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Measuring the Effects of Rearing Systems on Gaoyou Duck Performance, Carcass Quality, and Meat Characteristics

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Abstract

The raising system is a significant non-genetic component that has a considerable impact on chicken output. In this study, comparing "Floor Rearing Systems (FRS), Net Rearing Systems (NRS), and Cage Rearing Systems (CRS)," researchers looked at growth performance, serum biochemical parameters, Gaoyou ducks' meat quality and carcass characteristics.

Methods: The FRS, net raising organizations, and then CRS groups were each comprised of 450 healthy male Gaoyou ducks that were 22 days old and had a similar average body weight. Age range for the trial was 22 to 84 days.

Results: Daily growth, average feed consumption, and feed-to-gain ratio were all greater for CRS ducks than for control ducks (P <0.03). FRS ducks' decreased drip loss and belly fat content also increased breast and gizzard yields and shear force (P 0.05). FRS ducks also had greater amounts of high-density lipoprotein cholesterol and considerably lower levels of glucose, total protein, and triglycerides (P 0.05).

Conclusion: Gaoyou ducks' growth performance benefited with CRS, but the meat quality, carcass features, and several serum biochemical indicators benefited from FRS. The outcomes showed that both the CRS and FRS have advantages. As a result, the production goal and market demand should be considered while choosing an appropriate raising method.

Keywords: Serum biochemical parameters, poultry production, rearing system, growth performance, and carcass yield, China, Gaoyou duck, meat quality.

Introduction

The Chinese city of Gaoyou has a mesmerizing display of culinary talent and cultural history known as the Gaoyou Duck Performance. Gaoyou, well known for its delicious duck dishes, takes great delight in offering this unique entertainment to tourists and residents. Gaoyou ducks are prepared and roasted elaborately throughout the performance by talented chefs, demonstrating long-standing culinary customs. The chefs transform the common duck into a gourmet masterpiece by showcasing their knife abilities, seasoning methods, and cooking techniques with finesse and experience (1). A delectable dish from the Chinese village of Gaoyou is the Gaoyou Duck Carcass. Due to its exquisite flavor and tender meat, this treat represents the area's rich culinary culture. The Gaoyou Duck Carcass is masterfully cooked in every mouthful, filling the mouth with savory enjoyment. The tender duck meat is masterfully spiced with a delectable flavor (2). Many factors contribute to the Gaoyou Duck's brilliance, including its carefully picked breed, organic feeding practices, and exact growing techniques.

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Consequently, the duck has rich, luscious meat evenly balanced in succulence and juiciness. Gaoyou Duck has developed a reputation among chefs and food enthusiasts who seek to improve their culinary creations because of its remarkable quality. Because of its exquisite flavor and texture, the Gaoyou Duck represents the region's dedication to producing top-notch food (3). Food enthusiasts frequently choose Gaoyou Duck because of its notable distinguishing features. The delicate and juicy flesh of a Gaoyou Duck makes every mouthful a delight. It has a rich and delectable taste due to the employment of natural and organic feeding procedures throughout its growth. The superb marbling and precise balance of lean to fat in meat of the Gaoyou Duck contribute to its exceptional flavor and texture (4). When roasted, braised, or otherwise prepared, gaoyou duck meat retains its succulence and efficiently absorbs flavors, making it a highlight of many dishes. Gaoyou Duck flesh is a tribute to the meticulous design and commitment to quality that characterizes this culinary jewel with its outstanding flavor and texture. The Gaoyou Duck's extremely brief flying time is a noteworthy drawback. It does not have the same level of endurance as some other bird species, having powerful wings and the ability to fly through the skies gracefully. This limits its capacity to do lengthy airborne performances or travel great distances. Additionally, the weather may impact the Gaoyou Duck's performances (5).

The paper (6) investigated the impact of a floor, net, and cage-raising methods on Gaoyou duck development, serum biochemical markers, meat quality, and carcass characteristics. The paper (7) examined the impact of various raising techniques on growth effectiveness, small meat duck carcass production, and meat quality. The paper (8) investigating egg quality, yolk trimethylamine (TMA) content, and variations among duck cecum and the environment, we calculated duck egg rearing methods such as cage, floor, and pond on duck egg flavor, egg quality, and microbial diversity. Untargeted metabolomics using gas chromatography-ion mobility spectrometry (GC-IMS) and ultra-performance liquid chromatography-tandem mass spectrometry (UHPLC-MS/MS) was used to analyze the metabolites and volatile compounds in both cured and uncured duck tissue (9). The paper (10) looked at the factors of body fat deposition, serum metabolic markers, and growth-development trends in Cherry Valley ducks. The paper (11) examined the effects of vitamin E (VE) dietary supplementation on growth performance, breast muscle quality, fatty acid (FA) composition, and muscle fiber properties of geese. The paper (12) examined the impact of intramuscular fat (IMF) on Chaohu duck carcass features. The paper (13) determined if male and female ducks raised in cages and floor (PY group) differed in their cecal microbiomes. The makeup of the cecal microbiota, slaughter features, and mucosal and intestinal structural gene expression levels in ducks. The paper (14) examined an nutritional content eggs that a single generation of Leizhou Black Ducks, and trace elements, and effectiveness and characteristics of two generations' eggs. The paper (15) utilized to research lipid metabolism, liver function, gossypol residue, and cecal microbiota are all impacted by cottonseed meal (CSM). All those birds were randomly split into five groups for a 35-day trial. The paper (16) determined potential small-variation genomic areas affecting parameters related to the performance of duck meat. The molecular species and intramuscular phospholipid classes in Gaoyou duck

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flesh. By using Ultraviolet (UV) and evaporative light scattering detectors (ELSD) in conjunction with normal-phase High-Performance Liquid Chromatography (HPLC), classes of phospholipids were identified and measured (17). The paper (18) examined the fatty acid composition of the muscles and adipose tissues of Yangzhou geese, which included 20 320-day-old geese and 30 60-day-old goslings. Taiwan's Brown and White Tsaiya duck populations employed a collection of high polymorphism microsatellite markers from the Tsaiya duck (19).

Materials and Methods

Management of animals

Ducks that were 22 days old were employed in the current investigation. First, the FRS, NRS, and CRS groups were randomly created from 450 healthy ducks with comparable BW. Each group had five duplicates, and each replicate included thirty ducks. 150 ducks were housed for the FRS group in five indoor floor pens, with free access to outside concrete play areas and a pool. A 1.5 m high wall, a plastic mesh fence that was 1.0 m high, and a plastic net above served as a barrier among outer paddocks. Each pen's indoor section included clean wood shavings that were changed out every week. A plastic netting that is flat with 0.8-cm-diameter mesh holes was installed over 150 ducks in five stainless-steel frames for the NRS group, and it was cleaned weekly during the experiment. The net was positioned 90 cm above the ground. Wire fences managed to keep the NRS replicate apart. Three ducks per cage were kept in CRS group's cages, which included four levels of stainless steel fencing, linear feeders, and automated nipple-drinking devices. The enclosures have measurements of 70 (length), 60 (width), and 45 (height). There were 10 neighboring cages in each replication. The three raising systems' interior house temperatures, relative humidity, and illumination period were maintained, and their stocking density was 0.14 m2/bird. Ad libitum food and drink were available. Ducks were fed a single commercial formula meal that complied with nutritional advice from the National Research Council (1994). Table 1 is a list of the components and nutrients of various diets. Sixty-three days were spent feeding the ducks. Each replicate's overall feed consumption was tracked weekly. Mortality was noted at the time it happened.

Table (1): Basal diet ingredients and nutritional content for experimental ducks

Items	**Ages(days)**	
	22-58	**559-86**
Nacl	3.1	3.1
D,L^{-Met}	1.4	1.5
Ingredients(g/kg)	639.5	645.5
Corn	239.6	197.6
Soybean	48.5	60.2
Wheat bran	48.5	61.1

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Limestone	12.2	13.5
Rapeseed meal	38.5	63.6
Caciun phosphate	13.8	13.2
$Premix^{A}$	10.1	10.1
Nutrient Levels		
Methionine (%)	0.41	0.39
Methionina+Cysteie (%)	0.75	0.72
NPP(%)	0.42	0.50
TP(%)	0.68	0.69
Ca (%)	0.52	0.81
Lysine (%)	0.82	0.83
Crude protein(%)	18.23	18.25
Metabolisable energy (MCAL/kg)	3.89	3.85

Growth efficiency

Initial and final BWs, average daily gains, ADFI, and feed-to-grain ratios are all indicators of growth success. All ducks had their first BW evaluated both at 23 and 86 days of age, following they measured their final BW after a 12-hour fast. On a duplicate basis, ADG, ADFI, and F/G were computed.

Meat quality and carcass characteristics

After a 12-hour fast, individual duck BWs were measured on Day 84. In each replication, four ducks were chosen at random for blood sampling, electrical stunning, and exsanguination before being put to death. Following removing feathers and non-edible viscera, the weight of that partly eviscerated animal was calculated. After eliminating the heart, liver, gizzard, glandular stomach, lungs, and abdominal fat, total weight of animal was calculated as weight of about half eviscerated animal. Then, the leg muscle, stomach fat, gizzard, next, separate breast muscle weigh outs were conducted. That ratio about live BW's partly eviscerated weight to its eviscerated weight was computed. The proportions of each leg muscle, breast muscle and gizzard percentages of related eviscerated weight were computed. Using the left breast muscle, pH, meat colour, cooking loss, shear force, and shear strength were evaluated. Right breast muscle was sampled in an interim for drip loss and intramuscular fat studies. As previously mentioned, measurements of cooking loss and drip loss were made. Using the approaches, a PHB-4 pH meter, a tristimulus colorimeter, and a digital texture analyzer were used to gauge shear force, meat colour, and pH.

Characteristics of Serum's Biochemistry

Randomly selected four ducks with BWs similar to the average for each replication to have blood samples taken. They used commercial kits in a digital spectrophotometer to test the

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levels of Serum glucose, albumin, uric acid, triacylglycerol, total cholesterol, high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol.

Analyses of statistics

Software called SPSS 20.0 for Windows was used to analyze the data statistically. A one-way ANOVA model was used to assess the data, and then various range analysis by Duncan. As a marker of significance, P 0.05 was employed cut-off. Data are given as the mean ±s.d.

Results and discussion

Table 2 displays those ducks' growth performance under all three different rearing regimes evaluated. The rearing systems had a stronger influence on the final BW, ADFI, and ADG. both NRS and FRS groupings compared CRS group, duck NRS and FRS levels were higher than F/G. The NRS and FRS groups failed to show significantly different development outcomes (P > 0.05).

Table (2): Gaoyou duck development performance and effects of rearing system

Items	CRS	NRS	FRS	p-value
ADG	25.52±3.12a	26.63±2.72b	30.71±2.45b	0.020
ADFI	123.08±7.03a	142.93±8.70b	153.50±7.75b	0.025
Initial BW	615.98±25.69	615.10±152.56b	614.49±25.03	.154
F/G	4.26±0.25b	0.63±0.28b	5.84±0.32a	0.014
Final Bw	2528.70±160.52a	2652.06±162.85b	2154.66±1659.15b	0.029

Characteristics of carcass

Table 3 shows an analysis of various rearing methods on carcass traits. Compared to the CRS and NRS groups, FRS group of ducks had a larger proportion of breast muscle and a lower percentage of abdomen fat (P<0.05). The FRS group also showed a larger proportion of gizzards than the CRS group reported. Comparing a carcass features of CRS and NRS groups failed to identify any appreciable differences. Other carcass traits did not differ among three groups.

Table (3): Effects of raising system on Gaoyou duck carcass attributes

Item (%)	CRS	NRS	FRS	P-value
Leg muscle (%)	9.90 ± 0.56	7.45± 0.53	7.23 ± 0.89	.196
Full eviscerated (%)	70.26 ± 5.63	76.245± 4.09	78.35 ± 4.30	.140
A.b140dominal fat (%)	1.59 ± 0.10a	1.37 ± 0.08a	0.98 ± 0.064b	.029
Gizzard (%)	3.76 ± 0.25b	4.45 ± 0.25ab	5.28 ± 0.33a	.026
Partially eviscerated carcass	52.65 ± 3.84	70.41 ± 6.05	90.35 ± 3.14	.518
Breast muscle (%)	10.51 ± 0.45b	7.87 ± 0.51b	11.19 ± 0.82a	.057

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Meat grade

Table 4 shows the influence of various raising methods on meat quality. Compared to groups CRS and NRS, group FRS of ducks exhibited a larger shear force and a smaller drip loss. Compared to the FRS and NRS groups, the CRS group had a greater L* value in the breast muscle. Other meat quality factors were similar across the three groups.

Table (4): Comparing the FRS, NRS, and CRS groups' meat quality characteristics

Item	CRS	NRS	FRS	P-value
Drip loss (%)	2.25± 0.15a	2.27 ± 0.09a	2.04 ± 0.09b	0.040
pH_{24} h	5.77 ± 0.38	5.82 ± 0.42	5.83 ± 0.4	0.235
Cooking loss (%)	27.36 ± 1.82	26.85 ± 1.74	27.17 ± 1.76	0.152
IMF (%)	3.57 ± 0.25	3.43 ± 0.22	3.52 ± 0.27	0.343
Shear force (N)	21.16 ± 2.50b	24.30 ± 2.56b	24.43 ± 2.41a	0.030
b*	18.24 ± 1.25	18.55 ± 1.46	17.95 ± 1.39	0.276
a*	11.27 ± 0.98	10.75 ± 0.76	11.69 ± 0.89	0.093
L*	35.17 ± 3.53a	36.80 ± 3.65b	40.53 ± 3.76b	0.037

Characteristics of serum's biochemistry

Table 5 shows the impact of various rearing techniques on serum biochemical markers. Comparing the FRS group of ducks to groups CRS and NRS, found that FRS group had greater serum HDL-C and lower serum levels of TP, TG, and glucose. Serum biochemical characteristics of the CRS and NRS groups weren't significantly different against one another. Other serum biochemical variables did not show any kind of meaningful impact. An essential metric used to assess chicken production is growth performance. Research has demonstrated that raising techniques have an effect on a rise in performance indicators of chickens and ducks. It was discovered that BW, BWt gain, and ADFI of ducks were positively impacted by CRS parenting. That the CRS in chickens has advantages in production measures, leading to F/G considerably less than NRS, the bacterial counts on the floor, nest, and floor eggs surfaces.

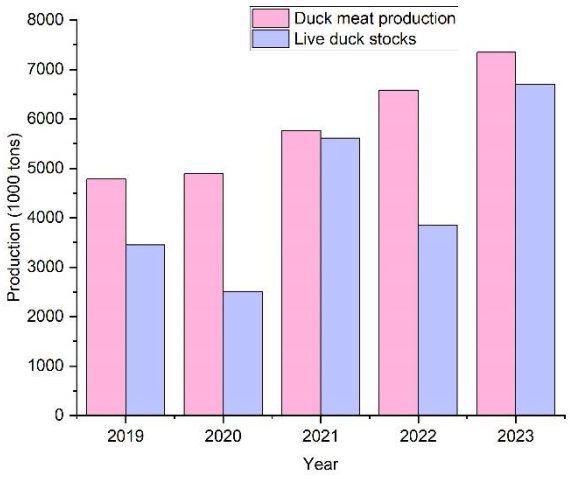

Figure (1): The number of germs on floor surfaces, nest eggs, and floor eggs

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Similarly, this research found Gaoyou ducks grown in NRS and FRS; CRS-raised ducks scored higher on the final BW, ADFI, and ADG tests. Compared to the NRS and FRS groups, ducks in the CRS group had lower F/G levels.

Table (5): Effects of Gaoyou ducks' serum biochemical characteristics under different rearing systems

Item	CRS	NRS	FRS	P-value
Uric acid $(\mu mol/L)$	250.47 ± 22.03	280.55 ± 25.12	325.13 ± 26.23	.424
TG $(mmol/L)$	2.13 ± .08a	2.04 ± .09a	.72 ± .07b	.052
Albumin (g/L)	14.16 ± 0.25	17.54 ± 0.90	41.25 ± 0.95	.683
Glucose $(mmol/L)$	15.69 ± .68a	19.65 ± 0.60a	9.13 ± 0.71b	.036
TC $(mmol/L)$	5.36 ± 0.23	4.63 ± 0.25	4.39 ± 0.23	.653
HDL-C $(mmol/L)$	2.77 ± 0.18b	2.68 ± 0.17b	3.88 ± 0.15a	.016
LDL-C $(mmol/L)$	2.45 ± 0.07	1.58 ± 0.13	1.52 ± 0.9	.464
Total protein (g/L)	32.33 ± 2.56a	39.61 ± 3.05a	36.26 ± 4.14b	.029

Discussion

Therefore, in comparison to NRS and FRS, the CRS might improve Gaoyou ducks' growth performance. As is generally known, numerous infections are contracted through exposure to chicken excrement. Encouraging feed intake and growth in ducks reared in CRS is easier because they are healthier and less inclined to be exposed to waste. Additionally, compared to ducks with CRS, NRS, and FRS had greater room also chances to peck, wander, path, and participate in other natural exercise habits that increase energy consumption and affect BW. Free-range systems are also vulnerable to several intrinsic and unavoidable variables, which might result in poultry's ability to function well and expand being hampered by a stress reaction. The factors obtained clearly show that ducks reared in CRS perform better in growth.

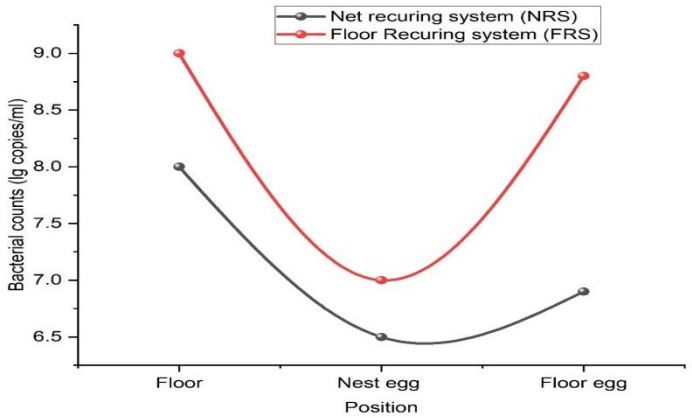

Figure (2): Duck meat production

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Carcass characteristics are significant indicators that may influence customers' buying intentions and chicken production profitability. In line with a prior study, they discovered that ducks bred under FRS yielded more carcass meat than ducks raised under CRS. The breast production of a small meat duck was observed being unaffected by the raising method. Furthermore, it was claimed that the carcass features of birds were unaffected by the various raising techniques. Multiple breeds are used, along with different development amounts might be one rationale for differences in findings of various research.

They are interesting; compared to the CRS group, the FRS group of ducks produced more gizzard and less abdominal fat. This outcome aligns with that noted that ducks across CRS group had a larger yield of belly fat and lower production of gizzards than those in FRS group. The reason that opportunities for pecking, strolling, running, and exhibiting natural behaviors were larger for FRS ducks is probably due to the decreased abdomen fat percentage of FRS ducks mentioned. As a result, there may be a higher energy expenditure and hence less fat accumulation.

Users are increasingly aware of a demand for premium meat in recent years, particularly in China. Local chicken varieties typically provide meat of higher quality than modern commercial breeds, as is extremely recognized. In the current study, a breast muscle's pH, intramuscular fat, meat colour, shear force, and cooking loss were all used to assess meat quality. When discussing meat's ability to hold onto water during slaughter, storage, processing, with transportation, drip loss is typically used as a measure. One of beef's most crucial sensory qualities is shear force, which reflects how readily the muscles get sliced or eaten. The prevalence of pale, soft, and exudative meat is typically considered simpler to increase in higher L*-valued and lower a*-valued meat, which is positively correlated with increased drip loss. In line with earlier research, the FRS group of ducks in this current research demonstrated stronger compared to their CRS and NRS groups, and they had a decreased shear force and drip loss.

Significant physical activity might improve growth and density of muscle fibers in chickens when FRS conditions are present, which may play an important role in higher shear force and reduced drip loss. Muscle growth and a greater myofibrillar protein-to-collagen ratio explained this outcome. Additionally, FRS birds had more room and opportunity to move around naturally for physical activity, such as pecking, walking, and running, which raised a percentage of oxidative fibers in their bodies. Indicating that FRS improves the meat quality of Gaoyou ducks, the FRS, and NRS groups, the L* value for each breast muscle increased throughout each group. The same study revealed that ducks grown in FRS, including Chaohu ducks, had lower L* values than ducks bred in NRS or CRS. Serum biochemical parameters, including various rearing techniques, serum biochemical measures, which are indicators of an animal's physiology and metabolic state, are affected. Their findings revealed the CRS and NRS groups had considerably greater blood glucose and TP contents than FRS group. This might exist among ducks under CRS and NRS conditions who underwent less exercise, as

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exercise can momentarily speed up protein synthesis and glucose metabolism and result in blood TP loss.

Future research should be done to determine whether the CRS and NRS circumstances may encourage gluconeogenesis. Similar research revealed that compared to poultry raised under NRS or CRS circumstances, Chaohu ducks and Wannan Yellow chicks raised under FRS conditions had reduced blood glucose and TP levels. According to the current study, ducks raised under CRS and NRS settings had greater ducks bred under FRS circumstances, increased TG levels in serum and lower HDL-C values, all blood indicators directly linked to depositing fat. This outcome is in line with their findings. Compared to ducks raised in FRS, those raised in CRS have lower HDL-C levels and higher TG levels in their blood. Chylomicrons and big, extremely low-density lipoprotein cholesterol, two triacylglycerol-rich lipoproteins, have trouble crossing the endothelial barrier and entering the intima of arteries because triacylglycerol (TG), an ester created with glycerol and fatty acids. Low-density lipoprotein triglycerides is a crucial movement transferred in liver to various organs as total cholesterol, whereas HDL-C is critical to movement of total cholesterol that is excreted that liver into other organs. This demonstrates the increased belly fat content of ducks bred in CRS and NRS, according to finding that CRS and NRS significantly stimulate fat deposits compared to FRS.

Conclusion

The CRS might enhance the Gaoyou ducks' growth performance by influencing variables including “BW, ADG, ADFI, and F/G." However, FRS is advantageous and designed that carcass characteristics, several serum biochemical markers, and meat quality. Since both “CRS and FRS” offer benefits, the best rearing method should be chosen depending on market's needs and the intended output level.

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