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Production Performance of Different Broiler Breeds Under Different Housing Systems

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Abstract: In today's broiler industry, different housing systems are used in broiler production. However, the most common one is raising broilers on the floor. Raising broilers in the cages is another type of broiler housing system, but yet it is not commonly used. Raising broilers in cage system has many advantages when compared to raising broilers on the floor. The first obvious advantage is the better utilization of space available and that is important especially when the lands are expensive. In addition, using cage to raise broilers provide better hygienic condition that could lead to improving the health and quality of broilers. However, it is not known whether or not different broiler breeds will behave similarly when are raised in cage versus floor. Therefore, the current study was conducted to compare the production performance as well as %carcass of broilers raised in the cage system with broilers raised on the floor. In addition the %fat and %protein of meat from broilers raised under the two housing systems were measured. Three broiler breeds were used in three separate experiments. These breeds were Indian River, Cobb500 and Ross. Data on body weight, feed consumption were measured at 1, 3 and 5 weeks of age. Feed efficiency, %mortality, %carcass were calculated. In addition the %protein and %fat of breasts and legs of different breeds under the two housing systems were measured. Our results indicate that raising broilers in cages could provide better production efficiency than raising broilers on the floor. Furthermore, our results show that %protein is higher in the breast than in leg meat, however, %fat was higher in the leg than in the breast meat. In conclusion, our experiments emphasis the importance and significancy of utilizing cages to raise broiler chicks.

Key words: Broilers, cages, floor, production parameters, %protein, %fat

INTRODUCTION

The broiler industry in Kuwait is an important and a significant part of the agriculture sector. This is because local broiler meat consumption has been consistently increasing and per capita consumption reached 60.8 kg in 2006 (Al-Nasser, 2006). However, the local broiler industry is facing serious competition from imported products because of the cheaper prices of such products. Therefore, the local broiler industry is to improve production efficiency and reduce cost of production. Currently broilers are raised in floor system and it is well known that the use of cages leads to better space utilization. Since space is very expensive in Kuwait, the use of cages to raise broilers instead of floor could lead to a reduction in production cost and therefore, price reduction. This price reduction will enable the broiler industry in Kuwait to compete with the imported products. Furthermore, more than 50% of broilers that are produced in Kuwait are sold in the live market (USDA, 2006) and therefore the birds should be raised in a housing system that provides good hygienic condition. It is expected that the cage system will provide more hygienic conditions than the floor system. Willis *et al.* (2002) found that the isolation rates of Campylobacter were found to be less in broilers raised in cages than the broilers raised on the floor indicating better hygienic conditions of birds that are raised in cages than those raised on the floor. In addition, some parameters of the immune system of the birds raised in cages were found to be better than those raised on floor (Wang *et al.*, 2003). Furthermore, Wang *et al.* (2002) reported that broilers on the floor inhaled litter dust and noxious fumes, which impaired pulmonary gas exchange and increased the arterial partial pressure of CO_2 when compared with broilers raised in cages. It also should be mentioned that Vitorovic and Nikolic (1995) reported that wing bones of broilers reared in cages are better than that raised on the floor and also the proliferative zone, hypertrophic zone and the total growth plate of the humerus are higher. All these facts could indicate that raising broilers in cages could lead to the production of birds that are of better health and therefore higher quality.

In addition to space utilization and hygienic conditions, production performance and efficiency are important factors when comparing broilers that are raised in cages

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vs. that which are raised on the floor. However, not much research has been conducted comparing production performance of broilers raised in cages with broilers raised on floor. Suk and Washburn (1995) found no difference in feed efficiency between broilers raised in cages and ones raised on the floor. In addition, Pedroso *et al*. (2006) found no differences in weight gain, feed consumption, or feed-to-gain ratio in broilers raised on the floor or in batteries. However, Garcia *et al*. (2008) found that daily body weight gain as well as feed: gain ratio was better for broilers raised in cages than that which are raised on the floor. Furthermore, Blair and Jacob (1990) and Guban *et al*. (2006) found that feed efficiency of broilers raised in cages is better than that raised on the floor. On the other hand, Santos *et al*. (2008) found that body weight of broilers in cage-system housing is less than that of broilers in litter housing.

It is clear that further investigations are needed to compare production performance of broilers that are raised in the conventional floor system and broilers that are raised in the cage system. Therefore, the purpose of the current study was to compare the production performance as well as %carcass of broilers raised in the cage system with broilers raised on the floor. In addition, this study investigated whether this difference related to the housing system, if any, varies between different broiler breeds.

Furthermore, the knowledge concerning the chemical composition of chicken meat is very limited. Consumers often demand information regarding the nutrient composition of food and the quality of products consumed (Horbanczuk *et al*., 2004; Horbanczuk, 2002). Therefore, it is beneficial to study and compare the %fat and %protein of meat from broilers of different breeds raised under different housing systems.

MATERIALS AND METHODS

The broiler breeds that were used in the current study included Indian River, Cobb500 and Ross and were straight-run. Separate experiment was conducted for each breed. In each experiment, the one-day old chicks were distributed randomly among two housing systems namely floor and cage battery system. In both systems, the space per bird was 0.05 m^2. Feed was provided to all broilers *ad libitum*. Seven floor pens were used for the floor system and six cage batteries were used for the cage system. Data on body weight and feed consumption from each floor pen or each cage were measured at 1, 3 and 5 weeks of age. Feed efficiency was calculated. Percent carcass was determined at 5 weeks of age. Mortality was recorded daily. Each floor pen or each cage battery was considered as a one replicate providing seven replicates for the floor system and six replicates for the cage system. At five weeks of age, the end of the experiments, the birds were slaughtered and random samples were collected from the breast and leg meat for measuring %protein and %fat on dry matter basis. This was done for the Cobb500 and Ross birds only. Number of replicates was 5 for each parameter.

One-way analysis of variance, using the General Linear Model (GLM) (SAS Institute, 1996) was used to compare the effect of housing system, within each breed, on production parameters and on the %carcass. The housing system was the only factor considered. However, two way analysis of variance was used to compare the effect of housing system and part, within each breed, on the %protein and on the %fat. The housing system and part were the two factors considered.

RESULTS AND DISCUSSION

Effects of the housing system on different production parameters in the different breeds: Data on effects of housing system on production performance of Indian River, Cobb500 and Ross breeds are shown in Table 1, 2 and 3, respectively.

Our results show that body weight of Indian River broilers, at 5 weeks of age, raised on the floor were significantly ($p<0.05$) higher than that of broilers raised in cages. These results agree with that of Santos *et al*. (2008), who found that body weight of broilers in cage-system housing was less than that of broilers in litter housing. However, our results disagree with Garcia *et al*. (2008) and Guban *et al*. (2006), who reported that body weight gain was better for broilers raised in cages than that raised on the floor and that of Deaton *et al*. (1974) who found that broiler chicks grown in the cages were heavier than the chicks that were grown in floor pens. This difference in results could be due difference in the broiler breed that is used. In our current study, it was also found that the difference in body weights between broilers that are raised in cages or on the floor depends on the breed used. We found that body weights, at 5 weeks of age, of Cobb500 raised in cages were significantly ($p<0.05$) higher than that raised on the floor (Table 2). On the other hand, using Ross breed, it was found that there was no significant difference in body weights of birds raised in cages or on the floor (Table 3). Therefore, our results and the results of others could indicate that the advantage of using cages vs. floor system, relative to body weight, depends on the broiler breed used. It should be mentioned that there was no significant difference ($p>0.05$) in %carcass between Cobb500 broilers (Table 2) or Ross broilers (Table 3), raised in cages or on the floor.

Our results on total feed consumption indicated that the birds from all the three breeds namely Indian River (Table 1), Cobb500 (Table 2) and Ross (Table 3), that were raised on the floor consumed significantly ($p<0.05$) more feed than the birds raised in cages. Suk and Washburn (1995) found similar results where total feed

Table 1: Effect of different housing systems on production performance of Indian River broiler breed

	Housing system	
Parameters	Cage	Floor
Body weight at five weeks of age (g)	1270.70±31.4*[b]	1368.20±11.1[a]
Total feed consumption (g/bird)	1906.10±45.6[b]	2051.50±21.3[a]
Overall feed efficiency	1.56±0.06[a]	1.55±0.03[a]
Total percent mortality	4.10±1.4[a]	2.60±1.0[a]

[ab]Means within the same raw with different superscripts are significantly different (p<0.05).
*Values are expressed as means±SD (n = 6 for cage system and 7 for floor system)

Table 2: Effect of different housing systems on production performance of Cobb500 broiler breed

	Housing system	
Parameters	Cage	Floor
Body weight at five weeks of age (g)	1665.00±53.0*[a]	1561.00±33.1[b]
Carcass%	70.59±2.58[a]	71.33±3.27[a]
Total feed consumption (g/bird)	2429.10±41.0[b]	2624.10±41.5[a]
Overall feed efficiency	1.51±0.06[b]	1.72±0.01[a]
Total percent mortality	6.90±1.9[a]	3.30±0.5[b]

[ab]Means within the same raw with different superscripts are significantly different (p<0.05).
*Values are expressed as means±SD (n = 6 for cage system and 7 for floor system)

Table 3: Effect of different housing systems on production performance of ROSS broiler breed

	Housing system	
Parameters	Cage	Floor
Body weight at five weeks of age (g)	1575.00±28.5*[a]	1548.00±45.0[a]
Carcass%	66.46±1.97[a]	67.89±5.47[a]
Total feed consumption (g/bird)	2481.60±22.1[b]	2604.30±43.4[a]
Overall feed efficiency	1.60±0.03[b]	1.70±0.04[a]
Total percent mortality	2.30±0.0[a]	1.60±0.4[b]

[ab]Means within the same raw with different superscripts are significantly different (p<0.05).
*Values are expressed as means±SD (n = 6 for cage system and 7 for floor system)

consumption for broilers raised on the floor is higher than that raised in cages. However, Santos *et al.* (2008) using Ross-508 broiler breed found no differences in total feed consumption between birds that were raised in cages vs. birds that were raised on the floor. Never less, our results indicating that, regardless to broiler breed used in our study, feed consumption for birds raised in cages was less than that which were raised on the floor, are very important and significant. This is because the cost of feed constitutes approximately 70% of the total cost of raising broilers as reported by Aggrey *et al.* (2010) and reduced feed consumption will lead to reduction in cost of feed and in turn reduce cost of production. This reduction in cost production could be reflected in reduction of prices to the consumer. Therefore, raising broilers in cages could have a significant advantage over raising broilers on the floor.

As to our results on feed efficiency, it was found that the difference in feed efficiency between birds that were raised in cages and that which was raised on the floor depends on the breed that was used. For Indian River broiler chicks, there were no significant differences (p>0.05) in feed efficiency between birds that were raised in cages and that which were raised on the floor (Table 1). However, feed efficiency for both Cobb 500 (Table 2) and Ross broiler chicks (Table 3) that were raised in cages was significantly (p<0.05) better than that which were raised on the floor. Our results on feed efficiency using Indian River broiler chicks agree with Pedroso *et al.* (2006) who found no differences in feed-to-gain ratio in broilers on the floor or in batteries. Furthermore, our results on feed efficiency using both Cobb500 and Ross broiler chicks agree with Guban *et al.* (2006) and of Garcia *et al.* (2008) who found that feed efficiency of broilers raised in cages is better than that raised on the floor. Our results on feed efficiency indicating that birds raised in cages have better feed efficiency than birds raised on the floor is very important and significant. This is because feed efficiency is an important indicator for production efficiency.

It should be mentioned that our data show that there were no significant differences (p>0.05) in %mortality between Indian River broilers raised in cages or on the floor (Table 1). On the other hand, %mortality for Cobb500 or Ross broilers raised in cages was significantly (p<0.05) higher than the broilers that were raised on the floor. However, the %mortality was within acceptable values.

Table 4: Effect of different housing systems on %protein and %fat of the breast and leg muscle of ross broiler breed

	Protein		Fat	
Parts	Floor	Cage	Floor	Cage
Breast	83.72±2.79*[a]	84.32±1.12[a]	11.04±1.35[c]	13.40±1.34[c]
Leg	66.93±5.26[b]	66.21±3.80[b]	27.19±4.04[b]	36.68±4.08[a]

[abc]Means within each parameter that has different superscript are significantly different (p<0.05).
*Values are expressed as means±SD (n = 5)

Table 5: Effect of different housing systems on %protein and %fat of the breast and leg muscle of Cobb500 broiler breed

	Protein		Fat	
Parts	Floor	Cage	Floor	Cage
Breast	84.08±1.53*[a]	79.56±5.15[a]	15.62±4.23[bc]	13.03±1.13[c]
Leg	62.06±2.99[b]	58.70±5.46[b]	21.48±4.38[ab]	26.16±4.34[a]

[abc]Means within each parameter that has different superscript are significantly different (p<0.05).
*Values are expressed as means±SD (n = 5)

Therefore, it can be generally concluded from our results that raising broiler chicks in cages could provide better production efficiency than raising broilers on the floor.

Effects of different housing systems on levels of protein and fat in different broiler breeds: Data on the effect of different housing systems on %fat and %protein of the breast and leg of broilers that were raised on the floor or in cages for Ross and Cobb500 are shown in Table 4 and 5, respectively.

Our results show that there were no significant differences (p>0.05) in %protein of Ross broilers (Table 4) or Cobb500 (Table 5) that were raised on the floor or in cages. This was the case for both breast and leg meat. This indicates that housing systems does not affect %protein of different parts of broilers. Our results agree with Souza *et al.* (2011) who found that the protein in the cuts of breast and thigh of broilers raised either on semi-intensive or intensive rearing systems was similar.

In addition, %protein in broiler's breast of Ross birds (Table 4) or Cobb500 (Table 5) that were raised either on the floor or in cages were significantly (p<0.05) higher than that in the leg's meat. Our results agree with the results obtained by Suchy *et al.* (2002) who studied the chemical composition of breast and thigh muscles in three hybrid combinations of broiler chickens (Ross 308, Cobb and Hybro) and found that breast muscles are characterized by an increase content of protein relative to the leg muscle. These differences in protein contents between breast and thigh muscles could be due to a large number of genetic and non-genetic factors as reported by Boskovic *et al.* (2010b). Therefore, chicken breast meat can be classified as a high-protein meat.

Furthermore, our data show that there were no significant differences (p>0.05) in %fat of the breast or of the leg for the broilers that were raised on the floor or in cages for both Ross (Table 4) and Cobb500 (Table 5) broilers. There was only one exception to this finding and that was for the leg of Ross broilers where the broilers that were raised in cages have significantly (p<0.05) higher %fat in the leg than those which were raised on the floor. Our results agree with that reported by Souza *et al.* (2011) who found that the ether extract in the cuts of breast and thigh of broilers raised either on semi-intensive or intensive rearing systems were similar. Furthermore, our results agree with that reported by Dou *et al.* (2009) who assigned the slow growing chickens to one of three raising systems (indoor-floor, indoor-net and free-range) and found no significant differences (p>0.05) in fat contents between the birds. However, our results disagree with that reported by Boskovic *et al.* (2010a) who suggested that housing systems, free range rearing system or extensive indoor system, has a significant effect as the free range system resulted in lower fat content of chicken meat. In addition, Boskovic *et al.* (2006) reported that intensively reared system significantly increased (p<0.01) lipid content in the broilers versus the semi-intensive (free range) rearing system.

These differences could be due to the difference in the broiler breed that was used, again indicating that there might be an interaction between housing systems and breed as it relates to %fat in broiler parts. Furthermore, variation in %fat could depend on the housing systems, including cage, floor, intensive, semi-intensive or free range.

It should be mentioned that regardless to the breed and housing system, the %fat in the broiler leg meat was significantly (p<0.05) higher than the %fat in the breast for both Ross (Table 4) and Cobb500 (Table 5). Our results agree with that reported by Suchy *et al.* (2002) who studied the chemical composition of breast and thigh muscles in three hybrid combinations of broiler chickens and found that thigh muscles are characterized by an increase in fat content. The differences in %fat between the leg and the breast might be influenced by

muscle type as reported by Majewska *et al.* (2009), or could be due to the different functions of particular muscle tissue. Furthermore, these differences in %fat could be due to an increase in acetyl-CoA carboxylase (the rate limiting enzyme in fatty acid synthesis) in the leg meat as reported by Sontoso (2001). He found that an increase in acetyl-CoA carboxylase lead to an increase in fatty acid synthesis, which could justify the high %fat in the leg versus the breast of broiler meat.

In conclusion, our results indicate that raising broiler chicks in cages could provide better production efficiency than raising broilers on the floor. In addition, raising broilers in cages could lead to improving the bird's hygienic condition. It is obvious that the space will be better utilized when the cage battery system is used to raise broilers. Furthermore, our results showed that %protein is higher in breast than leg, however, %fat was higher in the leg than in the breast. Therefore, consuming breast or leg meat would depend on the consumer's preference.

All in all, the overall results of our experiments emphasis the importance and significancy of utilizing cages to raise broiler chicks.

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