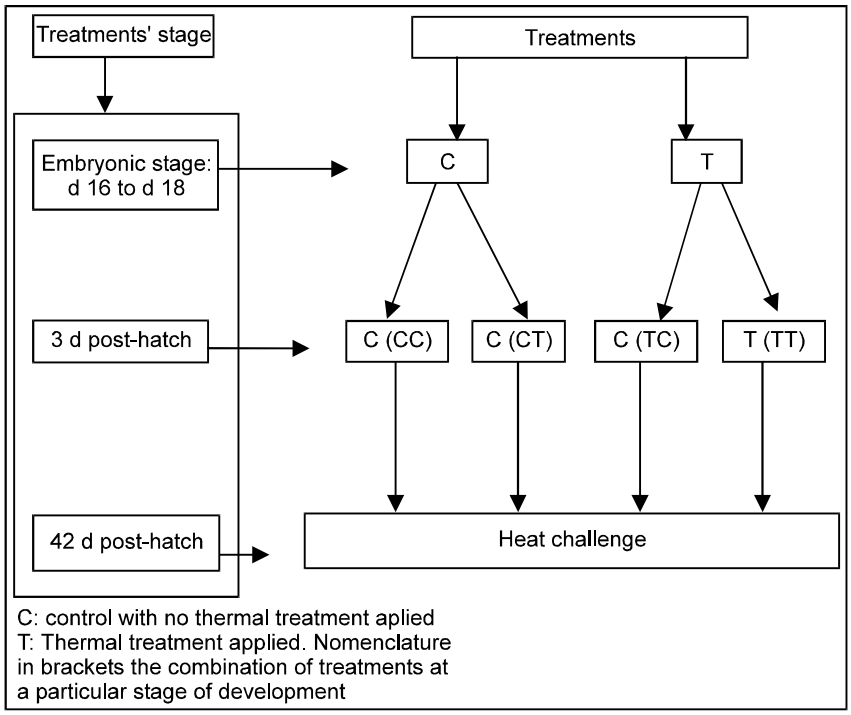

Fig. 3: Scheme of thermal treatments applied at embryonic stage, 3 d and 42 d post-hatch (Tona *et al*., 2008)

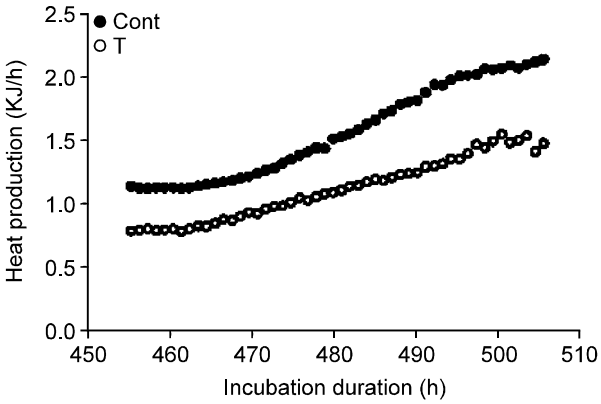

Fig. 4: Heat production according to the incubation duration and heat conditioning groups (T: temperature manipulation; Cont: control group). Each data point represents the mean heat production/hr/egg calculated from the O_2 consumption and CO_2 production during 456-510th h of the incubation period (Tona *et al*., 2008)

was recorded and blood samples were collected. The results indicate that thermal conditioning during incubation had no effect on hatchability of eggs but prolonged incubation duration, decreased T_3 (at IP), corticosterone (at IP and hatch), HP (Fig. 4) and Tb. Overall, at 3 d post-hatch, prenatal conditioning increased while post-natal conditioning decreased corticosterone levels. Heat challenge at 42 d post-hatch decreased T_3 levels in the TC group and increased corticosterone levels in postnatally conditioned group. Differences between BW become obvious from 28 d post-hatch and at 42 d, the highest BW was obtained in the broilers of TC group. Heat conditioning at 3 d of age improved heat tolerance in response to heat challenge at 42 d. post-hatch whereas prenatal treatment had a strong negative effect. For more information see Tona *et al*. (2008) in European Poultry Science.

Effect of low albumen quantity on chick embryo and post-hatch parameters: Hatching eggs from Isa Brown layer breeders were used in order to evaluate the effects of albumen removal on embryogenesis and chick juvenile growth. Prior to incubation, the eggs were weighed, numbered and divided into two groups (control and albumen). Two mL of thin albumen was removed from each egg of albumen group and all the eggs of this group were weighed again. Then, the hatching eggs of both groups were incubated randomly in the same incubator. During incubation, samples of eggs were used to measure albumen pH from 1 to 6 days of incubation and embryo and remaining thick albumen weights between 11 and 18 days of incubation. Also, yolk weights were recorded between 14 and 18 days of incubation. From 19.75 to 21.25 days of incubation, the hatched chicks were recorded every 2 h according to

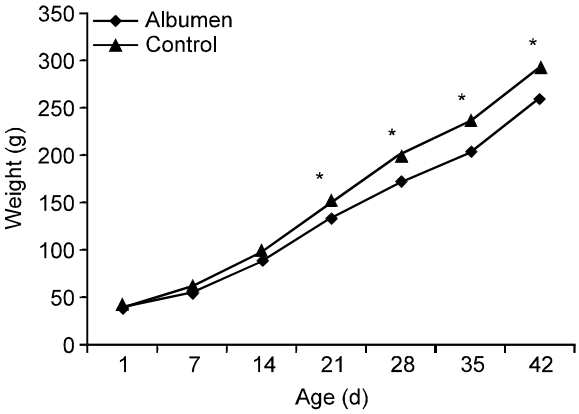

Fig. 5: Chick weights according to treatment and age and *indicates difference between albumen weights ($p<0.05$)

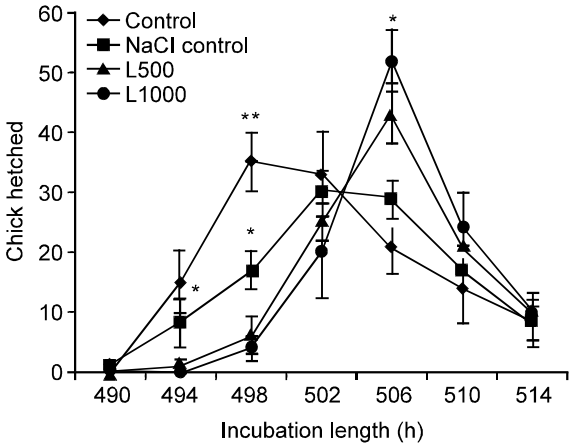

Fig. 6: Incubation length according to numbers of hatched chicks and treatments. For each incubation length, At each incubation time, *indicates significant differences between treatments ($p<0.05$) while **indicates high significant differences between ($p<0.01$)

treatment. Chick weight was determined at hatch. All the hatched chicks were fed for 6 weeks and were weighed weekly. In both treatments, albumen pH decreased between 2 and 4 days of incubation. But this decrease was more pronounced in Albumen group than in the control group indicating difference in embryo initiation. Albumen consumption followed the same trend in both groups so that at 17 and 18 days of incubation albumen was completely used, respectively in Albumen group and in control group. Yolk weight was not affected by the treatment. However, embryo dry or wet weights were similar until day 16 of incubation after which they started diverting so that embryos from control group grew better that those of treated group. Hatchability was negatively affected by albumen removal while incubation time was comparable between groups. The similarity between incubation time may suggest that insufficient thin albumen do not jeopardize embryo development. However at hatch, chicks of Albumen group were 2 g lighter than those of control group. In addition, during the 6 weeks of rearing, the chicks of control group continued to grow faster than those of treated group (Fig. 5) indicating that the effects of albumen removal can negatively affect post-hatch performance.

Effects of in ovo administration of l-carnitine on hatching events and juvenile performance of layer-type chick: L-carnitine enhances the transport of long chain fatty acids through mitochondrial membrane. It can be produced by animals' organism from lysine and methionine. However, it was reported that chicken embryos have a limited capacity to synthesize L-carnitine during incubation. The effects of in ovo injection of L-carnitine on hatchability and juvenile performance were investigated in two different studies. In the first study, fertilized eggs were injected in air chamber with 100 µL of L-carnitine (500 and 1000 µmol dissolved in 0.9% of NaCl) at d 18 of incubation. Two control groups (non injected and injected with 0.9% of NaCl) were also included. Hatched chicks were recorded every 4 h, beginning at 490 h of incubation and ending at 514 h, for incubation length and hatching spread determination. At the end of incubation, hatched chicks were recorded according to treatment for determination of hatchability. At 3, 7 and 14 d post-hatch, chick body weight (BW) and morbidity were recorded. Also, at d 3 and 7 post-hatch, 14 birds from each of 2 replicate groups within each treatment were used for intestine and yolk sac weights determination. Results indicate that BW, hatchability, or relative intestine weights were not affected by treatment. However, incubation length was longer while hatching spread was shorter in L-carnitine groups compared to control groups (Fig. 6). Also, relative yolk sac weights and morbidity were affected. Yolk sac relative weight was decreased by treatment with L-carnitine ($p<0.05$). Percentage of chicks showing morbidity sign was lower in L-carnitine treated groups from d 7 and onward. The results of the present study suggest that in ovo injection of L-carnitine at d 18 of incubation delayed hatching time but resulted in narrower hatching spread, faster utilization of yolk sac content and improved morbidity.

For the second study, hatching eggs from Ross broiler breeders and Isa Brown layer breeders of 35 wk old (600 eggs/line) were used. At d 18 of incubation, eggs from each genotype were divided into 4 groups i.e., control eggs (without any treatment), Saline (eggs injected with saline solution of 0.9%), eggs injected with L-carnitine of 500 µmole (LC500) or 1000 µmole (LC1000). For each solution, 100 µL was injected in the air chamber. At hatch and at 7 d post hatch, blood samples were collected for plasma triglyceride, glucose, total protein, uric acids, triiodothyronine (T_3), thyroxine

Table 1: Effects of L-carnitine administration at d 18 of incubation on embryo mortality, hatchability and chick quality according to chicken genotype

	Parameters					
	Hatchability (%)		Chick of optimal quality (%)		Embryo mortality (%)	
Treatment	Ross	Isa Brown	Ross	Isa Brown	Ross	Isa Brown
Control	97.54^{a*}	92.65^{a}	96.72^{a*}	91.18^{a}	2.46^{a*}	7.35^{a}
Saline	96.30^{a*}	93.85^{a}	95.81^{ab*}	92.31^{a}	3.70^{a*}	6.15^{a}
LC500	97.84^{a*}	92.54^{a}	97.12^{a*}	92.54^{a}	2.16^{a*}	7.46^{a}
LC1000	95.17^{a*}	84.21^{b}	94.48^{b*}	74.44^{b}	4.83^{b*}	15.79^{b}

^{a,b}Within column mean values with different superscript letters are significantly different ($p<0.05$) and *indicates difference between Isa Brown and Ross strains ($p<0.05$)

(T_4) and corticosterone concentrations determination. Table 1 shows hatchability, proportion of chick of optimal quality and embryo mortality according to genotype and in ovo injection treatments. Hatchability and percentage of chick of optimal quality were higher in Ross than in Isa Brown.

Overall, layer-type chicks had higher levels of T_4, total protein and uric acid than those of broiler chicks. With regard to L-carnitine injection, eggs of LC1000 groups had the lowest hatchability and this negative effect was more pronounced in Isa Brown eggs. At hatch and 7 d post-hatch, control chicks had the lowest levels of triglyceride and T_3 but the highest levels of T_4. At 7 d-old and irrespective of genotype, the highest and the lowest levels of corticosterone were obtained in chicks of LC1000 and LC500 groups, respectively, compared to control and saline groups.

Interaction effects of mixing hatching eggs of differential embryo growth trajectory and incubator CO_2 concentration on embryo physiological parameters: Two experiments were designed to investigate the effects of mixing of egg of different genotype x incubator CO_2 concentration on embryonic parameters. In experiment 1 hatching eggs of Ross broiler breeders and Isa Brown layer breeders of 35 week old were used. Before setting for incubation, eggs were numbered, weighed and sample of eggs were used to determine albumen Haugh unit and albumen pH. The eggs were mixed at random during incubation. In experiment 2, only hatching eggs of Isa Brown were used. For both experiments, half of the eggs were incubated in a CO_2 controlled incubator (VCO_2) during the first 10 d of embryonic development. In this incubator, CO_2 concentration increased curvilinearly between embryonic 3 and 10 d of incubation from 0.05 to 1%. The CO_2 concentration was constantly monitored using a computerized system with a CO_2 sensor (Vaisala GMM221, Waarloos, Belgium). The other half of the eggs was incubated at standard ventilation condition (SV) during the first 10 d. From d 11 until the end of incubation, all the eggs were at standard incubation conditions. Sample of eggs were used for albumen pH measurements between 1 and 6 days of incubation. From 10 to 18 days of incubation, remaining thick albumen and embryos were weighed. Blood samples were collected at day 18 of incubation, at internal pipping (IP) stage and at hatch for T_3, T_4 and Corticosterone levels determination. Also, partial O_2 and CO_2 pressures were measured in air chamber at IP stage. Embryo weights were recorded for all the eggs used for blood sampling and gas pressures measurements. During the last 2 days of incubation, hatching events such as IP, external pipping (EP) and hatch of individual egg were monitored every 2 h. At setting, Ross eggs were slightly heavier (61.12±0.16 g) than those of Isa Brown (60.10±0.17 g) ($p<0.05$). But albumen HUs of both genotypes were not significantly different (78.39±1.38 for Isa Brown vs. 79.64±1.12 for Ross). The pH values of Ross strain were lower than those of Isa Brown ($p<0.05$) while at day 6 of incubation pH values were similar for both genotypes. From d 12 of incubation onward, Ross embryos grew faster than those of Isa Brown ($p<0.05$). But at d 14 and d 16 of incubation, only Ross eggs in controlled CO_2 incubator had lower albumen weights compared to all other treatments ($p<0.05$). T_3 concentrations of Ross eggs were higher in both incubation treatments than those of Isa Brown eggs ($p<0.05$). Table 2 indicates that IP and EP occurred earlier in broiler eggs than in layer eggs ($p<0.05$) with no differences between incubation treatment. But, incubation times up to 50% of hatch were similar between genotype×incubation treatment. Chick weights at hatched were affected by genotype as well as incubation treatment and were in the following order: Isa Brown SV<Isa Brown VCO_2 = Ross SV<Ross VCO_2. More details about interaction effects of mixing hatching eggs of differential embryo growth trajectory and incubator CO_2 concentration on embryo physiological parameters are provided in a paper accepted for publication in British Poultry Science (Tona *et al*., in press).

In experiment 2, results about albumen pH, weights of embryo, albumen and chick and hormones concentration followed the same trend as in experiment 1 for Isa Brown embryos. But, incubation times of VCO_2 eggs until IP, EP and hatch were significantly shorter than those of SV eggs ($p<0.05$).

Table 2: Incubation time up to internal pipping (IP), external pipping (EP) and hatching (Hatch) stages and chick weight at hatch according to treatments in experiment 1

	Isa Brown		Ross	
	SV	VCO_2	SV	VCO_2
50% IP	466.48±0.39[a]	467.50±0.43[a]	463.22±0.35[b]	462.40±0.34[b]
50% EP	476.52±0.55[a]	476.43±0.76[a]	473.52±0.62[b]	473.39±0.53[b]
50% Hatch	487.82±0.44[a]	487.45±0.60[a]	486.78±0.61[a]	487.32±0.57[a]
Chick weight at hatch (g)	43.32±0.39[c]	44.12±0.36[b]	44.46±0.34[b]	45.44±0.44[a]

[a,b,c]Within row, mean values with different superscript letters are significantly different ($p<0.05$)

Table 3: Yolk sac weights, morbidity and mortality according to delayed feed access duration

	0 h delay	48 h delay	72 h delay
Yolk sac weight (g)			
D-old	4.89±0.32[a]	4.80±0.22[a]	4.95±0.37[a]
3 d-old	1.27±0.15[a]	1.25±0.13[a]	1.06±0.09[a]
7 d-old	0.19±0.07[a]	0.16±0.01[a]	0.27±0.09[a]
Morbidity up to 7 d-old (%)	3.50±1.35[c]	9.40±2.15[b]	15.10±3.35[a]
Mortality up to 56 d-old (%)	1.70±0.33[c]	2.70±0.45[b]	4.50±0.61[a]

[a,b,c]Within row, mean values with different superscript letters are significantly different ($p<0.05$)

Effect of delayed feed access on production and blood parameters of layer-type chicks: A total of 684 Hisex Brown day-old chicks were studied. The chicks were randomly assigned into three groups as follows: (1) chicks with immediate feed access; (2) chicks with 48 h delay in feed access and (3) chicks with 72 h delay in feed access. For each group, chicks were assigned into 4 replications of 57 birds each. Prior to feed access, the chicks were weighed. Samples of chicks were used to weigh yolk sac at 1, 3 and 7 days and to collect blood at 1, 3, 7, 14 and 56 days. Also, reared chicks were weighed weekly. The results indicated that chick weights decreased during the holding period. Yolk sac utilization was similar between groups, while morbidity and mortality increased linearly with the duration of delay in feed access (Table 3).

The linear relationship between the duration of delay in feed access and morbidity or mortality obtained in this study may be due to insufficient development of immune system in chicks with delayed feed access. At 56 days, chicks having delayed access to feed were lighter than those without delay in feed access (Fig. 7). Serum concentration of glucose up to 14 days and of total protein and triglycerides until 56 days decreased with the increasing duration of delay in feed access. For more information, see Gaglo-disse *et al*. (2010) in Acta Veterinaria Hungarica.

Induced moulting of layer chickens: Two different forced moulting programmes were tested and their effects on feather characteristics, production and egg quality parameters of Hisex Brown laying hen were investigated. The hens had 67 weeks of age at the beginning of the moulting process. The moulting programmes were:

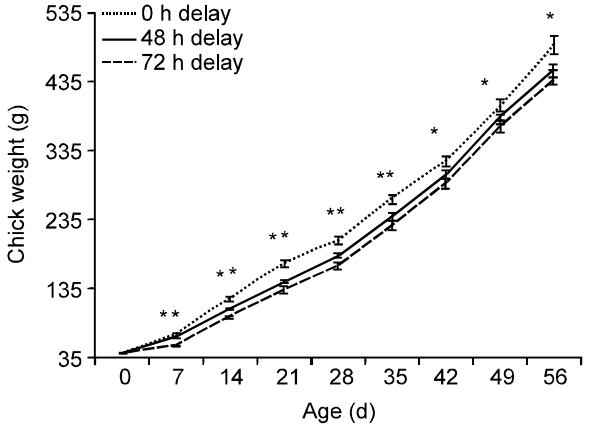

Fig. 7: Chick weights up to 56 d-old according to treatments and age of chicks. At each age, *indicates differences between 0 h delay group and 48 and 72 h delayed groups ($p<0.05$) while **indicates differences between 48 h delay and 72 h delay groups (Gaglo-Disse *et al*., 2010)

- Feed withdrawal at the first day followed by feeding with 20, 30, 70 and 90 g/hen/day of wheat bran, respectively during at the second day, from 3 to 9 days, from 10 to 19 days and from 20 to 23 days during the moulting process (group 1)
- Feed withdrawal during the first 8 days followed by feeding with 60 and 80 g/hen/day of wheat bran, respectively from 9 to 18th day and from 19 to 28th day (group 2)

The control group was fed with standard laying diet during the experimental period. Every week, lost and renewal of primary wing feathers and the weight of hen were recorded. Also, laying performances and egg weights were recorded from the beginning of the second cycle of egg production. Moreover, egg quality parameters (albumen Haugh unit, yolk colour and shell thickness) were measured.

The results indicate that, between 14 and 32 days during the moulting process, numbers of wing feathers' lost were comparable for hens subjected to moulting but were higher than those of the hens of control group. Hen body weight decreased up to 20% and 22%, respectively at 20 days for group 1 and at 14 days for group 2 indicating that prolonged feed withdrawal resulted in

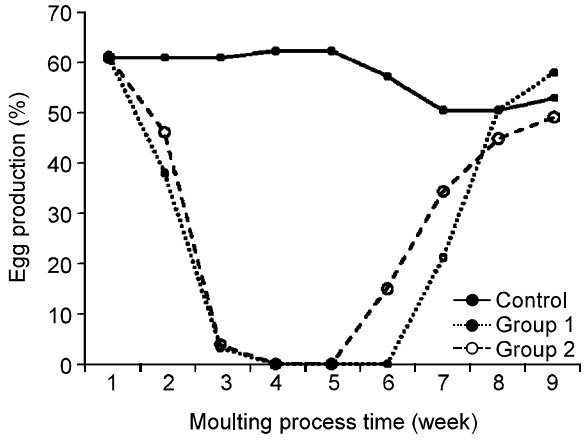

Fig. 8: Egg production change during the moulting process according to moulting treatment and moulting time

rapid and pronounced body weight loss. As shown in Fig. 8, egg production decreased sharply in both moulting groups and was at nadir level at day 17 and at day 9, respectively in group 1 and group 2. But the beginning of the next egg production cycle started earlier in group 2 than in group 1. These effects of moulting programme on egg production suggest a relationship between body weight loss and egg production. In addition, albumen Haugh units were improved and eggshell thickness as well as yolk colour was more pronounced in moulted groups compared to control group ($p<0.05$).

Conclusion: From the results of research activities concerning incubation conditions of the current project, we could conclude that in Togolese poultry management aspects:

- Mixing of hatching eggs of differential embryo developmental trajectory during incubation should be avoided because of its detrimental effects on embryonic growth
- L-carnitine administration during embryonic life affected differentially hatchability and blood parameters during post-hatch juvenile growth according to genotype and dose of L-carnitine
- Heat treatment during incubation or during post-hatch life induces completely different effects. It was expected that conditioning would have increased metabolism and therefore a shorter incubation period but the reverse was found
- Earlier transferring does not affect embryo weights but may influence differentially hatchability according to the sex

These findings suggest that differences in physiological parameters during embryonic development and also in physical parameters of the eggs may lead to the hypothesis that incubation conditions could be improved in a strain- dependent manner.

With regard to management practices results from this project brought out that:

- Moulting process can be included in poultry farms' management practices in order to face several difficulties due to availability and cost of day old chicks
- Delayed feed access is detrimental to the juvenile performance of layer-type chicks and has a negative age-related effect on the serum concentrations of glucose, triglycerides and total protein

In addition, a collaborative project between universities or research and development institution with regard to technology and knowledge transfer between developed and developing countries may avoid widening the gap in knowledge and research capabilities. This is crucial in a process of mondialization of every aspect of life and economy.

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