EFFECT OF FEEDING STANDARDS ON MEAT QUALITY AND GROWTH PERFORMANCE OF BROILER CHICKEN

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Abstract – This study was conducted to evaluate effects of NRC recommendations (with high nutrition level) and Japanese Feeding Standard (JFS) requirements (with low nutrition level) on meat quality and growth performance of broiler chicken from 28 days to 38 days of age - 10 days trial and from 0 to 38 days of age - 38 days trial. Separated chicks were provided by experimental diets and water *ad libitum*. At 38 days all chickens were weighed and slaughtered. Pectoral muscles, liver and abdominal fat were dissected from the carcass immediately and were weighed. Carcass yields, body weight gain, feed intake and feed efficiency were calculated. Meat pH, color, free amino acid content, shear force value, cooking and drip loss were measured. For the growth performance there was no significant difference in 38 days trial. For meat quality analysis, there were also no significant differences between two groups in each trial besides redness of meat. JFS group had lower redness than NRC group. From free amino acid analysis, JFS group was higher amount of free essential amino acids in muscle. From these results, we can conclude that it is beneficial and better to use recent standard JFS in broiler breeding.

Key Words – feeding standard, growth performance, meat quality

I. INTRODUCTION

Many studies which to improve meat quality have been conducted by breeding management of animals, nutritional science and processing. Dietary nutrients play a significant part in determining growth rate and meat yield. World main feeding study of livestock animal is based on the recommendation of the National Research Council (NRC, 1994) - National Academy of Science, Washington, DC. No comparable recommendations exist in other countries. Even UK nutrient requirement standards (ARC, 1975), Australian feeding standards (SCA, 1987) and French publication on requirements is the Institut National de la Recherché Agronomique (INRA, 1984) were published but they have not been yet revised (Robert Blair, 2008)[5]. However during last years, poultry breeding companies have been designing their own standards for particular genotype to be more useful than the NRC values. Basically, some standards had started to be modified by changing the NRC values to have nutrients requirements higher than NRC recommendation. In contrast, there are many studies about minimum nutrient requirements for ecological reason, e.g. decrease the fecal nitrogen, phosphorus, etc. Also it is necessary to apply requirements that are provided by economically, ecologically pure and have an optimal production and good meat quality for poultry breeding. Japanese Feeding Standard for Poultry (JFS, 2011) was designed as a low level of nutrient requirements especially focused on crude protein (CP) amount and amino acids requirement for poultry breeding. Perhaps low CP content of JF-Standard can influence production of broiler, because of a manipulation of the dietary protein can have various effects on broiler performance but effects of these standards' requirement difference on meat quality aren't studied yet. So, it is necessary to compare these standards to each other, evaluate the influence on chicken growth performance, especially on meat quality. Therefore purpose of this experiment is to evaluate effects of two feeding standards (NRC, JFS) on broiler chicken growth performance and in exact on meat quality.

II. MATERIALS AND METHODS

Animals

0 day-old female Ross strain broiler chicks were purchased from commercial hatchery.

Experiment 1 (10 days trial): All chicks were housed in a brooder kept warm from 0 to 28 days of age and fed by commercial starter diet. From 28 to 38 days of age, they were separated into cages

and allotted 2 experimental feedings (NRC-experimental diet that met for National Research Council recommendation and JFS-experimental diet that meet Japanese Feeding Standard requirement).
Experiment 2 (38 days trial): All chicks were housed in a brooder kept warm from 0 to 14 days. From 14 days they were separated into cages. All chickens were allotted into two experimental feedings same with previous trial from 0 day to 38 days of age.
The birds were given *ad libitum* access to water and diet. The ambient temperature was gradually decreased from 36 to 24^{0}C over the period of 0 to 28d of age and lightning had been for 15 hours from 04:00 to 19:00. All procedures were performed through "Management manual" of Ross broiler chicken.

Diet Formulation

There were two kind of experimental diets which were belonging to semi-purified diet. One diet had a nutrition level that was met the recommendations of NRC standard and another one had a nutrition level that was met the recommendations of JFS. Minerals and vitamins premix was prepared individually for each standard.

Table1 Recommendation of standards [3, 4]

	Starter period		Grower period	
Chemical composition of feed	NRC 1994 (USA)	JFS 2011 (Japan)	NRC 1994 (USA)	JFS 2011 (Japan)
CP, %	23.0	20.0	20.5	17.0
ME, kcal/g	3.2	3.1	3.2	3.1
Total EAA,%	6.37	6.24	5.73	5.49
Minerals, %	2.21	2.11	1.91	1.8
Trace minerals, mg/kg	188.5	183.5	188.1	183.1
Water soluble vitamins, mg/kg	1354.6	1357.61	1049.6	772.4
Fat soluble vitamins, IU	1710	2910	1710	2910
Vitamin K, mg/kg	0.5	0.5	0.5	0.5

Measurements

Growth performance:
In each experimental trial, initial and final body weights were measured and feed intake, feed efficiency were calculated individually. At the end of experimental period, 38 days old chickens were slaughtered by cutting the carotid arteries. After slaughtering, breast muscles (*M. Pectoralis superficialis*), liver and abdominal fat were dissected from the carcass, weighed and muscle samples were taken and stored at -80^{0}C for amino acid analysis.

Meat quality analysis:
Meat color and pH: Just after slaughter and after storing 2 days at 4^{0}C, in breast muscle pH by pH-meter TPX-90i (Toko Chemical Laboratories Co., Ltd., Tokyo, Japan) and surface color were measured by Colorimeter CR-400 (Konica Minolta Sensing, Inc., Osaka, Japan) expressed as a color L^*-(lightness), a^*-(redness) and b^*-(yellowness) values.
Meat texture: The breast muscles had been refrigerated for 2 days at 4^{0}C and then were measured weight. After measuring, meat had been cooked for an hour at the internal temperature was 70^{0}C. After cooling till room temperature, meat was cut into 1x1x4cm and measured Shear Force Value (SFV) by Rheo-meter (Fudoh-Rheo Meter RT-2005J, Rheotech Ltd., Japan) and calculated drip loss (DL) and cooking loss (CL).
Free amino acids content: After extracting free amino acids by using 10% perchloric acid under homogenizing high-speed homogenizer (Ultra-Turrax T25 basic, Ikawerke, Staufen, Germany), free amino acids content in muscle were measured as a described by Imanari *et al*. (2007) using amino acid analyzer (JLC-500/V; JEOL, Tokyo, Japan).

Statistical analysis:

Means and standard errors were calculated for chickens in both groups. For statistical analysis, one-way analysis of variance (ANOVA) was used with the GLM procedure in SAS (SAS Institute, 1985).
Significant differences between means were determined by the LSD method.

III. RESULTS AND DISCUSSION

Table 2 Effect of feeding standards on broiler growth performance and carcass yield

Parameters	28-38 days trial				0-38 days trial			
	NRC		JFS		NRC		JFS	
Body weight gain, g/d	82.33 ± 5.11[a]		73.84 ± 6.42[b]		67.41 ± 5.72		64.07 ± 3.78	
Feed intake, g/d	140.59 ± 5.15		140.70 ± 6.24		125.64 ± 8.69		127.39 ± 4.61	
Feed efficiency	0.57 ± 0.02		0.51 ± 0.03		0.54 ± 0.03		0.50 ± 0.01	
Breast muscle, %	13.37 ± 0.46		13.07 ± 0.46		11.49 ± 0.56		12.05 ± 0.23	
Abdominal fat, %	1.97 ± 0.18		2.08 ± 0.12		0.91 ± 0.08[A]		1.46 ± 0.17[B]	

Values are mean ±SE for 6 chickens in each group
[A, B] – values in rows for each trial with different letters differ significantly at P<0.01
[a, b] – values in rows for each trial with different letters differ significantly at P<0.05

Table 3 Effect of feeding standards on broiler meat color

Parameter		28-38 days trial				0-38 days trial			
		NRC		JFS		NRC		JFS	
After slaughter	Lightness	40.68 ± 0.45[a]		42.00 ± 0.53[b]		41.63 ± 0.48		41.72 ± 0.59	
	Redness	2.25 ± 0.21		2.33 ± 0.25		4.02 ± 0.26[A]		2.62 ± 0.27[B]	
	Yellowness	4.52 ± 0.20		4.90 ± 0.19		6.85 ± 0.36		6.96 ± 0.31	
After 48 hours	Lightness	54.85 ± 0.87		56.55 ± 0.85		54.30 ± 1.08		54.73 ± 1.03	
	Redness	1.46 ± 0.22		0.99 ± 0.26		3.26 ± 0.42[a]		2.08 ± 0.35[b]	
	Yellowness	9.64 ± 0.53		8.61 ± 0.53		12.85 ± 0.62		13.18 ± 0.72	

Values are mean ±SE for 6 chickens in each group
[A, B] – values in rows for each trial with different letters differ significantly at P<0.01
[a, b] – values in rows for each trial with different letters differ significantly at P<0.05

Table 4 Effect of feeding standards on broiler meat quality

Parameter	28-38 days trial				0-38 days trial			
	NRC		JFS		NRC		JFS	
Shear force value, kg	3.41 ± 0.54		4.74 ± 0.10		3.46 ± 0.59		2.90 ± 0.73	
Drip loss, %	0.86 ± 0.11		0.72 ± 0.08		1.67 ± 0.20		1.59 ± 0.27	
Cooking loss, %	12.11 ± 0.74		12.52 ± 0.52		20.66 ± 1.05		16.01 ± 0.50	
pH (AS)	6.40 ± 0.09		6.71 ± 0.19		6.28 ± 0.07		6.44 ± 0.06	
pH (A48)	5.56 ± 0.04		5.46 ± 0.06		5.69 ± 0.08		5.73 ± 0.07	

AS – After slaughter, A48 – After 48 hours
Values are mean ±SE for 6 chickens in each group

Table 5 Total essential amino acid content in muscle, μg/g

	28-38 days trial		0-38 days trial	
	NRC	JFS	NRC	JFS
Total essential amino acid	275.85 ± 10.82	307.15 ± 27.27	327.3 ± 34.7[a]	409.2 ± 49.2[b]

Values are mean ±SE for 6 chickens in each group
[a, b] – values in rows for each trial with different letters differ significantly at P<0.05

Growth performance:
For the performance both of trials, there were not significant differences between each group beside body weight gain of JFS group was significantly lower than NRC group in 10 days trial. But in 38 days trial there weren't significant differences in growth performance (Table 2). Even JFS has a lower content of dietary CP level in feed than NRC group but there wasn't significant difference on performance of both trails. However this result haven't met to some researches reports that low-CP diet decrease growth performance of broiler but it may agreeable to the report of Yamazaki M et al. (1998) [6] that feeding a greater rate of essential amino acids (EAA) to nonessential amino acids (NEAA) in low-CP diets tends to improve performance. So it is can be suggested that JFS may have better ratio of EAA and NEAA contents. However in 10 days trial, abdominal fat content wasn't different in two groups but in 38 days trial JFS group's abdominal fat content was higher that NRC group. So, it met to many researchers reports that low-CP diet increases abdominal fat deposition.
Meat quality:
Meat pH and color: There were no significant differences in pH, yellowness and lightness on two groups for both trials after slaughter and after 48 hours beside after slaughter lightness of JFS group in 10 days trial (Table 3). So it can be suggested that these standards are not causing any stress for broiler. For redness, even there were not significant differences between two groups in 10 days trial but in 38 days trial JFS group had a significant low amount of redness in after slaughter and after 48 hours. This result is met with report of Niu Z et al. (2009) [7], that low-CP diet decrease redness of meat.

Meat texture: There were no significant differences in SFV, DL and CL amount in two groups for each trial (Table 4). These results were in agreement with the report Gu H *et al.*, (2008) [1] that CP content cannot influence on meat SFV.
Amino acid: However, in 10 days trial there was no significant difference for total EAA content, but 38 days trial there were significant differences in total EAA content between two groups (Table 5). Actually recommendation of EAA content of JFS is lower than NRC but contents that in muscle were significantly higher than NRC group. Kobayashi *et al.* (2003) [2] reported that in 10 days trial, higher CP diet was increasing some EAA contents in muscle significantly. But results in this trial might be caused by using purified experimental diets and JFS group was used crystalline amino acids more than NRC group.

IV. CONCLUSION

In this study we evaluated two kind of feeding standard that has a higher nutrient level recommendation - NRC and standard that has a lower nutrient level recommendation - JFS for poultry breeding in purified diets during in starter and from starter to grower period. In general, these standards recommendations could not influence on broiler growth performance and meat quality significantly. Therefore there might be beneficial to use JFS in broiler breeding economically and ecologically.

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