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Effect of the stocking rate on growth performance, carcass traits and meat quality of male Peking ducks

Besatzdichte männlicher Pekingenten in ihrer Auswirkung auf Mastleistung, Schlachtkörper- und Fleischqualität

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1 Introduction

The prevailing sources of poultry meat in Egypt are broiler chicks and ducklings. Although there is much published research on the effect of the stocking rate on the growth performance of broilers, information on the relationship between the stocking rate and the productivity of Peking ducks is sparse. LAZAR et al. (1984) found negative correlation between the body weight of ducklings reared on the floor or on a slatted floor and stocking density, but feed conversion was not affected. HUDSKY (1977) also found similar results when ducklings were fattened in cages at densities of 12, 14, 16 and 18 birds/m^2 floor area, whilst MACHALEK and HUDSKY (1981) recommended that ducks could be caged up to 21 days of age at 13.5 birds/m^2. With the gradual expansion of duck production in Egypt, it is necessary to estimate the optimum stocking density of ducklings fattened on the floor or in cages under summer environmental conditions of upper Egypt. Therefore, the objective of this investigation was to study the effect of the stocking rate on the growth performance, carcass traits and meat quality of male Peking ducks.

2 Materials and methods

Two hundred and forty, one-day-old male Peking chicks purchased from a commercial hatchery were reared in cages at a stocking rate of 20 chicks/m^2 up to 2 weeks old. At 2 weeks of age, ducklings were randomly allocated to provide stocking density. The average initial body weight of ducklings was similar among all treatments. Birds in each replicate

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had nearly equal feeding and drinking space regardless of stocking density. Ducklings were fed *ad-libitum* on a starter mash diet of 17% protein and 11.7 MJ ME/kg feed during the first two weeks of age, then switched on a grower diet of 15.53% protein and 12.3 MJ ME/kg feed up to the end of the experiment according to DLG (1982).

Ducklings had full-access to drinking water. Ambient temperature and relative humidity were recorded continuously using thermohygrograph and fluctuated between 22-32°C and 40-68% respectively. Ducklings in each replicate were weighed at bi-weekly intervals and average body weight, feed intakt, cumulative feed conversion and mortality were computed.

At 10 weeks of age, eight birds from each treatment were taken at random, deprived of feed, but not water for about 12 hours and then slaughtered. After bleeding out, the birds were scalded, plucked with an electrical cyclomatic picker and eviscerated. Heads and shanks were separated and then carcasses were soaked in tap-cold water for about 15 minutes. Eviscerated carcasses with giblets and abdominal fat, but without heads, were individually weighed and dressing % was calculated (eviscerated carcass + liver + purified gizzard + heart + abdominal fat in relation to pre-slaughter weight). Eviscerated carcasses were portioned into breast, legs, back, wings and neck according to WPSA (1985). Abdominal fat was added to back because most of the fat in Peking ducks is deposited in the subcutaneous region. The different cuts and giblets were each weighed and related to the carcass weight as a percentage.

The right side of large breast and thigh muscles from each carcass were separated, kept in plastic bags, chilled in a refrigerator at +4°C for 24 hours, then frozen at -15°C until required, to evaluate physical meat quality.For measuring pH-value after storage, meat colour and juice-holding capacity, the frozen samples were left to thaw in a refrigerator at +4°C for 24 hours without removing them from the plastic bags. The pH-value was measured directly using pH-meter (650-Knicke Company, Germany). Meat colour was measured by a colour-meter (Goefo-Meter) from E-Schutt Company, Germany. The value varied from very light at zero to very dark at 100. To determine juice holding capacity a piece of 0.3 g. muscle from each individual meat sample was put on filter paper (previously held over saturated Kcl. solution in a dessicator) and pressed between two glass plates for five minutes according to the Grau and Hamm method (1957). The areas of meat and meat + juice were estimated by the axis method according to Hafmann (1982). The juice holding capacity was calculated using the following formula:

Juice holding capacity = meat's area/total area x 100. The higher value means higher juice holding capacity and vice versa.

The statistical analysis was carried out according to SAS programme (1989). Differences among treatments were calculated at 5% level of significance.

3 Results and Discussion

3.1 Growth performance:

Growth performance data of male Peking ducks as affected by the stocking rate are shown in Tab. 1. The stocking rate had an insignificant effect on body weight of birds reared on the floor during the first four weeks of age. Increasing densities above 4 birds/m^2 on the floor at 6 weeks of age and above 2 birds/m^2 at 8 weeks old significantly ($P < 0.05$) decreased body weight at the previous age respectively. At 10 weeks old, birds reared on the floor at a stocking density of 4 birds/m^2 were able to compensate the retardation in body weight and had similar body weight to those reared at the density of 2 birds/m^2. When the stocking rate exceeded 4 birds/m^2 on the floor, the retardation in body weight represented from 4.66 to 18.86% and from 9.05 to 17.27% at 8 and 10 weeks of age respectively.

Rearing ducklings in cages at a stocking rate above 8 birds/m^2 significantly ($P < 0.05$) decreased body weight at 4 weeks of age. At 6 and 8 weeks old, the stocking rate should not exceed 4 birds/m^2 of the cage area. When the growing period was prolonged up to 10 weeks of age, the density could reach 8 birds/m^2 of the cage area. Increasing the density above 8 birds/m^2 of the cage area caused 10.90% to 21.96 % and from 6.5% to 18.81% retardation in body weight at 8 and 10 weeks of age respectively. The retardation in body weight associated with the increasing stocking rate was attributed to the fact that feed intake was progressively decreased ($P < 0.01$) with increasing density at all growing age intervals.

Increasing the density above 2 and 4 birds/m^2 on floor and in cages respectively decreased feed intake by about 24.15% to 37.45% and 13.09% to 38.64% respectively at 8 weeks of age. The corresponding reduction percentages at 10 weeks old were 18.58% to 36.28% and 11.06% to 36.47% respectively. The reduction in feed intake with increasing density may be due to that birds are indirectly denied free access to the feed troughs and drinkers.

Cumulative feed conversion was significantly ($P < 0.05$) improved, when stocking rate increased from 2 to 4 birds/m^2 of floor area at 4,8 and 10 weeks of age, but no further improvement was observed in relation to the stocking rate. At 6 weeks of age, the improvement ($P < 0.05$) in cumulative feed conversion had occurred when stocking rate increased from 2 to 6 birds/m^2. The improvement in cumulative feed conversion represented 16.75% and 14.33% at 8 and 10 weeks old respectively when stocking rate increased from 2 to 4 birds/m^2 of floor area at the previous ages. Also, increasing birds' density in cages, improved cumulative feed conversion, but the differences were significant ($P < 0.05$) only at 4 and 8 weeks old, when density exceeded 4 and 8 birds/m^2 of cage area at such ages respectively. The improvement in feed conversion at higher stocking densities may be due to the better nutrient utilization and the reduction in body fat deposition as a result of indirect feed restriction. BOLTON et al. (1972) indicated that the improvement in feed conversion at higher stocking rate was attributed

Tab. 1: Least squares means ± S.E. of growth performance of male Peking ducks as influenced by the stocking rate.

Items	Floor				Cage			
Stocking rate (birds/m^2)	2	4	6	8	4	8	12	16
No. of birds	8	16	24	32	16	32	48	64
1 - 4 weeks old:								
Body weight (kg)	0.618 ± 0.027	0.588 ± 0.027	0.573 ± 0.027	0.507 ± 0.027^{NS}	0.534 ± 0.016^{a}	0.507 ± 0.016^{ab}	0.457 ± 0.016^{b}	0.391 ± 0.016^{c} **
Feed intake (kg)	2.316 ± 0.079^{a}	1.734 ± 0.079^{bc}	1.615 ± 0.079^{cd}	1.405 ± 0.079^{d} **	1.818 ± 0.027^{a}	1.610 ± 0.027^{b}	1.183 ± 0.027^{c} **	^{d}
Feed conversion :1	4.120 ± 0.180^{a}	3.230 ± 0.180^{b}	3.090 ± 0.180^{b}	3.080 ± 0.180^{b} **	3.770 ± 0.070^{a}	3.530 ± 0.070^{b}	3.480 ± 0.070^{b}	3.470 ± 0.070^{b} *
1 - 6 weeks old:								
Body weight (kg)	1.151 ± 0.039^{a}	1.041 ± 0.039^{ab}	0.960 ± 0.039^{bc}	0.847 ± 0.039^{c} **	0.969 ± 0.027^{a}	0.849 ± 0.027^{b}	0.751 ± 0.027^{cd}	0.669 ± 0.027^{d} **
Feed intake (kg)	5.564 ± 0.088^{a}	4.338 ± 0.088^{b}	3.867 ± 0.088^{cd}	3.644 ± 0.088^{d} **	4.585 ± 0.052^{a}	4.176 ± 0.052^{b}	3.521 ± 0.052^{c}	2.960 ± 0.052^{d} **
Feed conversion :1	5.100 ± 0.170^{a}	4.380 ± 0.170^{ab}	4.250 ± 0.170^{b}	4.580 ± 0.170^{b} *	5.050 ± 0.200	5.230 ± 0.200	5.030 ± 0.200	4.780 ± 0.200 NS
1 - 8 weeks old:								
Body weight (kg)	1.673 ± 0.045^{a}	1.522 ± 0.045^{bc}	1.451 ± 0.045^{c}	1.235 ± 0.045^{d} **	1.475 ± 0.027^{a}	1.339 ± 0.027^{b}	1.193 ± 0.027^{c}	1.045 ± 0.027^{d} **
Feed intake (kg)	9.736 ± 0.147^{a}	7.385 ± 0.147^{b}	6.831 ± 0.147^{c}	6.090 ± 0.147^{d} **	8.572 ± 0.153^{a}	7.450 ± 0.153^{b}	6.396 ± 0.153^{c}	5.260 ± 0.153^{d} **
Feed conversion :1	6.030 ± 0.160^{a}	5.020 ± 0.160^{b}	4.880 ± 0.160^{b}	5.150 ± 0.160^{b} **	6.020 ± 0.120^{a}	5.780 ± 0.120^{ab}	5.610 ± 0.120^{bc}	5.290 ± 0.120^{c} *
1 - 10 weeks old:								
Body weight (kg)	2.143 ± 0.047^{a}	2.033 ± 0.047^{a}	1.849 ± 0.047^{b}	1.682 ± 0.047^{c} **	1.833 ± 0.088^{a}	1.659 ± 0.088^{ab}	1.550 ± 0.088^{bc}	1.347 ± 0.088^{c} *
Feed intake (kg)	14.115 ± 0.160^{a}	11.492 ± 0.160^{b}	10.133 ± 0.160^{c}	8.994 ± 0.160^{d} **	12.298 ± 0.239^{a}	10.938 ± 0.239^{b}	9.254 ± 0.239^{c}	7.813 ± 0.239^{d} **
Feed conversion :1	6.770 ± 0.180	5.800 ± 0.180	5.630 ± 0.180	5.530 ± 0.180 **	7.050 ± 0.310	6.810 ± 0.310	6.170 ± 0.310	6.040 ± 0.310^{NS}

Means within the same row having different letter (s) are significantly different ($P < 0.05$).

to decreasing energy requirements as a result of decreasing birds activity and the conservation of heat.Mortality rate was not affected by density and it was just zero throughout the experimental period (from 2 to 10 weeks old).

These results are in good agreement with STANLEY and KRUEGER (1981); VO and FANGUY (1982); DAFWANG et al. (1987); QUINONES et al. (1987) and SHANAWANY (1988) who reported that body weight of broilers was depressed, but feed conversion was improved at high stocking densities. Also, SHANAWANY (1988), indicated that feed intake decreased but mortality rate was not affected when broilers were reared at high stocking rate.

3.2 Carcass traits:

Least squares means ± SE of carcass traits of male Peking ducks as influenced by stocking rate are illustrated in Tab. 2. There was negative linear relationship ($P < 0.05$) between stocking rate on floor and starved body weight and carcass weight, also, starved body weight and carcass weight from another side. Also, starved body weight and carcass weight significantly ($P < 0.05$) decreased with increasing density above 8 birds/m^2 of cage area. The dressing % for birds reared on floor significantly ($P < 0.05$) decreased with increasing density above 4 birds/m^2 but no further decrease with increasing density was observed. This could be attributed to the higher variation in starved body weight and carcass weight in relation to density.

Dressing % for birds reared in cages was not affected by stocking rate. This may be due to that birds in cages reared at high density and the differences in both starved body weight and carcass weight in relation to density were not sufficient to produce significant effect on dressing %, moreover, the higher variation in the previous criteria.

Breast % decreased ($P < 0.05$), while legs % increased ($P < 0.05$) with increasing densities on the floor or in cages. This could be attributed to the differences in starved body weight in relation to density and to the fact that different organs had different growth rates.

Valuable cuts (breast + legs %) were lower ($P < 0.05$) at density of 8 birds/m^2 on the floor compared to other densities. This may be due to that breast 5 decreased at a higher rate than the increase in legs % in relation to the stocking rate. Also, increasing density above 8 birds/m^2 of cage area significantly ($P < 0.05$) decreased the valuable cuts % (breast + legs %), but no further reduction with increasing density was observed. Birds reared on the floor at a density of 8 birds/m^2 because of their higher ($P < 0.05$) back % had the highest ($P < 0.05$) percentage of less valuable cuts (back + wings + neck + giblets %). Stocking rate on the floor had insignificant effect on wings %, neck % and giblets %. Also, the density in cages had insignificant effect on back %, wings % and neck %. The higher ($P < 0.05$) giblets % at stocking rate of 12 and 16 birds/m^2 in cages resulted in an increase ($P < 0.05$) in the total less valuable cuts % (back +

wings + neck + giblets %) at the previous densities. These results confirmed the results of PROUDFOOT et al. (1979) who reported that increasing density adversely affected carcass quality of broilers' based on grade A carcasses and breast blisters. Also, HUDSKY (1977), reared ducklings in cages at densities of 12, 14, 16 and 18 birds/m^2 and found that the 1st grade carcasses progessively decreased with increasing densities.

3.3 Meat quality:

Least squares means ± SE of the physical properties of breast and thigh muscle of male Peking ducks as influenced by stocking rate are presented in Tab. 3. pH-value of breast progressively increased with increasing density on floor but the difference was significant ($P < 0.05$) only when the density exceeded 6 birds/m^2 of floor area. Also, increasing the density in cages resulted in an increasing the pH-value of breast, but the differences were insinificant. This may be due to the lower glycogen reserve as a result of limited feed intake and to increasing stress susceptability caused by crowding. SIEGEL (1960) reported that high stocking density may be viewed as a non-specific stressor that results in adrenal hypertrophy. pH-value of thigh was not affected by the stocking rate on both the floor or in cages.

Stocking rate on the floor or in cages insignificantly affected meat colour of breast and thigh muscles. Also, juice holding capacity of breast was not affected by stocking rate, while that of the thigh was significantly ($P < 0.01$) affected by density on floor only but without clear trend. These results agree with DEAN et al. (1972) who reported that meat colour, cooking loss, moisture and fat content of broilers were unaffected by stocking rate.

4 Summary

At two weeks of age, two hundred and forty male Peking ducklings were allocated at ramdom to provide stocking densities of 2, 4, 6 and 8 birds/m^2 on the floor and 4, 8, 12 and 16 birds/m^2 in cages. At 10 weeks old, eight birds from each treatment were slaughtered for measuring carcass traits and meat quality. The study revealed the following results.

On the basis of body weight, the optimum stocking rate of ducklings is 8 birds/m^2 during the period from 2 to 4 weeks old and thereafter it should be reduced to 4 birds/m^2 up to 10 weeks of age on both floor or in cages. Feed intake was decreased ($P < 0.05$) with increasing stocking rate at all growing age intervals. Cumulative feed conversion was improved, when the stocking rate exceeded 2 birds/m^2 on floor at all studied ages. Lower improvements in feed conversion related to the stocking rate were also observed for ducklings reared in cages. Mortality rate was not affected by birds' density.

Dressing % was decreased ($P < 0.05$) with increasing density above 4 birds/m^2 on floor and in cages respectively.

Tab. 2: Least squares means ± S.E. of carcass traits of Peking ducks as influenced by the stocking rate.

	Floor				Cage			
Items	Stocking rate (birds/m^{2})							
	2	4	6	8	4	8	12	16
Starved body wt. (kg)	2.144 ± 0.045^{a}	1.998 ± 0.045^{b}	1.829 ± 0.045^{c}	1.570 ± 0.045^{d} **	1.760 ± 0.059^{a}	1.605 ± 0.059^{a}	1.430 ± 0.059^{b}	1.284 ± 0.059^{b} **
Carcass wt. (kg)	1.507 ± 0.034^{a}	1.382 ± 0.034^{b}	1.216 ± 0.034^{c}	1.033 ± 0.034^{d} **	1.262 ± 0.046^{a}	1.150 ± 0.046^{ab}	1.022 ± 0.046^{bc}	0.901 ± 0.046^{c} **
Dressing (%) NS	70.31 ± 0.480^{a}	69.19 ± 0.480^{a}	66.37 ± 0.480^{b}	65.81 ± 0.480^{b} **	71.52 ± 0.840	71.62 ± 0.840	71.50 ± 0.840	70.17 ± 0.840
Breast (%)	22.75 ± 0.780^{a}	20.04 ± 0.780^{b}	20.72 ± 0.780^{ab}	16.53 ± 0.780^{c} **	19.54 ± 0.800^{a}	17.26 ± 0.800^{ab}	15.20 ± 0.800^{bc}	13.66 ± 0.800^{c} **
Legs (%)	19.02 ± 0.370^{b}	20.17 ± 0.370^{a}	20.11 ± 0.370^{a}	21.06 ± 0.370^{a} **	22.10 ± 0.510^{c}	22.68 ± 0.510^{bc}	23.78 ± 0.510^{ab}	24.68 ± 0.510^{a} **
Breast + legs (%)	41.77 ± 0.650^{a}	40.21 ± 0.650^{a}	40.83 ± 0.650^{a}	37.60 ± 0.650^{b} **	41.63 ± 0.770^{a}	39.94 ± 0.770^{ab}	38.98 ± 0.770^{b}	38.33 ± 0.770^{b} *
Back (%)	24.62 ± 0.670^{b}	25.60 ± 0.670^{ab}	23.52 ± 0.670^{b}	26.25 ± 0.670^{a} *	25.77 ± 0.850	26.76 ± 0.850	26.95 ± 0.850	26.68 ± 0.850 ^{NS}
Wings (%)	13.72 ± 0.460	13.50 ± 0.460	14.44 ± 0.460	13.81 ± 0.460 ^{NS}	11.75 ± 0.790	12.19 ± 0.790	11.67 ± 0.790	11.85 ± 0.790 ^{NS}
Neck (%)	11.08 ± 0.570	11.41 ± 0.570	12.16 ± 0.570	12.67 ± 0.570 ^{NS}	12.02 ± 0.460	12.37 ± 0.460	12.00 ± 0460	13.22 ± 0.460 ^{NS}
Giblets (%)	8.81 ± 0.280	9.29 ± 0.280	9.06 ± 0.280	9.67 ± 0.280 ^{NS}	8.81 ± 0.320^{b}	8.80 ± 0.320^{b}	10.40 ± 0.320^{a}	9.92 ± 0.320^{a} **
Back + Wings + Neck + Giblets %	58.22 ± 0.650^{b}	59.80 ± 0.650^{b}	59.17 ± 0.650^{b}	62.40 ± 0.650^{a} **	58.36 ± 0.780^{b}	60.06 ± 0.780^{ab}	61.01 ± 0.780^{a}	61.67 ± 0.780^{a} *

Means within the same row having different letter (s) are significantly different ($P < 0.05$).

There was a tendency for increasing pH-value of breast and deterioration of the juice holding capacity in thigh meat with increasing birds' density reared on floor. With the exception of the previous mentioned criteria, stocking rate had no effect on the other physical characters of breast and thigh meat.

Zusammenfassung

Einfluß der Besatzdichte auf die Mastleistung sowie die Schlachtkörper- und Fleischqualität bei den männlichen Pekingenten.

Der Einfluß der Besatzdichte auf das Wachstum sowie die Schlachtkörper- und Fleischqualität wurde bei 240 männlichen Pekingenten im Alter von 2 bis 10 Wochen sowohl bei der Boden- als auch bei der Käfighaltung untersucht. Es wurden Besatzdichten von 2, 4, 6 und 8 Tiere pro qm in der Bodenhaltung und 4, 8, 12 und 16 Tiere pro qm in der Käfighaltung geprüft.

Die optimale Körpergewichtsentwicklung wurde sowohl bei der Boden- als auch bei der Käfighaltung bei einer Besatzdichte von 8 Tiere pro qm bis zum Alter von 4 Wochen und danach von 4 Tiere pro qm bis Ende der Mast im Alter von 10 Wochen erzielt. Die Futteraufnahme war bei stärkerer Besatzdichte geringer. Die kumulative Futterverwertung wurde bei stärkerer Besatzdichte als 2 Tiere pro qm verbessert. Dies war bei der Boden- deutlicher als bei der Käfighaltung festzustellen. Die Besatzdichte hatte keinen Einfluß auf die Mortilitätsrate.

Die Besatzdichte von mehr als 4 Tiere pro qm übte negativen Einfluß auf die prozentuale Schlachtausbeute bei der Bodenhaltung aus. Der Anteil der wertvollen Teilstücke (Brust und Schenkel) war bei stärkerer Besatzdichte als 6 bei der Boden- und 8 bei der Käfighaltung geringer.

Bezüglich der Fleischqualität konnte lediglich in der Bodenhaltung eine Tendenz für einen höheren pH-Wert und geringeres Safthaltevermögen im Schenkelfleisch bei Erhöhung der Anzahl der Tiere pro qm beobachtet werden.

References

1. BOLTON, W.; DEWAR, W.A.; MORLEY, R.; JONES, R. and THOMPSON R., 1972: Effect of stocking density on performance of broiler chicks. – British Poult. Sci. 13, 157-162.
2. DAFWANG, I.I.; COOK, M.E. and SUNDE, M.L., 1987: Interaction of dietary antibiotic supplementation and stocking density on broiler performance and immune response. – British Poult. Sci. 28, 47-55.
3. DEAN, P.; SUTTON, H. and PROUDFOOT, F.G., 1972: The effect of environmental flock treatments on broiler carcass quality. – Poult. Sci. 51, 1476-1477.
4. D.L.G., 1982: Mischfutter-Standards für Geflügel, Schweine und Rinder, Teil 2.

Tab. 3: Least squares means e S.E. of meat quality of male Peking ducks as influenced by the stocking rate.

Items	Floor				Cage			
	Stocking rate (birds/m^2)							
	2	4	6	8	4	8	12	16
pH-values:								
Breast	5.96 ± 0.04^{b}	6.01 ± 0.04^{b}	6.08 ± 0.04^{b}	6.25 ± 0.04^{a} **	6.06 ± 0.07	6.21 ± 0.07	6.27 ± 0.07	6.19 ± 0.07 NS
Thigh	6.40 ± 0.05	6.31 ± 0.05	6.38 ± 0.05	6.39 ± 0.05 NS	6.42 ± 0.07	6.53 ± 0.07	6.54 ± 0.07	6.48 ± 0.07 NS
Meat colour:								
Breast	86.38 ± 1.35	86.36 ± 11.35	89.25 ± 1.35	85.75 ± 1.35 NS	84.38 ± 1.48	84.13 ± 1.48	82.88 ± 1.48	82.88 ± 1.48 NS
Thigh	90.13 ± 0.64	90.25 ± 0.64	91.88 ± 0.64	91.63 ± 0.64 NS	88.50 ± 0.77	90.38 ± 0.77	89.88 ± 0.77	89.25 ± 0.77 NS
Juice holding capacity:								
Breast	25.17 ± 2.26	21.52 ± 2.26	22.67 ± 2.26	22.61 ± 2.26 NS	17.35 ± 1.75	18.48 ± 1.21	22.24 ± 1.21	19.82 ± 1.21 NS
Thigh	36.07 ± 1.89	24.75 ± 1.89	27.41 ± 1.89	31.13 ± 1.89 **	24.00 ± 3.42	32.68 ± 3.42	34.69 ± 3.42	28.87 ± 3.42 NS

Means within the same row having different letter (s) are significantly different ($P < 0.05$).

5. GRAU, R. and HAMM, R., 1957: Über das Wasserbindungsvermögen des Säugetiermuskels II. – Mitteilung: Über die Bestimmung der Wasserbindung des Muskels, Zeitschrift für Lebensmittel-Untersuchung und Forschung 105, 446-460.

6. HOFMANN, K., 1982: Bestimmung der Wasserbindung des Fleisches: Schnelle, nicht Planimetrische Auswertung der Filterpapier-Pressmethode. – Die Fleischwirtschaft 62 (3), 346-348.

7. HUDSKY, Z., 1977: Fattening ducklings in two-tier cages. – Ani. Br. Abstr. 45, 465.

8. LAZAR, V.; OSICKA, R.; SILHAVY, V. and PORCHAZKOVA H., 1984: The optimum stocking density of ducklings fattened on deep litter and on a slatted floor. – Ani. Br. Abstr. 52, 12, 973.

9. MACHALIK, E. and HUDSKY Z., 1981: The cage system of rearing and fattening ducks. – Nutr. Abstr. and Rev., 51,3,181.

10. PROUDFOOT, F.G.; HULAN, H.W. AND RAMEY, D.R., 1979: The effect of four stocking densities on broiler carcass grade, the incidence of breast blisters and other performance traits. – Poult. Sco. 58, 791-793.

11. QUINONES, R.; POLANCO, G. and MOREJON, O., 1984: A comparison of three housing densities for broilers reared on the floor. – Revista Aviculture 28, 241-249.

12. QUINONES, R.; POLANCO, G. and LLORENTE, R., 1987: Rearing of broiler chickens in batteries with high housing densities and separate sexes. – Revista Aviculture 31, 89-95.

13. RICHTER, G.; PRINZ, M. and PUTSCHE, M., 1985: Einfluss der Besatzdichte auf die Leistungen in der Putenmast. – Archiv Tierzucht 1, 63-73.

14. S.A.S., 1989: SAS user's guide. Basics Inst. Inc., Cary, NC.

15. SHANAWANY, M.M., 1988: Broiler performance under high stocking densities. – British Poult. Sci. 29, 43-52.

16. SIEGEL, H.S., 1960: Effect of population density on the pituitary adrenal cortical axis of cockerels. – Poult. Sci. 39, 500-509.

17. STANLEY, V.G. and KRUEGER, W.F., 1981: The effect of stocking density on commercial broiler performance. – Poult. Sci. 60, 1737.

18. VO, K.V. and FANGUY, R.C., 1982: Rearing density as a stressor in the production of commercial broilers. – Poult. Sci. 61, 1563.

19. WEAVER, JR.; BEANE, W.D.; BEANE, W.L. and CHERRY J.A., 1982: Effect of light, feeding space, stocking density and dietary energy on broiler performance. – Poult. Sci. 61, 33-37.