Effects of two types of post-deprivation diet on performance of moulted Isa brown laying hens

Kokou VOEMESSE[1,23],
Yaah Aimée Emmanuelle KOUAME[1],
Aicha Edith SOARA[1], Cocou Claude KPOMASSE[1],
Paulinus Ogbonnaya ESSEN[1*] and Kokou TONA[1]

Abstract

Moulting rejuvenates commercial laying hens' reproductive systems and prolongs their productive lifespan. This study assessed the impact of forced moulting on Isa-Brown layers using feed withdrawal followed by refeeding with either grower feed (G1) or wheat bran (G2). A total of 375 hens, aged 59 weeks with an average body weight of 1.69 kg and a laying rate of 67.33%, were allocated into three groups: a non-moult control, G1 and G2. The hens were then fed restricted daily rations according to the schedule. Each group had five replicates of 25 hens. Hens underwent a 14-day fasting period. Data collected included body weight loss, laying performance, egg weight, and mortality for 10 weeks. During Weeks 3-6 of refeeding, weight loss was significantly lower (P<0.05) in G1 than in G2. Mortality rates showed no significant differences. Egg laying resumed after three weeks in G1 and four weeks in G2. G1 reached 50% production by week 4, whereas G2 required 6 weeks. Moulted hens had significantly higher egg weights and laying rates (P<0.05), with G1 recovering faster and more efficiently. Forced moulting enhances laying productivity in Isa-Brown hens. Recovery diets, especially pullet-feed, reduce recovery time, increase egg-yield, and improve egg-traits, highlighting the importance of post-fast nutrition.

Keywords: Moulting, Isa-Brown layers, Economic lifespan, Egg production, Egg-traits

Effets de deux régimes alimentaires après privation sur les performances des pondeuses Isa brown mues

Résumé

La mue rajeunit le système reproducteur des pondeuses et prolonge leur durée de production. Cette étude avait évalué l'impact d'une mue iduite chez des pondeuses

[1] Regional Center of Excellence in Avian Sciences, University of Lomé, Lomé Togo, PMB 01BP1515
[2] Togolese Institute of Agricultural Research (ITRA-Togo), BP:1163, Lomé, Togo
[3] Environment and Agricultural Research Institute, Centre National de la Recherche Scientifique et Technologique (CNRST), 03 BP 7047 Ouagadougou 03, Burkina Faso
***Corresponding Author:** Paulinus Ogbonnaya ESSEN essenpaulinus93@gmail.com / essenpaulinus33@cersa-togo.org, https://orcid.org/0009-0006-3467-964X ; +234(0)8131907537

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sur les performances de production. Un total de 375 pondeuses de 59 semaines d'âge, avec un poids moyen de 1,69 kg et un taux de ponte de 67,33 %, ont été réparties en trois lots: lot témoin et les lots G1 et G2 (ayant subi la mue) avec cinq répétitions de 25 poules chacun. La mue a été induite par le retrait d'aliment pendant 14 jours et la réalimentation avait commencé avec un aliment de croissance chez G1 et avec du son de blé chez G2 de manière rationnée. Les données collectées étaient la perte en poids, les taux de ponte, le poids des œufs et la mortalité pendant 10 semaines. Comme résultat, la perte en poids a été réduite (P<0,05) chez G1, comparée à G2, pendant la période de la réalimenation. La mortalité n'a pas été affectée. La ponte avait repris après trois semaines chez G1, et quatre semaines chez G2. Les sujets du G1 avaient atteint 50 % de ponte après 4 semaines de réalimenation contre six semaines pour G2. Dans l'ensemble, le taux de ponte et le poids des oeufs étaient plus élevés (P<0,05) chez les sujets ayant subi la mue avec un meilleur résultat obtenu chez G1. La mue avait amélioré les performances de production des pondeuses. La réalimentation avec la ration poulette avait donné de meilleurs résultats et devrait être vulgarisée.

Mots-clés : Mue, poules pondeuses Isa Brown, durée de vie économique, production d'œufs, caractéristiques des œufs

Introduction

The poultry industry plays a vital role in providing high-quality animal protein, both through meat and eggs. It is one of the most efficient and profitable ways to enhance access to nutritious food, as eggs are considered an ideal source of essential amino acids, minerals, and vitamins (Okedere *et al.,* 2020). In other words, the poultry industry remains a significant contributor to animal protein production.

According to Anene *et al.* (2020), Isa Brown hens are highly valued for their exceptional adaptability and prolific egg production, capable of laying up to 500 eggs per cycle. These efficient hybrid layers convert feed effectively, ensuring cost-efficiency for commercial egg producers. Renowned for their hardiness, they perform well in diverse climates and housing systems, including cages, barns, and free-range setups. Their eggs are consistently large, with strong, high-quality shells.

Egg-laying rate and its sustainability over time are critical indicators of productivity in the poultry industry. For laying hens, their biological rhythm alternates between egg-laying cycles and intervals of rest. Typically, a hen's production cycle spans just over a year (52–56 weeks), during which hens naturally molt, marking a resting period (Anikó *et al.,* 2017; Ahmet & Brian, 2020). However, artificial or induced moulting can be applied to commercial hens to extend their productive lifespan for a second or third laying cycle.

According to Zhang *et al.* (2022), induced moulting is a common practice in poultry farming aimed at prolonging the productive period of hens. Despite its utility, artificial moulting raises animal welfare concerns, such as elevated stress levels due to increased adrenocorticotropic hormone (ACTH) (Chowdhury and Yoshimura, 2003), cloacal narrowing, reduced pelvic spacing (Oguike *et al.,* 2005), and autophagy and apoptosis of granulosa cells (Han *et al.,* 2022). Additional adverse effects include regression of organs such as the liver, ovary, and oviduct (Rafeeq *et al.,* 2013), as well as protein and lipid catabolism for energy, leading to weight loss in chickens (Webster, 2003).

Nonetheless, induced moulting has demonstrated significant benefits for both hens and farmers. In hens, it rejuvenates ovarian function for subsequent egg-laying cycles and fosters feather renewal, enhancing overall well-being (Wang *et al.,* 2024). In commercial poultry production, molting is used to optimize laying performance and manage periods of decreased productivity, ultimately ensuring profitability (Wang *et al.,* 2024; Foreman *et al.,* 2023).

Feed removal is an economical and practical approach to induced moulting, offering an alternative to purchasing replacement pullets (Tiwary *et al.,* 2019). Various techniques are employed to induce moulting, including feed deprivation (Moustafa *et al.,* 2010), diets rich in minerals (Ahmed, 2007), hormone injections (Bass *et al.,* 2007), and probiotics with vitamins (Wang *et al.,* 2024). Feed withdrawal lasting 14 days or more in warm climates is the most widely adopted method due to its simplicity and effectiveness in achieving weight loss and desired results (Webster, 2003). The efficacy of feed withdrawal varies with the duration. For instance, Rafeeq *et al.* (2013) observed a 36% weight loss in hens fasted for 13 days, whereas Ahmad and Hassan (2007) reported a 20% weight loss after just 5 days. Similar findings, with weight loss ranging from 24% to 31%, have been documented in other studies (Wang *et al.,* 2024).

Despite the benefits of induced moulting, limited research has focused on the response of Isa Brown hens to moulting in tropical climates. To bridge this gap, the present study aims to evaluate the effects of induced moulting on the productive performance of Isa Brown layers through feed withdrawal, followed by refeeding with either pullet feed, a balanced ration expected to support rapid recovery, or wheat bran, a locally available low-cost alternative commonly used by farmers.

I. Materials and Methods

I.1. Study Location

This research was conducted at the Regional Centre of Excellence in Poultry Science (CERSA) at the University of Lomé, located 17 kilometers northeast of Lomé in the Maritime Region of Togo. The site is positioned at 6°13' N latitude and 1°22' E longitude, with an altitude of 21.63 meters above sea level. It lies within the tropical rainforest zone of southwestern Togo, characterized by an average annual rainfall of 1300–1485 mm. During the rainy season, the relative humidity ranges from 67% to 89%, and the environmental temperature varies between 27°C and 30°C (UL, 2024; AccuWeather, 2024).

I.2. Experimental Ethical Statement

All experimental protocols were reviewed and approved by the Ethics Committee of the Regional Centre of Excellence in Poultry Science (CERSA) at the University of Lomé, Lomé Togo, a branch of the National Ethics Committee for the control and supervision of experiments on animals.

I.3. Experimental Design and Management

A total of 375 Isa Brown hens, aged 59 weeks, with an average body weight of 1.69 kg and a laying rate of 67.33%, originating from the Experimental Unit of the Regional Centre of Excellence in Poultry Science (CERSA) at the University of Lomé, Togo, were used in this study. The hens were divided into three groups: non-molt (control), molt and re-feeding with pullet feed (G1), and moult and re-feeding with wheat bran (G2). Each group consisted of 125 hens, further divided into five replicates of 25 hens each, and housed together. Moulting was induced through a fasting period lasting two weeks (14 days). On the first day, all hens were subjected to feed and water withdrawal, followed by feed withdrawal with water provided ad libitum until day 14. After the fasting period, the hens were re-fed with specific diets: pelleted pullet feed for G1 and wheat bran for G2. The feeding regimen was as follows: Week 2 to Week 3: 30 g per bird per day. Week 3 to Week 4: 60 g per bird per day. Week 4 to Week 5: 90 g per bird per day. From Week 5 onwards, all hens received layer feed at 120 g per bird per day until the end of the experiment. Light exposure was gradually increased after two weeks of resumed feeding, ultimately reaching 16 hours. The non-moulted birds (control group) were consistently fed a normal layer diet ad libitum throughout the experiment at a rate of 120 g per bird per day, as shown in table 1.

Table I: Chemical Composition of the Experimental Diet Provided to Isa Brown Layers

Ingrédients	Control	PFG	WBFG
Maize	58	56	0
Wheat brand	5	23	100
Brewer's dried grains	3	3	0
Soybean meal	6	5	0
Roasted soybean	15	8	0
BC (5%)	0	3	0
layer concentrate	5	0	0
Oyster shell	7	2	0
Total	**100**	**100**	**100**
Calculated Composition			
ME (Kcal/Kg)	2824.72	2757.27	1619.12
Crude Protein (%)	19.07	16.38	15.5
Calcium (%)	2.34	0.91	0.19
Phosphorus (%)	0.47	0.63	1.15
Lysine total (%)	1.06	1.09	0.64
Methionine total (%)	0.86	0.57	0.24
Meth. + cysteine (%)	0.72		0.56

PFG= Pullet feed-group; WBFG= Wheat bran feed group; BC= Broiler concentrate; ME=Energy Metabolizable

I.4. Data Collection

I.4.1. Weight loss rate

The birds in each batch were weighed on the day before moulting. Following this, the control group birds were weighed weekly until the end of the experiment, whereas the moulted birds had their weights recorded three times per week to closely monitor rapid changes during fasting and refeeding. To determine the percentage of weight loss, the average weight of each moulted group was compared to the initial average weight. The formula for calculating weight loss is as follows:

$$W = \frac{W_i - W_t}{W_i} \times 100$$

Where;

W= Average weight loss (%)

Wi= initial average weight

Wt = average weight at time X

I.4.2. Egg Production and Egg Mass

Following the moulting period and the resumption of egg production, the total number of eggs laid by both moulted and non-moulted hens across all replicate groups was collected. Daily measurements of egg number (EN) and egg weight (EW) were recorded. These values were then used to calculate the weekly egg production percentage (EP%) and egg mass (EM).

$$\text{EP (\%)} = \frac{\text{EN} \times 100}{\text{Period (days)}}$$

$$\text{EM} = \frac{\text{EN} \times \text{EW}}{\text{Period(days)}}$$

I.4.3. Mortality Percentage

Mortality was monitored daily throughout the experiment. At its conclusion, the mortality rate was determined by calculating the ratio of deceased birds to the total number of birds in each treatment group, expressed as a percentage.

I.5. Statistical Analysis

Statistical analysis was carried out using GraphPad Prism 5. A one-way ANOVA was utilized to examine the impact of the two types of diets administered during the molting process on the productive performance of birds. Tukey's multiple range test was applied to analyze differences in means between groups.

II. Results

II.1. Changes in Weight Loss Rate

Figure 1 illustrates the changes in the average weekly body weight loss of hens across different groups throughout the experiment. During the fasting period, the moulted groups showed a notable weight reduction compared to the control group, followed by a gradual recovery of weight upon the resumption of feeding. In the first two weeks of fasting, moulted chickens experienced weight loss without significant differences (p>0.05), reaching 21.58% in the grower-feed group (G1) and 22.28% in the wheat-bran group (G2). During the recovery phase, after refeeding, the rate of weight loss progressively decreased. As depicted in figure 1, a statistically significant decrease (p<0.05) was observed in G1 compared to G2 between the third and sixth week of the trial. By the eighth week of the experiment, the body weight of the hens had nearly returned to the pre-fasting levels.

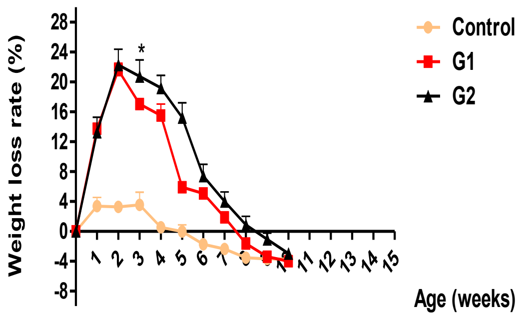

Figure 1: Body weight loss

II.2. Changes in Egg Laying Rate

Figure 2 demonstrates that there were no significant differences (p>0.05) in the average egg-laying rate between treatment groups at the start of the trial. During the fasting period, the laying rate of the moulted groups (G1 and G2) gradually declined without significant differences (p>0.05), reaching 13.33% in the grower-feed group (G1) and 12.33% in the wheat-bran group (G2) by the first week of the experiment. Egg-laying was ceased in the moulted hens after one week of feed withdrawal (8 days), and the birds entered a resting period. During this phase, by the 15th day (after two weeks of fasting), the moulted hens remained in the rest period and resumed laying eggs during the fifth week of the trial (three weeks after feeding recommenced) in the grower-feed group (G1) and the sixth week (four weeks after feeding recommenced) in the wheat-bran group (G2).

Following the resumption of feeding, egg-laying rates gradually increased, with the grower-feed group (G1) achieving 50% of the average egg-laying rate within four weeks, whereas the wheat-bran group (G2) reached the average rate two weeks later. By the end of the 10-week experiment, moulted groups exhibited significantly higher laying rates ($p<0.05$) compared to the control group. Throughout the moulting process, hens in G1 began producing eggs earlier (Figure 2)

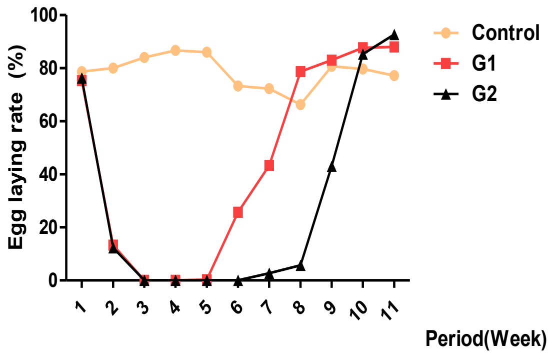

Figure 2: Laying rate

II.3. Changes in Egg Weight

The findings of the current study revealed that, prior to moulting, the egg weight values were similar across all treatment groups. During the investigation period, the moulted birds exhibited significantly higher average egg weights compared to the control group, with the order of values being G1 < G2 < control ($p<0.05$), as shown in figure 3.

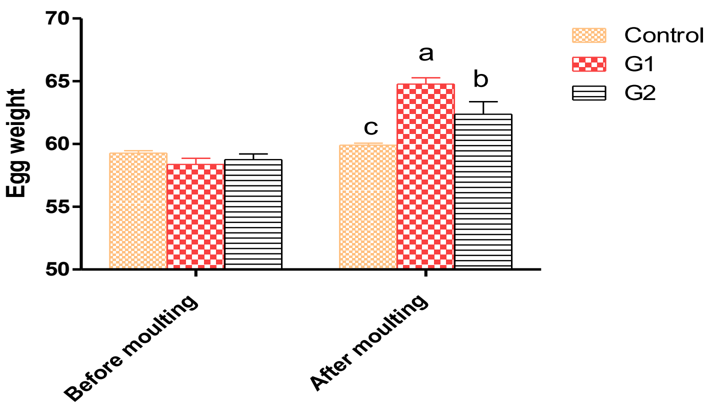

Figure 3: Egg weight

II.4. Mortality Rate

Overall, mortality rates were comparable among the control group, G1, and G2 throughout the moulting process as shown Table 2.

Table II: Mortality rate according to the treatment

Items	Treatments		
	Control	G1	G2
Mortality rate	0.10± 0.07	0.05± 0.04	0.13± 0.07

III. Discussion

This study demonstrated that moulting affected the hens' performance during both the fasting and recovery periods. During the induced moulting fasting phase, body weight loss in laying hens gradually increased. In moulting practices, the rate of weight loss serves as a key indicator for determining the timing of refeeding. In this study, the birds fasted for 14 days, resulting in a body weight loss of 21.58%–22.28%. This value is slightly lower than those reported in other studies, where weight losses of 25%–31% (Akbari *et al.,* 2018; Wang *et al.,* 2024) and 36% (Rafeeq et al., 2013) were observed during molting. However, the 23.84% weight loss reported by Tiwary *et al.* (2019) is comparable with the values observed in the present study.

These differences may be attributed to factors such as the housing system and the season of the year (Rafeeq *et al.,* 2013), as well as the reduction of adipose tissue and the regression of visceral organs. This explanation aligns with Andrews *et al.* (1987), who attributed 25% of weight loss during molting to the regression of the liver, ovary, and oviduct. Additionally, moulting hens must maintain basic metabolism and energy for egg production, relying on fat and protein reserves to meet nutritional and energy demands during the initial fasting phase, as noted by Webster (2003).

After feeding resumed, body weight loss rapidly declined in the moulting groups. This is because fat depletion and protein catabolism for energy ceased, allowing the hens to restore tissues and support follicle development for the next egg-laying cycle through dietary nutrients. Both moulting groups ceased egg production during fasting due to the lack of energy and nutrients, including calcium, required to sustain metabolic needs for survival. This depletion can lead to follicle atresia, as supported by Wang *et al.* (2024), who observed reduced hierarchical follicles during moulting-induced fasting.

In the current study, the post-fasting resting period lasted 14 days (2 weeks) in the pullet-feed group, with a 50% laying rate achieved within 4 weeks of resumed feeding. In contrast, the wheat-bran group had a post-fasting resting period of 21 days, achieving 50% egg production after 6 weeks. The delayed recovery in egg production and longer time to reach 50% in the wheat-bran group (G2) may be attributed to the lower nutrient levels in the diet provided during the resting phase. The pullet diet contained higher levels of nutrients (2,757.27 kcal/kg and 0.91% calcium) compared to the wheat-bran diet (1,619.12 kcal/kg and 0.19% calcium). Calcium, essential for egg production, was particularly deficient in G2, suggesting that the type of post-deprivation diet influences the length of the resting period. Supporting earlier studies, hens in the pullet-feed group showed earlier physiological changes, including oviductal tissue rejuvenation, enhanced digestive enzyme activity, and increased serum cholesterol, triglycerides, and very low-density lipoproteins (VLDL), which are critical for egg production (Peebles *et al.,* 2004; Oyewole *et al.,* 2024).

The results of this trial revealed that moulted groups achieved the highest egg production, with hens in G1 (pullet-feed group) performing better in terms of egg weight by the end of the 10-week trial. Egg production in G2 (wheat-bran group) increased rapidly after switching all groups to a layer diet, reaching the same level as G1 by the 10th week. This suggests that during the extended resting period, nutrients in the wheat-bran diet supported oviductal rejuvenation and follicle development, which were later stimulated by the layer diet. The observed increase in egg weight in G1 may primarily result from enhanced nutrient absorption when fed a laying diet. These findings align with Bar *et al.* (2001), who reported superior egg production and livability in moulted hens compared to non-moulted layers. Additionally, Bell (2003) indicated that mortality rates during induced moluting ranged from 0–12%, depending on the moulting program. The low mortality observed in this study may be attributed to the shorter trial duration and the absence of significant physiological stress, as noted by Aksit *et al.* (2003).

Conclusion

The results of this study demonstrate that the procedure adopted for moulting significantly influences the performance of hens in the subsequent laying cycle. Notably, the type of post-deprivation diet affects the length of the resting period in hens. Using pullet-feed during the recovery phase effectively shortens the molting cycle, enhances egg production, and improves egg weight. Layers that have completed their first laying cycle can be successfully rejuvenated for a second cycle.

Additionally, the moulting method applied significantly impact mortality, egg production, and the profitability of the next laying cycle. Induced moulting proves to be a cost-effective practice that enhances income generation for farmers while improving the production potential of laying hens. To minimize irregular mortality, implementing a strict routine and sound scientific management practices is essential.

Further research is warranted to explore "Non-Feed Removal Approaches" to moulting, which may provide additional benefits and advancements in this area.

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Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this paper

Authors' Contributions

EP contributed to conceptualization, methodology, data curation, formal analysis, investigation, validation, software, resources, project administration, visualization, writing – original draft, and writing – review and editing.VK and TK contributed to supervision, methodology, and writing – review and editing.YK, SA, and CK contributed to data curation, formal analysis, investigation, validation, software, and resources.

Data Availability Statement

All data generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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