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EFFECT OF TYPE OF LITTER ON BROILER PERFORMANCE

M. El-Sagheer, M.N. Makled and M.A. Mohamed

Department of Animal and Poultry Production, Faculty of Agriculture, Assiut University, Assiut, Egypt

SUMMARY

One hundred and eighty one-day old broilers (Arbor Acres) were used in this study. The chicks were divided into three groups: The chicks were reared on wheat straw litter (group 1); the birds were reared on sand litter (group 2) and Group 3 where the birds were reared on saw dust litter. The chicks were raised on these types of litter from 0 to 49 days of age. The obtained results could be summarized as follows:

The birds reared on sand litter had the heaviest body weights as compared with those reared on wheat straw or saw dust. Also, the overall mean for body weight gain (BWG) followed the same trend as body weight (BW). The type of litter had no effect on feed consumption (FC). The cumulative feed conversion ratio (FCR) was significantly ($P<0.05$) better for birds of groups 1 and 2 as compared with those of group 3. Birds of group 2 had better FCR as compared with those of group 3. The mortality rate (MR) was 16.7, 6.7, and 20.0 % for groups 1, 2, and 3, respectively.

No significant differences were found in carcass, feet and shanks, head, neck, drumsticks, femurs, breast, wings, and back weight percentages. Moreover, type of litter had no significant effect on fat contents (drumstick, femur and breast), shank length or heart, liver, proventriculus, spleen, lungs, gizzard, intestines, and kidneys weight percentages. Broilers reared on wheat straw or saw dust showed a larger number of foot lesions than those reared on sand litter. Besides, sand litter had lower bacterial counts than saw dust and wheat straw, which showed the greatest bacterial counts. No mold populations were observed at sand or wheat straw litter, however, high mold populations were found in saw dust litter. Red blood cells (RBCs) increased significantly ($P<0.05$) by 6.93 % in birds reared on sand than that of birds reared on wheat straw or saw dust. Hemoglobin (HG) and heamatocrit (HC) were decreased significantly ($P<0.05$) in birds of group 3 as compared to those of groups 1 and 2.

It was proved that group 2 (reared on sand litter) had the best economic efficiency (EE) value as compared with groups 1 and 3 (reared on wheat straw or sawdust, respectively).

Keywords: Broilers performance, type of litter, sand, wheat straw, saw dust, fat content, bacterial and mold counts, economic efficiency

INTRODUCTION

Poultry litter is a mixture of excreta, feed, feathers, and bedding materials. However, both new and unused bedding materials are generally referred to as litter. There are many factors, which must be taken into account for successful litter

management. These include the type of litter used, the time of the year, depth of the litter, and floor space per bird (Snyder *et al.,* 1958).

In general, bedding material need to be very absorbent. This is probably a good criterion for organic materials but might not apply to inorganic materials such as sand and clay. In order to be used as a poultry bedding material, it must be reasonably available. If the current litter material becomes difficult to obtain or has a low quality, poultry growers may decide to use alternative litter material. Ultimately, bird performance parameters, such as growth rate, feed efficiency, and carcass quality, as well as litter cost and availability will have priority in evaluating the usefulness and suitability of the litter material (Grimes *et al.,* 2002).

Wood shavings, wheat straw and saw dust are common superior broiler litter products because of their costs, availability, and suitability. However, as the broiler industry continues to expand, the supply of these litter materials is sometimes inadequate to meet local demand. This has forced the poultry industry to search for alternative litter materials. In some countries without adequate supplies of traditional litter materials, sand has been used for some times to rear broilers without reported results (Parsons and Baker, 1985).

The objective of this study was to determine the feasibility of sand as alternative litter material to wheat straw or saw dust for rearing broilers.

MATERIALS AND METHODS

The present work was carried out at the Research Poultry Farm of Animal and Poultry Production Department, Faculty of Agriculture, Assiut University from 9 June to 28 July 2002. The experiment was planned to study the effect of type of litter on performance, carcass parts, fat deposition, foot lesions, bacterial counts, and some blood parameters of broiler chicks.

One hundred and eighty one-day old broilers (Arbor Acres) were used in this study. All chicks were wing banded, weighed, and housed in floor pens in 3 groups, each group included 6 replicates of 10 chicks each. Each replicate was kept in a partition of 2 meter square provided with deep litter (8 - 10 cm). The chicks were maintained under continuous lighting with water and feed available *ad libitum* all the time. In group 1 which served as control group, the birds reared on wheat straw litter. In group 2, the birds reared on sand litter and in group 3 the birds reared on saw dust litter. The birds received starter diet until two weeks of age, grower diet from two to four weeks of age and finisher diet from five to seven weeks of age (Table 1).
The traits studied in this experiment were as follows:

Body weight (BW) and feed consumption (FC):

Birds of each treatment were weighed individually every week. Also, FC of each replicate was calculated weekly.

Feed conversion ratio (FCR):

Mean FCR was calculated weekly by dividing total FC in a pen by the total gain in BW of the birds in that pen.

Carcass criteria and blood parameters:

At 49-day old, 12 birds per treatment were taken as a representative sample (three per replicate) around the average weight of the group, sacrificed and blood samples were taken to estimate Heamatocrit (HC), Hemoglobin (HG) and red blood cells (RBCs) by using blood analysis device (Cell DYN 1100).

The internal organs were removed from the body. The heart, liver, empty gizzard, proventriculus, spleen, kidneys and lungs were weighed. The empty gastrointestinal tract including the pancreas was weighed. The head was removed at the occipital bone, feet and shanks were removed at hock joints, wings were removed at shoulder joints, neck was removed close to the shoulder and then all parts were individually weighed. Breast, femurs and drumsticks were also weighed as separate carcass parts. The back was separated from breast along the vertebral column. The breast weight included the bones of sternum and ribs. Shank and sternum bones length were measured to the nearest 0.1 cm. After chilling at 9 °C, the abdominal fat was removed and weighed.

Mortality rate (MR):

Died birds were recorded daily, and then MR was calculated.

Fat deposition:

Fat content in breast, femurs, and drumsticks meat were estimated in representative samples according to the procedure of the Association of Official Analytical Chemists (AOAC, 1987).

Economic efficiency (EE):

Feed cost per bird and litter cost per group were calculated. Net revenue was calculated by subtracting feed and litter cost from bird price. EE was estimated by dividing net revenue by feed and litter costs.

Bacterial and mold counts:

Six samples were taken from each group (1 sample/ replicate). From each litter sample, 1 g was taken and placed in sterile Erlenmeyer flask with 99 ml sterile saline-pepton-water solution (8 g Na Cl, 1 g peptone + 1 L distilled water) and stirred with mechanical shaker for 30 minutes. While suspension was in motion, 2 ml of the suspension were withdrawn, added to 18 ml of the saline-pepton-water solution in a screw cap plastic bottle and shaked for 5 minutes. The dilution and shaking process were repeated until 10^{-3} dilution, which was obtained to estimate bacterial populations. Aliquotes of 0.1 ml were taken and dispersed on the surface of nutrient sucrose agar medium in Petri dishes. The same method was used to estimate mold population using Potato-Dextrose-Agar medium (PDA) supplemented with antibiotic (streptomycin) to prevent bacterial growth. Plates were incubated at 25 ºC for 7 days and the developed bacterial and mold colonies were counted by using visual ranking system.

Statistical analysis:

Data collected were subjected to ANOVA applying the General Linear Models Procedure of SAS software (SAS institute, version 6.12, 1996). Duncan's multiple range test (1955) was used to detect the significance of the differences between means of the different groups.

Table 1. Composition of the experimental diets

Ingredient (%)	Starter	Grower	Finisher
Corn	60.47	66.20	71.45
Soybean meal	25.74	21.04	18.13
Concentrates	10.41	9.29	6.30
Bone meal	0.38	0.45	0.75
Limestone	0.00	0.25	0.25
Salt	0.00	0.00	0.12
Oil	3.00	3.00	3.00
Calculated analysis*:			
ME, Kcal/ Kg	2908	2960	2985
Crude protein, %	21.84	19.79	17.86
Crude fat, %	5.24	5.78	5.93
Calcium, %	1.02	0.94	0.87
Phosphorus, %	0.49	0.47	0.43
Crude fiber, %	5.72	5.64	5.53

*Calculated on dry matter basis.

RESULTS AND DISCUSSION

1- Body size:

Effect of type of litter on body weight (BW) is presented in Table (2). At the age of one week, birds of group 1 had significantly ($P<0.05$) higher body weights than those of both groups 2 and 3. The reduction in body weights at one week of age was 7.51, and 4.92 % for group 2, and 3, respectively, as compared to theirs control. However, at two weeks of age the differences disappeared. From week 3 to 7 of age, birds of group 3 had significantly ($P<0.05$) lower body weights than those of group 2. Birds of group 2 tended to be heavier in body weights than those of group 1 from 4 to 7 weeks of age, however, the difference was insignificant till the age of 6 weeks, and thereafter it was significant at 7 weeks of age. These results are in agreement with the finding of Bilgili *et al*., (1999a) who reported that broilers reared on sand litter had significantly higher body weights than those reared on pine shavings**.**

From Table (2) it could be detected that litter type had no effect on shank length among different treatments.

Table 2. Effect of type of litter on live body weight (g) and shank length (cm)

Intervals (in weeks)	Type of litter		
	Wheat Straw ±SE	Sand ±SE	Saw dust ±SE
Day-old	41.8±0.4	41.5±0.4	41.2±0.4
1*ST*	106.6±1.9[a]	98.6±1.7[b]	101.4±2.0[b]
2nd	229.0±4.3	229.6±4.7	222.9±5.0
3rd	385.3±6.0[a]	383.5±8.2[a]	355.8±7.3[b]
4th	632.5±11.8[a]	644.1±12.8[a]	589.8±12.0[b]
5th	984.7±17.1[ab]	1022.1±18.5[a]	946.1±15.6[b]
6th	1241.7±23.1[ab]	1300.7±23.3[a]	1192.8±21.2[b]
7th	1488.8±30.1[b]	1596.8±30.1[a]	1457.5±28.8[b]
Shank length, (cm)	6.71±0.13	6.71±0.10	6.54±0.10

[a, b and c] means with the same row with different superscripts are significantly different (P≥ 0.05).

2. Body weight gain (BWG):

Effect of type of litter on BWG is presented in Table (3). At the first week of age, it was found that broilers of group 1 gained significantly (P<0.05) more weight than those of groups 2 and 3. However the differences were not significant. From 2 to 7 weeks of age, no significant differences were found among all groups. Nevertheless, the overall mean indicates that birds of group 2 gained significantly (P<0.05) more weight than those of both groups 1 and 3. The reduction in growth for birds reared on wheat straw or saw dust may be due to increased leg disorders and feet lesions that make birds unable to walk and reach feeders and waterers, or may be due to the high microbial and mold content of litter which may be consumed by birds.

Footpad lesions can cause pain, which together with a deteriorated state of health constitutes a welfare issue. It has been indicated that broilers with severe foot lesions show slower weight gain (Martland, 1985; Ekstrand and Alger, 1997), which has been suggested to be a result of pain (Martland, 1985).

Table 3. Effect of type of litter on daily weight gain (g/bird/d)

Intervals (in weeks)	Type of litter		
	Wheat Straw ±SE	Sand ±SE	Saw dust ±SE
1*ST*	9.3±0.2[a]	8.2±0.2[b]	8.6±0.4[ab]
2nd	17.5±0.9	18.8±0.8	17.4±1.1
3rd	22.3±0.8	22.0±0.9	19.1±1.5
4th	35.4±2.8	37.2±2.6	33.1±1.7
5th	50.4±1.6	54.4±1.9	51.3±2.1
6th	35.9±1.8	39.9±2.1	36.8±3.0
7th	36.5±2.6	42.4±3.2	38.3±2.0
Overall mean	29.5±0.6[b]	31.7±0.6[a]	28.9±0.6[b]

[a, b and c] means with the same row with different superscripts are significantly different (P≥ 0.05).

3. Feed consumption (FC): Effect of type of litter on FC is presented in Table (4). It was found that type of litter had no effect on FC. These results are in agreement with those reported by Martinez and Gernat (1995), and Lien *et al*., (1992).

4. Feed conversion ratio (FCR): Effect of type of litter on FCR is presented in Table (5). No significant differences were found in FCR among all treatments from 1 to 4 weeks of age. At the 5th week of age, birds of group 2 had significantly (P<0.05) better FCR than those of group 1 and 3. Also, at weeks 6 and 7, birds of group 2 had significantly better FCR than those of group 3, while birds of groups 1 and 2 had an equal FCR. The cumulative FCR was significantly (P<0.05) better for birds of groups 1 and 2 as compared with those of group 3. Birds of group 2 had superior FCR as compared with those of group 3.

Table 4. Effect of type of litter on feed consumption (g/bird/d)

Intervals (in weeks)	Type of litter		
	Wheat Straw ±SE	Sand ±SE	Saw dust ±SE
1ST	10.9±0.4	10.3±0.6	10.6±0.4
2nd	22.1±1.2	25.2±1.3	22.8±1.4
3rd	34.0±1.2	33.0±1.2	29.6±2.7
4th	58.8±3.2	60.9±4.1	57.4±4.1
5th	91.0±2.3	94.0±2.0	92.8±2.9
6th	77.2±3.0	82.7±2.8	82.9±6.1
7th	91.4±5.0	101.1±7.3	97.6±5.2
Overall mean	55.0±0.9	58.2±1.8	56.2±1.4

Table 5. Effect of type of litter on feed conversion ratio (g feed / g gain)

Intervals (in weeks)	Type of litter		
	Wheat Straw ±SE	Sand ±SE	Saw dust ±SE
1ST	1.18±0.04	1.25±0.05	1.24±0.06
2nd	1.26±0.04	1.34±0.03	1.32±0.04
3rd	1.52±0.02	1.50±0.03	1.55±0.04
4th	1.68±0.04	1.64±0.04	1.73±0.04
5th	1.81±0.02^{a}	1.73±0.03^{b}	1.81±0.02^{a}
6th	2.16±0.03^{ab}	2.09±0.05^{b}	2.26±0.04^{a}
7th	2.52±0.05^{ab}	2.39±0.05^{b}	2.55±0.04^{a}
Overall mean	1.86±0.02^{b}	1.83±0.02^{b}	1.92±0.02^{a}

$^{a, b \text{ and } c}$ means with the same row with different superscripts are significantly different (P≥ 0.05).

5. Carcass traits:

Effect of type of litter on carcass weight and carcass parts is presented in Table (6). No significant differences were found in carcass, feet and shank, head, neck, drumsticks, femurs, breast, wings, and back weights.

Willis *et al*. (1997) found that there were no significant differences in carcass weight and carcass yield percentage between broilers reared on pine shavings or leaves and those reared on mix of 50% leaves and 50% pine shavings. Lien *et al*., (1992) found that litter type, recycled paper chips and pine shavings had no significant effects on carcass yields of broiler chickens.

Effect of type of litter on body organs weights is presented in Table (7). It was found that type of litter had no significant effect on heart, liver, proventriculus, spleen, lungs, gizzard, intestines, and kidneys weights as a percentage of carcass weight. However, Malone and Chaloupka (1983) observed that broilers reared on wood shavings had significantly larger gizzards (1.42%) than those reared on composted municipal garbage (1.29%).

Table 6. Effect of type of litter on carcass parts weights as percentage of live body weight

Carcass parts (%)	Type of litter		
	Wheat Straw ±SE	Sand ±SE	Saw dust ±SE
Live BW, (g).	1547.1±33.0	1579.6±33.0	1551. 7±25.8
Carcass W, (g).	1031.7±21.6	1053.2±26.1	1030.0±24.0
Carcass, %	66.7±0.6	66.6±0.6	66.3±0.5
Feet & Shank	5.4±0.2	5.2±0.2	5.6±0.2
Head	3.1±0.1	3.2±0.1	3.2±0.1
Neck	5.1±0.3	5.8±0.3	5.7±0.2
Drumsticks	10.4±0.3	10.8±0.2	10.9±0.3
Femurs	12.0±0.9	10.8±0.2	10.6±0.2
Breast	16.5±0.3	15.9±0.3	14.5±1.3
Wings	8.6±0.2	8.5±0.2	8.3±0.2
Back	14.8±0.5	15.1±0.3	14.6±0.4
Abdominal fat	1.5±0.2	1.4±0.1	1.2±0.1

Table 7. Effect of type of litter on body organs weights as percentage of carcass weight

Organ (%)	Type of litter		
	Wheat Straw ±SE	Sand ±SE	Saw dust ±SE
Live BW, (g)	1547.08±33.17	1579.58±33.03	1551.67±25.76
Carcass W, (g)	1031.66±21.58	1053.24±26.13	1030.02±23.99
Carcass, %	66.71±0.56	66.64±0.58	66.31±0.53
Heart	0.45±0.02	0.50±0.03	0.45±0.03
Liver	2.05±0.14	2.20±0.10	1.99±0.13
Proventriculus	0.56±0.03	0.63±0.04	0.63±0.03
Spleen	0.12±0.01	0.12±0.01	0.16±0.04
Lungs	0.47±0.03	0.45±0.02	0.46±0.03
Gizzard	2.16±0.19	2.13±0.14	2.17±0.11
Intestine	4.91±0.27	4.81±0.34	5.49±0.24
Kidneys	0.54±0.03	0.62±0.04	0.57±0.05

6. Fat deposition:

According to the data presented in Table (8), no significant differences were found in fat deposition in different carcass parts among all treatments.

7. Blood parameters:

Effect of type of litter on blood parameters is presented in Table (8). It was found that rearing broilers on different types of litter induced some changes in the hematology of the birds. The RBCs increased significantly ($P<0.05$) in birds reared on sand than that of birds reared on wheat straw or saw dust. The increase in RBCs was 6.93 % for birds of group 2 as compared to their controls.

The HG concentrations were decreased significantly ($P<0.05$) in birds of group 3 as compared to that of groups 1 and 2. Also, HC followed the same trend as HG.

Table 8. Effect of type of litter on fat contents in different carcass parts (on dry matter basis), mortality rate, blood parameters and bacterial count per one gram of litter

Item	Type of litter		
	Wheat Straw ±SE	**Sand ±SE**	**Saw dust ±SE**
Fat, %			
Drumsticks	14.85±0.42	14.56±0.66	14.10±0.23
Femurs	23.96±0.62	24.09±0.41	23.98±0.29
Breast	5.84±0.18	6.35±0.20	5.82±0.17
Mortality rate (%)	16.7	6.7	20.0
Blood parameters			
Red blood cells (10^6/mm^3)	2.45±0.04^b	2.62±0.06^a	2.32±0.04^b
Heamatocrit, (%)	29.28±0.42^a	29.37±0.95^a	23.92±0.56^b
Hemoglobin, (g/100ml)	12.07±0.18^a	12.10±0.22^a	11.43±0.20^b
Bacterial count per one gram of litter:			
Dilution 10^{-3}	96.67±1.52^a	17.50±7.27^c	65.83±4.64^b
Dilution 10^{-2}	137.17±7.02^a	35.67±6.36^c	85.33±2.94^b

$^{a, b \text{ and } c}$ means within the same row with different superscripts differ at ($P \geq 0.05$).

8. Bacterial and mold counts:

Effect of type of litter on bacterial count and mold populations is presented in Table (8). It was found that sand litter had lower bacterial count than saw dust and wheat straw, and it was observed that wheat straw had the greatest bacterial count. No mold populations were observed in sand and wheat straw, however, high mold populations were found in saw dust litter.

Wood fiber-based litter materials have been previously documented to contain relatively high aerobic bacteria counts and fungal populations, (Bilgili *et al*., 1999a,b).

Bilgili *et al*. (1999a) observed that coliforms and aerobic plate counts were significantly lower on sand than on pine shavings. Wood based litter material has been previously documented to contain relatively high aerobic bacteria counts and fungal populations. On the contrary, the same author (1999b) found no significant

differences in coliforms, aerobic plate counts, and molds between reused sand and reused pine shavings litters. Lien *et al*. (1992) observed greater populations of aerobic bacteria in pine shavings than in recycled paper chips, however fungal populations were lower in recycled paper chips litter.

9. Mortality rate (MR):

Effect of type of litter on MR is presented in Table (8). It was found that birds in-group 2 had fewer deaths than those of group 1 and 3. The MR was 16.7, 6.7, and 20.0 % for groups 1, 2, and 3, respectively. The high MR for groups 1 and 3 may be due to the increased incidence of feet lesions and leg disorders that make birds unable to walk and reach feeders and waterers and die from starvation and dehydration, or may be related to the high bacterial and mold content in saw dust and wheat straw litter (Table 8).

10. Foot lesions:

It was observed that broilers reared on wheat straw and saw dust showed more cases of foot lesions than those reared on sand litter. About 8.33, 0.00, and 6.66 % of groups 1, 2, and 3, respectively, had severe foot lesions, and about 6.66, 5, and 11.66 % of groups 1, 2, and 3, respectively had moderate lesions, and about 13.33, 8.33, and 10 % of groups 1, 2, and 3, respectively had mild foot lesions. The severity of foot lesions was recorded by using visual ranking system. Although not primarily caused by any particular microbial agent, the lesions often become infected by a variety of bacteria and fungi (Greene *et al*., 1985), especially *staphylococcus ssp*. (Hester, 1994).

Bilgili *et al.* (1999a) observed that broilers reared on sand showed a lower incidence of foot lesions than those reared on pine shavings. Also, Sorensen and Kestin (2000) showed that broilers reared on wheat straw had poorer walking ability and more foot burns than those reared on wood shavings.

11. Economic efficiency (EE):

EE at using a different type of litter is presented in Table (10). It was found that the mean feed cost per bird of group 2 was higher than that of both groups 1 and 3, because the mean FC per bird was the highest in-group 2. Also, bird price of group 2 was the highest, because it had the heaviest body weights. Wheat straw litter was more expensive than saw dust and sand litter. Sand litter was the cheapest. It was detected that birds of group 2 had the highest net revenue value as compared with groups 1 and 3. Since the net revenue per bird was 4.657, 5.114, and 4.54 L.E for groups 1, 2, and 3, respectively. EE was calculated by dividing net revenue per bird by total costs. It was found that group 2 (sand litter) had the best EE value as compared with groups 1 and 3 (1.79 for group 2 *v.s* 1.67 and 1.65 for groups 1 and 3, respectively).

Table 9. Economic efficiency at using different types of litter

Item	Type of litter		
	Wheat Straw	**Sand**	**Saw dust**
Live bird weight (g)	1488.8	1596.8	1457.5
Feed consumption (kg)	2.70	2.85	2.75
Feed cost (L.E)	2.65	2.79	2.70
Bird price (L.E)	7.44	7.98	7.29
Litter cost per bird (L.E)	0.133	0.076	0.050
Costs of feed and litter (L.E)	2.783	2.866	2.750
Net revenue per bird	4.657	5.114	4.540
Economic efficiency	1.67	1.79	1.65
Relative economic efficiency	100%	107.18%	98.8%

Price of 1 kg of diet = 0.98 L.E Cost of 1 kg of live body weight. = 5.00 L.E
L.E = Egyptian pound.

GENERAL CONCLUSION

Based on the results obtained from this experiment, it could be concluded that using sand as a litter during rearing broiler chicks up to 7 weeks of age, is better for their performance and EE than either wheat straw or saw dust.

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تأثير نوع الفرشة على الأداء الإنتاجي لكتاكيت اللحم

محمد الصغير محمد، أ.د. محمد نبيل مقلد، محمد عبد الحميد محمد

قسم الإنتاج الحيواني والدواجن، كلية الزراعة، جامعة أسيوط

استخدم ١٨٠ كتكوت من سلاله الاربر ايكرز بغرض دراسة تأثير نوع الفرشة على الأداء الإنتاجي لكتاكيت اللحم حتى عمر ٧ أسابيع.

قسمت الكتاكيت إلى ثلاث مجاميع كالتالي: المجموعة الأولي ربيت كتاكيتها على فرشة من تبن القمح والمجموعة الثانية ربيت كتاكيتها على فرشة من الرمل والمجموعة الثالثة ربيت كتاكيتها على فرشة من نشارة الخشب. وامكن تلخيص النتائج المتحصل عليها كما يلي:

الكتاكيت المرباة على فرشة من الرمل كان لها وزن جسم أعلى عند التسويق مقارنة بتلك المرباة على فرشة من تبن القمح أو نشارة الخشب. كما وجد أن لنوع الفرشة نفس التأثير على متوسط الزيادة اليومية فى وزن الجسم. بينما لم يكن لها تأثير معنوي على كمية الغذاء المستهلك. ولقد وجد أن الكتاكيت المرباة على فرشة من الرمل كانت لها كفاءة تحويل غذائي أفضل من الكتاكيت المرباة على فرشة من نشارة الخشب بينما كانت كفاءة التحويل الغذائي للكتاكيت المرباة على فرشة من تبن القمح متوسطة ما بين الاثنين. وكان معدل النفوق في المجاميع الثلاثة هو ١٦.٧ و٦.٧ و٢٠% على التوالي.

هذا ولم يوجد أي تأثير معنوي لنوع الفرشة على وزن أجزاء الذبيحة المختلفة أو على وزن الأعضاء الداخلية. وأظهرت الكتاكيت المرباة على فرشة من تبن القمح ونشارة الخشب عدد اكبر من أورام القدم بالمقارنة بمثيلاتها المرباة على فرشة من الرمل. ولم توجد أي نموات فطرية على فرشة الرمل أو تبن القمح ولكن وجدت نموات فطرية بأعداد كبيرة في فرشة نشارة الخشب, كما وجد أن أعداد مستعمرات البكتريا في نشارة الخشب كانت أكثر معنوياً من فرشة الرمل وتبن القمح. وأدت التربية على فرشة من الرمل إلى زيادة عدد كرات الدم الحمراء في دم الكتاكيت عن مثيلاتها المرباة على فرشة من نشارة الخشب أو تبن القمح. كما أدت التربية على فرشة من نشارة الخشب إلى زيادة تركيز الهيماتوكريت والهيوجلوبين بالمقارنة بالمجاميع الأخرى.

من دراسة الجدوى الاقتصادية وجد أن التربية على الرمل كانت أسلم من الناحية الصحية و أكفأ اقتصادياً من التربية على تبن القمح أو نشارة الخشب.