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PRE AND POST-MOULT PRODUCTIVE EFFICIENCY IN FOUR VARIETIES OF INDIGENOUS ASEEL CHICKEN DURING DIFFERENT PRODUCTION CYCLES

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ABSTRACT

The objective of current study was to assess the effect of moulting on productive efficiency in Aseel chickens at different phases of age. A total of 168 hens, 42 from each of four varieties (Mushki, Lakha, Mianwali and Peshawari) divided into 3 age groups, young (50-67 weeks), medium (80 -97 weeks) and old (115-132 weeks) were maintained in cages during pre and post-moult phases. The data thus collected during both the phases were subjected to analysis of variance in Randomized Complete Block Design. The results showed that overall productive efficiency remained better in post-moult as compared to pre-moult phase. Mushki showed significantly higher egg production, egg mass, egg weight, and better FCR/ dozen eggs. Feed intake was higher in Peshawari variety while, body weight and FCR/Kg egg mass showed non-significant differences. The birds of younger age showed significantly higher feed intake, egg mass, egg production, and better FCR/dozen eggs, while, egg weight and FCR/kg egg mass were not affected by age. Older birds showed significantly higher body weight.

Key word: Aseel Chicken, Production performance, Pre-moult, Post-moult, Variety

INTRODUCTION

Poultry production has been playing an important role in bridging the gap between supply and demand of animal protein for human needs. The rural poultry is also contributing a major part in this regard. In most of the Asian countries, rural population has been engaged to rear local poultry breed like Aseel. Aseels are considered to be the ancestors of the Cornish breed (Bhatti. 1991), and the male line of modern day broilers has been developed from Cornish indicating great inherent potential of Aseel (Platt, 1925). Many varieties of Aseel are being locally maintained in rural areas of Pakistan mainly for cock fighting (GOP, 2003).

Almost all the varieties of Aseel are characterized with heavy body weight and poor egg production potential thus leading to low progeny size due to erratic ovulation, short or erratic clutches and broodiness. The productive potential of these birds have not been fully exploited yet and modern techniques used to improve the performance has not been tested on Aseel chickens. Moulting is a technique, employed commercially to cease egg production in laying and breeding hens in order to recycle them for another season of egg production. After the moulting, egg production and quality may improve significantly compared to pre-moult period. Induced moulting has been reported to improve egg production and other performance parameters (Usman *et al*. 2013; Akram,998; Lee, 1982, Increasing age of birds has been associated with decreased production (Bogdanova *et al*. 2006; Cloete *et al*. 2004, 2006; Lambrechts, 2004; Ipek and Sahan, 2004; Hipfner *et al*. 2003; Williams and Christians, 2003). Egg weight is reported to increase with advancing age of hens (Johnston and Gous, 2007; Rizzi and Chiericato, 2005; Danilov, 2000; Joyner *et al*. 1987). Contrarily, Zemková *et al*. (2007) reported that egg weight was not significantly influenced by age. Higher feed intake was observed in older hens than in young birds (Mehta *et al*. 1986). However, Yasmeen *et al*. (2008) did not find effect of age on feed intake, whereas, the feed efficiency was decreased. Contrarily, Vargas *et al*. (2009) indicated that FCR was not influenced by age in breeders. Egg mass was increased with the advancing age of pullets (El-Aggoury *et al*. 1989). However, no concrete evidence is available regarding effect of moulting during different periods of age on productive performance of indigenous Aseel chicken.

Keeping in view the significance of Aseel chicken in our rural economy, the present study was undertaken to evaluate the effects of moulting on productive efficiency in four varieties of indigenous Aseel chicken in three different age groups.

MATERIALS AND METHODS

One hundred and sixty eight (168) Aseel hens of three age groups i.e. younger (50 to 67 weeks), medium

(80 to 97 weeks) and older birds (115 to 132 weeks) from four varieties of native Aseel i.e. Lakha, Mushki, Peshawari and Mianwali were selected. There were forty two (42) hens from each variety with fourteen (14) birds in each age group. These were randomly maintained in cages for 16 weeks to evaluate their pre-moult productive performance, including feed intake, body weight, egg production, feed conversion ratio (FCR)/ dozen eggs, egg weight, egg mass and feed conversion ratio (FCR)/ kg egg mass. The hens were then induced moulting with the help of fasting and feed restriction (Akram, 1998) and all parameters of productive performance were recorded during Post-moult period of 16 weeks. The experimental birds were fed a balanced ration, formulated according to NRC (1994) standards and recommendations made by Summers and Leeson (2005) for broiler breeder 1 and breeder 2 diets.

Experimental plan: The experimental plan of the study has been presented in Table 1

Table 1. Experimental plan

Aseel variety	Age groups	Number of birds (replicates)
Lakha		(42)
	Younger (50-67 weeks)	14
	Medium (80-97 wee	14
	Older (115-132 weeks)	14
Mianwali		(42)
	Younger (50-67 weeks)	14
	Medium (80-97 weeks)	14
	Older (115-132 weeks)	14
Mushki		
	Younger (50-67 weeks)	(42)
	Medium (80-97 weeks)	14
	Older (115-132 weeks)	14
		14
Peshawari		
	Younger (50-67 weeks)	(42)
	Medium (80-97 weeks)	14
	Older (115-132 weeks)	14
		14

Statistical analysis: The data thus collected were subjected to Analysis of Variance (ANOVA) in Randomized Complete Block Design using SAS 9.1. Comparison among treatment means was made through Duncan's Multiple Range (DMR) test (Duncan, 1955). Effects of moulting, age group, and variety of Aseel on the dependent variables were represented by the following model:

$Y_{ijk} = \mu + M_i + A_j + V_k + E_{ijkl}$

Where

Y_{ijk} = dependent variable (feed intake, body weight, egg production, egg weight, egg mass);

μ = overall population mean;

Mi = fixed effect of i^{th} moulting (i = premoult, post moult);

Aj = fixed effect of j^{th} age group (j = 1, 2, 3);

Vk = fixed effect of k^{th} varieties of Aseel (k= 1, 2, 3, 4,);

Eijk = residual error term

RESULTS AND DISCUSSION

Feed Intake (kg): In the present study, significantly higher feed intake (8.505±0.065 kg /16 weeks) during post-moult relative to pre-moult period (7.743±0.069 kg) was observed in Aseel chickens. This could be attributed to higher post-moult body weight, greater egg weight and better egg production which might have increased feed requirement of birds resulting in higher feed intake. In post-moult birds, higher body weight (Hurwitz *et al*. 1998), greater egg weight and better egg production (Lourens *et al*. 2006; Ahmad *et al*. 1995) have been reported which consequently require more feed. The similar findings indicating higher feed intake during post-moult relative to non-moulted birds have also been reported (Hurwitz *et al*. 1998). The maximum feed intake was observed in Mushki (8.286± 0.082 kg) variety. The increased feed intake has been associated with production traits (Hurwitz *et al*. 1998) and Mushki variety had higher egg mass production which might explain the increased feed intake in this variety in line with current findings

Bell and Weaver (2005) observed that feed intake varied in different varieties and strains. The similar findings have also been reported in another study showing great variability in feed intake in different strains (Reddy *et al*. 2008**).** However, Hurwitz *et al*. (1998) did not find difference in feed intake among different strains

In this study, older birds (age = 115-132 weeks) had significantly higher feed intake (8.317± 0.090 kg). Higher body weight with advancing age might be the reason of increased feed intake in older birds (Hurwitz *et al*. 1998). The feed intake of aged birds was reported to be higher than in young birds (Mehta *et al*. 1986).

Body weight (g): Results of the current study showed significantly higher body weight (2188± 26 g / 16 weeks) in post-moult phase than that of pre-moult, where body weight was 2039 ± 25g (Table 2). Higher body weight in post-moult birds has been reported earlier (Hurwitz *et al*. 1998). Similarly, increase in body weight of all the experimental hens after moulting has been observed by Mazzuco *et al*. (2005). The increase in body weight due to advancement of age appeared to be a natural phenomenon. Similar findings indicating improvement in body weight due to moulting and increasing age have been reported (Hassan *et al*., 2008). However, Ocak *et al.* (2004) did not find any difference between pre and post molt body weight.

The highest body weight was recorded in older birds (2382± 15 g, mean ± S.E) followed by medium and younger ($P<0.05$) (Table 2). Higher body weight has been observed previously in aged birds (Akram 1998; Aslam *et al*. 2012). In current study, no difference in body weight among different varieties of Aseel has been observed (Table 2).

Egg Production (percent): In this study, significantly higher egg production percent was observed in post-moult phase (14.5± 0.63%) than in pre-moult (12.8 % ± 0.7) which could be attributed to loss in body fat deposits in the ovary (Table 2). High egg production after moulting has been reported in previous studies (Berry, 2003, Christmas *et al*. 1985).

Effect of variety on egg production percent has been observed in present study (Table 2). The highest egg production (15.73± 0.9) was observed in Peshawari followed by that of Mushki, Mianwali and Lakha (10.63± 0.9) varieties of Aseel, which could be attributed to variety or strain variation. Significant effect of strain on egg production percent due to moulting has also been reported by Hurwitz *et al. (*1998). Modern strains of laying hens produce more egg, than in the past (Korver *et al*. 2004).

Egg production significantly decreased with age (Tale 2). Younger birds had the highest egg production (15.5± 0.8) as compared to older birds (12.8± 0.75). Current finding are in line with those of previous studies indicating decrease in egg production with increasing age (Buhr and Cunningham, 1994; Verheyen and Decuypere, 1986)

Egg weight (g): Moulting significantly influenced egg weight (Table 2). Egg weight was higher (46.885± 0.547 g, mean ± SE) during post-moult as compared to pre-moult phase (41.776 g ± 0.382) which could be attributed to increase in the oviduct size and enhancment of ovarian functions (Ocak *et al*. 2004). Improvement in egg size after moulting with a higher percentage of large size eggs have been reported in earlier studies (Ahmad *et al*. 1995; Cleaver *et al*. 1986; McDaniel, 1985).

Egg weight significantly varied among Aseel varieties (Table 2). The highest egg weight was recorded in Mushki (45.199± 0.799g) and Lakha (45.076± 0.837g) hens and the lowest in Peshawari variety (42.893± 0.638g) which could be due to their higher body weights. The effect of strain could be explained due to differences in egg weight and egg components (Joseph and Moran, 2005).

In present study, the age of birds did not show any effect on egg weight (Table 2). Non-significant effect of age on egg weight has previously been reported (Zemková *et al*. 2007). In contrast to current findings, advancement of hen's age has been associated with egg weight (Abudabos, 2010; Abanikannda and Leigh, 2007; Johnston and Gous, 2007). Smaller egg size of Aseel chicken with less egg variability might be the reason showing no effect of age on egg weight.

Egg mass (g): The current findings showed significantly ($P< 0.05$) higher egg mass during post-moult (763.155± 33.316 g , mean ± SE) as compared to pre-moult phase (600.731± 35.288g) as shown in Table 2. The higher egg mass could be attributed to higher egg production (Yousf and Ahmad, 2006; Hassan *et al*. 2008; Aygun and Olgun, 2010). The similar findings were reported by Bar *et al.* (2001) who observed higher egg production and egg mass in moulted hens than those of non-moulted.

The effect of variety on egg mass indicated that Mushki variety had significantly higher (802.066± 50.384 g) egg mass than Lakha (551.589± 45.199g) which could be attributed to normal physiological response of these birds to produce greater number of eggs as a result of higher feed intake.

Significantly higher egg mass was observed in younger birds (764.487± 38.933 g) followed by that of medium (643.426± 39.957 g) and older birds(637.916± 48.915 g) which could be attributed to decrease in egg production with increasing age (Seeland *et al*. 1995; Summers and Leeson, 1983; Weatherup and Foster, 1980).

Feed conversion ratio (feed/ kg egg mass): In the present study, significantly better feed conversion ratio per kg of egg mass (FCR/Kg egg mass) was observed during post-moult (15.946± 1.339) than in pre-moult phase (19.753± 1.940) which could be attributed to higher egg production in post-moult phase (Table 2). The similar findings have been reported (Christmas *et al*. 1985). In line with current findings, Lee (1982) observed higher feed consumption, egg production and better FCR in moulted hens as compared to non-moulted birds. However, some studies indicated non-significant differences in feed consumption and feed conversion ratio during post-moult laying periods (Ogun and Aksoy, 1991; Soldevila and Siberio, 1987).

The FCR/Kg of egg mass significantly differed among Aseel varieties (Table 2). The Mushki had better FCR (14.881± 2.427), while poor FCR was observed in Lakha variety (21.666± 2.416). These results are in agreement with those of Bell and Weaver (2005).

The age of birds had significant effect on FCR/kg of egg mass (Table 2). The younger birds had better FCR/kg mass (14.800± 1.538) than medium (18.544± 2.282), and older age birds (20.205± 2.221) which might be due to decrease in egg production with advancement of age (Verheyen and Decuypere, 1986). These results are in agreement with those of Yasmeen *et al*. (2008) who reported improvement in FCR with the decreasing age. Haq *et al*. (1997) also indicated better FCR in layers during their first production cycle than in the second. Contrarily, Vargas *et al*. (2009) in another study reported that age of the breeders did not influence feed conversion ratio.

Feed conversion ratio (feed/ per dozen eggs): In the present study, feed conversion ratio (feed/dozen eggs) was significantly better during post-moult phase (7.4± 0.41) as compared to pre-moult (10.3± 1.01) which could be attributed to higher feed intake leading to better egg production and FCR during post moult period. The similar findings have also been reported (Berry, 2003; Hurwitz *et al*. 1998; Christmas *et al*. 1985).

The results indicated that Peshawari variety had significantly better FCR per dozen eggs (7.2± 1.04) than Lakha (10.66± 1.15) that could be due to the higher egg production in Peshawari variety than in Lakha as mentioned earlier.

The results of the present study showed significant effect of age on FCR/dozen eggs (Table 2). The younger birds had better FCR (7.27± 0.78) than exhibited by medium (9.06± 1.01), and old age birds (10.09±1.06). These results are in line with the findings of Yasmeen *et al*. 2008) who reported improvement in FCR with the decreasing age. Similarly, Haq *et al*. (1997) also observed better FCR in layers during their first production cycle than in the second.

Table 2. Pre and post moult production performance in four varieties of Aseel at three different ages.

Age / Variety	Feed intake (kg)	Body weight (gm)	Egg production %	Egg weight (gm)	Egg mass (kg)	FCR per Dozen	FCR/Kg egg mass
Moulting							
Pre-Moult	7.743± 0.069^{b}	2039± 25b	12.8± 0.7^{b}	41.776± 0.382^{b}	600.731± 35.288^{b}	10.3± 1.01^{a}	19.753± 1.940^{a}
Post-Moult	8.505± 0.065^{a}	2188± 26a	14.5± 0.63^{a}	46.885± 0.547^{a}	763.155± 33.316^{a}	7.4± 0.41^{b}	15.946± 1.339^{b}
Varieties							
Lakha	7.956± 0.109^{b}	2133± 39	10.63± 0.9^{b}	45.076± 0.837^{a}	551.589± 45.199^{c}	10.66± 1.15^{a}	21.666± 2.416^{a}
Mianwali	8.109± 0.105^{ab}	2081± 35	13.18± 0.7^{a}	44.152± 0.781^{ab}	643.141± 50.294^{bc}	9.83± 1.19^{ab}	19.453± 2.293^{ab}
Mushki	8.286± 0.082^{a}	2077± 41	15.09± 1.1^{a}	45.199± 0.799^{a}	802.066± 50.384^{a}	7.55± 10.3^{b}	14.881± 2.427^{b}
Peshawari	8.143± 0.141^{ab}	2163± 38	15.73± 0.9^{a}	42.893± 0.638^{b}	730.975± 46.971^{ab}	7.2± 1.04^{ab}	15.398± 2.257^{ab}
Age groups							
1st	8.034± 0.091^{b}	1842± 14c	15.5± 0.8^{a}	44.186± 0.670^{a}	764.487± 38.933^{a}	7.27± 0.78^{b}	14.800± 1.538^{b}
2nd	8.021± 0.104^{b}	2117± 15b	12.6± 0.9^{b}	44.499± 0.610^{a}	643.426± 39.957^{b}	9.06± 1.01^{ab}	18.544± 2.282^{ab}
3rd	8.317± 0.090^{a}	2382± 15a	12.8± 0.75^{b}	44.305± 0.736^{a}	637.916± 48.915^{b}	10.09± 1.06^{a}	20.205± 2.221^{a}

Means with unlike superscripts in a column are different significantly (P<0.05)

Conclusions: Based on the findings of this study, it may be stated that overall productive efficiency was improved in Assel chickens during the post moult phase with better productive performance in Mushki than in other varieties. The higher egg mass and better FCR were recorded in younger birds; whereas, the age did not influence egg weight in Aseel chickens.

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REFERENCES

Abanikannda, O. T. F. and A. O. Leigh (2007). Allometric relationships between composition and size of chicken table eggs. Int. J. Poultry Sci., 6(3): 211-217.

Abudabos, A. (2010). The effect of broiler breeder strain and parent flock age on hatchability and fertile hatchability. Int. J. Poultry Sci., 9(3): 231-235.

Ahmad, S. M., J. Akram, H. Iqbal, A Riaz and M. Saleem (2012). Comparative study on productive performance, egg quality and egg geometry and hatching triats of three age groups of indigenous Peshawari Aseel chickens., Book of Abstracts, National Science Conference on Agriculture and Food Security Issues in Global Environmental Perspectives The university of Poonch Rawlakot, Azad Jammu & Kashmir pp. 288.

Ahmed, N., Zia-ur-Rehman, M. Akram, T. H. Shah and M. Yousaf (1995). Effect of a new moulting programme on productive performance of spent layers under indigenous conditions. Pak. Vet. J., 15: 46-48.

Akram, M. (1998). Effect of induced moult on the subsequent second production cycle performance of commercial layers reared under various lighting and feeding regimes. Deptt. of Poultry Husbandry Ph.D Thesis University of Agriculture, Faisalabad, Pakistan.

Aslam, M. F., M. Akram, J. Hussain, A. Iqbal, S. Ahmad and S. Latif (2012). Comparative study on productive performance and hatching traits of three age groups of indigenous Mushki Aseel chicken. In Book of Abstracts; National Science Conference on Agriculture and Food Security Issues in Global Environmental Prospectus The University of Poonch, Rawalakot Azad Jammu & Kashmir pp. 289.

Aygun, A. and O. Olgun (2010). The effect of non- feed and feed withdrawal molting methods on molt and postmolt performance in laying hens. Trends Anim. Vet. Sci., 1: 45-48.

Baker, M., J. Brake and G. R. McDaniel (1981). The relationship between body weight loss during a forced moult and post moult reproduction performance of caged layer. Poultry Sci., 60: 1594.

Bar, A., V. Razaphkovsky, E. Wax and Y. Malka (2001). Effect of age at moulting on postmoulting performance. Poultry Sci., 80: 874-878.

Bell, D. D. (1991). Ten versus fourteen day fasting with and without moult feed. Poultry Adv., 24: 59-61.

Bell, D. D. and W. D. Weaver (2005). Commercial Chicken Meat and Egg Production, 5th edit.Springer Publishers, USA. pp-1075-1090.

Berry, W. D. (2003). The physiology of induced moulting. Poultry Sci., 82:971-980.

Bogdanova, M. I., R. G. Nager and P. Monaghan (2006). Does parental age affect offspring performance through differences in egg quality? . Functional Ecology, 20: 132-141.

Buhr, R. J. and D. L.Cunningham (1994). Evaluation of moult induction to body weight loss of fifteen, twenty, or twenty-five percent by feed removal, daily limited, or alternate-day feeding of a moult feed. Poultry Sci., 73: 1499-1510.

Campos, E. J. and N. C. Baiao (1979). The effect of restricted feeding on performance of commercial layer. Poultry Sci., 58: 1040-1041.

Christmas, R. B., R. H. Harms and O. M. Junqueira (1985). Performances of single comb White Leghorn hens subjected to 4- or 10-day feed withdrawal force rest procedures Poultry Sci., 64: 2321-2324.

Cleaver, W. T., V. L. Chirstensen and J. F. Ort (1986). Physiological characterstics of a moult and second cycle of egg laying in turkey breeder hens. Poultry Sci., 65: 2335-2342.

Cloete, S. W. P., K. L. Bunter, H. Lambrechts, Z. Brand, D. Swart and J. P. C. Greyling (2006). Variance components for live weight, body measurements and reproductive traits of pair-mated ostrich females. Brit. Poultry Sci., 47: 147-158.

Cloete, S. W. P., K. L. Bunter, Z. Brand and H. Lambrechts (2004). Co-variances for reproduction, egg weight and chick weight in ostriches. South African J. Anim. Sci., 34: 17-19.

Danilov, R. V. (2000). Effect of hen’s age on quality of hatching eggs and embryonic development. In Proceedings of 21st World’s Poultry congress Montreal, Canada. CD-ROM (WPSA).

Duncan, D. B. (1955). Multiple range and multiple F test. Biometrics, 11: 1-42.

El-Aggoury, S. M. A., Hanafi and S. A. R. Allah (1989). Traits of egg quality under the effect of different feedings regimes and lighting programs.Third

British Conf. on Anim. Fish and Poultry Prod., Alexandria.

GOP (2003). Country Report on State of Animal Genetic Resources of Pakistan. prepared by Ministry of Food Agriculture and Livestock. Govt. of Pakistan, Islamabad, for submission to FAO for First Report on the State of the Worlds' Animal Genetic Resources (SoWAnGR) .pp: 4-5.

Haq, A. N. Ahmad S. Rasool and T. H. Shah (1997). Effect of light and feed restriction during rearing on production performance of egg strain layers. Asian-Austr. J. Anim. Sci., 10: 657-664.

Hassan M. Malik, Ehsan-Ul-Haq and F. Ahmad (2008). Effect of age and body weight at molting on the performance of broiler breeder hens under environmental control houses in Pakistan. Pak. Vet. J., 28(4): 189-193.

Hipfner, M. A. J., G. R. Gaston, J. T. Herzberg Brosnan and A. E. Storey (2003). Egg composition in relation to female age and relaying: constraints on egg production in Thick billed Murres (Urialomvia). The Auk, 120: 645–657.

Hurwitz, S., E. Wax, Y. Nisenbaum, M. Ben-Moshe and M Plavink. (1998). The response of laying hens to induced moult as affected by strain and age. Poultry Sci., 77: 22-31.

Hussnain, F., J. Hussain, M. Akram and A. Iqbal (2012). Comparative study on productive performance, egg quality, egg geometry and hatching traits of three age groups of indigenous Lakha Aseel chicken In Book of Abstracts; National Science Conference on Agriculture and Food Security Issues in Global Environmental Perspectives. The University of Poonch, Rawalakot. Azad Jammu & Kashmir. pp. 287.

Ipek, A. and U. Sahan (2004). Effect of breeder age and breeding season on egg production and incubation in farmed ostrich Brit. Poultry Sci., 45: 643-647.

Johnston, S. A. and R. M. Gous (2007). Modelling the changes in the proportions of the egg components during a laying cycle. Brit. Poultty Sci., 48: 347-353.

Joseph, N. S. and E. T. Moran (2005). Effect of age and post emergent holding in the hatcher on broiler performance and further processing yield. J. App. Poultry Res., 14: 512-520.

Joyner, C. J., M. Peddie and T. G. Taylor (1987). The effect of age on egg production in the domestic hen. Gen. and Compar. Endocrin., 65: 331-336.

Korver, D. R., J. L. Saunders-Blades and K. L. Nadeau (2004). Assessing bone mineral density in vivo: quantitative computed tomography. Poultry Sci. 83:222–229.

Lambrechts, H. (2004). Reproduction efficiency of ostriches in commercial farming systems Ph.D. Thesis, University of the Free State, Bloemfontein, South Africa

Lee, K. (1982). Effects of forced moult period on post moult performance of Leghorn hens. Poultry Sci., 6: 1594.

Lourens, A. R. Molenaar H. Van Den Brand M. J. Heetkamp, R. Meijerhof and B. Kemp (2006). Effect of egg size on heat production and the transition of energy from egg to hatchling. Poultry Sci., 85: 770-776.

Mazzuco, H. J. P., A. Y. McMurtry Kuo and P. Y. Hester (2005). The effect of pre and post-moult diets high in n-3 fatty acids and moult programs on skeletal integrity and insulin-like growth factor-I of White Leghorns. Poultry Sci., 84: 1735-1749.

McDaniel, G. R. (1985). Factor affecting broiler breeder performance. 6. The relationship of pre-moult performances to post-moult performance. Poultry Sci., 64: 2267-2272.

Mehta, V. S., R. L. Lakhotia and B. Singh (1986). A study on forced resting and recycling of white layers. Indian J. Prod. Management, 2: 138-140.

Nakazawa, M., K. Furuta, T. Fuke and H. Geshi (1970). Studies on the forced moulting in layer: Effect of forced moulting in autumn on the performance of the layer. Jpn. Poultry Sci. 7:12.

North, M. O. and D. D. Bell (1990). Commercial Chicken Production Manual, AVI Publishing Inc, New York, USA

Ocak, N., M. Sarica, M. Erener and A. V. Garipoglu (2004). The effect of body weight prior to moulting in brown laying hens on egg yield and quality during second production cycle. Int. J. Poultry Sci., 3: 768-772.

Ogun, S. and T. Aksoy (1991). Effect of forced moulting on subsequevt egg production and quality Doga Turk. VeterinerlikVeHayvancilik, dergisc, 15: 338-348.

Platt and L. Frank (1925). All breeds of Poultry, origin: history: description, mating and characteristics. American Poultry, 45: 181-187.

Reddy, V., V. K. Malathi, B. S. Venkatarami and Reddy (2008). Effect of induced moulting in male and female line broiler breeder bens by Zinc Oxide and feed withdrawal methods on post moult performance parameters. Int. J. Poultry Sci., 7: 586-593.

Riaz, A., M. Akram, J. Hussain, S. Mehmood, M. M. Saleem and S. Ahmad (2012). Comparative study on productive performance, egg quality and egg geometry of three age groups of indigenous Mianwali Aseel chicken in Pakistan In Book of Abstracts, National Science Conference on Agriculture and Food Security Issues in Global Environmental Perspectives

The university of PoonchRawlakot, Azad Jammu & Kashmir. pp. 285.

Rizzi, C. and G. M. Chiericato (2005). Organic farming production. Effect of age on the productive yield and egg quality of hens of two commercial hybrid lines and two local breeds. Ital. J. Anim. Sci., 4: 160-162.

Rolon, A. R. J. Buhr and D. L. Cunningham (1993). Twenty-four-hour feed withdrawal and limited feeding as alternative methods for induction of moult in laying hens. Poultry Sci., 72: 776-786.

Seeland, G. R., Hubner and B. Roder (1995). Beziehungenzwischen der Legeleistung und Eiqualitätsmerkmalen von Legehennen. Arch. Tierz., 38: 489-501.

Soldevila, M. and V. Siberio (1987). Effect of forced moulting on subsequent laying performance of hens producing brown eggs. J. Agri. Univ. Puerto Rico, 71: 255-262.

Summers, J. D. and S. Leeson (1983). Factors influencing early egg size. Poultry Sci., 62: 1155-1159.

Summers, J. D. and S. Leeson (2005). Commercial Poultry Nutrition, 3rd edition. Nottingham University Press.

Usman, M. Z. Ahmad M. Akram J. Hussain S. Mehmood M Shafiq A. Rehman S. Ahmad and A. Iqbal (2013). Pre and Post moult productive performance of three age groups in four varieties of Aseel chicken. Abstracts of 33rd Pakistan Cong. of Zoology (International), Pakistan. 355.

Vargas, F. S. C., F. R. Baratto, A. Magalhães, Maiorka and E. Santin (2009). Influences of breeder age and fasting after hatching on the performance of broilers. J. Appl. Poultry Res., 18: 8-14.

Verheyen, G. and E. Decuypere (1986). Les re´sultats de production chez des poulesreproductricesnaines du type chair en function de technique d’induction de l’arreˆt de la ponte. Rev. Agric., 39: 163-175.

Weatherup, S. T. C. and W. H. Foster (1980). A description of the curve relating egg weight and age of hen. Brit. Poultry Sci., 21: 511-519.

Williams, T. D. and J. K. Christians (2003). Experimental dissociation of the effect of age and experience on primary reproductive effort and interactions with diet quality. J. Avi. Bio., 34: 379-386.

Yasmeen, F., S. Mahmood, M. Hassan, N. Akhtar and M. Yaseen (2008). Comparative productive performance and egg characteristics of pullets and spent layers. Pak. Vet. J., 28: 5-8.

Yousaf, M. and N. Ahmad, 2006. Effects of housing systems on productive performance of commercial layers following induced molting by aluminum oxide supplementation. Pak. Vet. J., 26(3): 101-104.

Zemková, Ľ, J. Simeonovová, M. Lichovníková and K. Somerlíková (2007). The effects of housing systems and age of hens on the weight and cholesterol concentration of the egg. Czech. J. Anim. Sci., 52: 110-115.