# Differences in Growth Performance and Protein Metabolism-Related Parameters of Broiler Chickens and Native Chickens (Niigata Jidori)

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**Life and Food Science**
**Graduate School of Science and Technology**
**NIIGATA UNIVERSITY, JAPAN**

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***DEDICATED***

***TO***

***PARENTS &***

***TEACHERS***

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# SUMMARY

Poultry industries is the most promising sector worldwide where chicken is the major contributor. There are two major sources of chicken meat those are indigenous (native) chicken and commercial hybrid genotypes (broiler chicken). Among the meat, chicken has been considered as the cheapest and available to the consumers regarding to its price and quality. Meat from native chickens are preferred widely by consumers, because of their good pigmentation, better taste, leanness and their suitability for special dishes. The Japanese native chicken, Niigata Jidori, is available in the Niigata prefecture of Japan. Niigata Jidoriis bred from Plymouth Rock and the $F_1$ hybrid of Tomaru and Nagoya, like HinaiJidori in Hinai area of North Akita prefecture of Japan. Hinaidori is one of the famous Japanese memorial native chickens. Since eating memorial native chickens in Japan is prohibited, $F_1$ of Hinaidori and Rhode Island Red called HinaiJidori, is consumed instead. The meat of HinaiJidori is palatable and delicious in local dishes, like Kiritampo. Fujimura *et al.*, (1991) have shown that the meat of HinaiJidori is tastier than that of broiler chickens.Similarly, the meat of Niigata Jidori is also tastier than broiler chicken meat. Market price of Niigata Jidori is higher than that of broiler owing to its good taste.

Bangladesh consumer demands for native chickens are increasing because of their good pigmentation, better taste, leanness and their suitability for special dishes. Due to higher demand day by day, this indigenous chicken is being produced under intensive or semi-intensive system of production on fully commercial diets. However, there are limited reports available on meat yield and quality attributes of native chicken feed on commercial diets of varying ingredients and nutrient composition. Most of the previous research has been focused on corn based diet with different rearing system and growing performance of broiler

and native chicken. Still there is a lack of research on the production potential of Japanese and Bangladeshi native chickens and broiler with replacement of corn by rice in diet. Researches on their growth and other production parameters have not been adequately studied. Thus the objectives of the present study were to determine and compare the growth performance, tissue weights, nitrogen retention, free amino acids concentration in breast muscle, mRNA expression of IGF-I in liver, atrogin-1 and proteasome C2 sub unit in breast muscle of broiler and native chicken from Bangladesh and Japan (Niigata Jidori) by using different level of rice instead of corn in their diet.

In the first experiment, we studied the effects of rice in different level (0%, 50% and 100% instead of corn) in diet to compare the growth performance, feed intake and feed conversion ratio of broiler (Cobb 500) and native chicken from Bangladesh. A total of 360 (180 native and 180 Cobb 500) one-day-old mixed-sex chickens were randomly allotted to three treatments (T), namely $T_1$ (Based on corn, 0% rice), $T_2$ (50% corn and 50% rice), and $T_3$ (0% corn, based on rice 100%) with three replicates for each treatment (20 birds per replicate). The experimental birds were fed ad libitum diet with free access to drinking water. Data were analyzed by using SPSS based on 2×2 factorial design. Initial body weight (day old chicken) of broiler chicken were 42.33, 41.67, 43.33g and native chicken were 29.67, 31.00, 30.33g for $T_1$, $T_2$, and $T_3$ feeding group respectively. After five weeks body weight for broilers were 1251, 1266, 1287g and for native chickens were 297.67, 314.33, 317.67g for $T_1$, $T_2$, and $T_3$ feeding group respectively. Body weight gain in broiler for $T_1$, $T_2$, and $T_3$ feeding group were 1208.67, 1224.33, 1244.67g and 268, 283.33, 287.34g were for native chicken respectively. The average daily gain (ADG) during five weeks period were 34.5, 34.98, and 35.53g in broiler for $T_1$, $T_2$, and $T_3$ feeding group, whereas 7.65, 8.09 and 8.20g in native chicken for $T_1$, $T_2$, and $T_3$ feeding group respectively.

Feed intake of broiler chicken at five weeks were 2126, 2132, 2147g and native chicken were 1001, 1057, 1051, for $T_1$, $T_2$, and $T_3$ feeding group respectively. Feed conversion ratio (FCR) was 1.76, 1.74, 1.72 for broiler chicken and 3.78, 3.73, 3.65 for native chicken in different treatment ($T_1$, $T_2$, and $T_3$) respectively. After five weeks, the results showed that all treatments of broiler chicken groups had higher body weight gain, feed intake, FCR, and average daily gain compared to native chicken.

In the second experiment, we compare the growth performance, tissue weight, nitrogen retention and mRNA expression of Japanese native chicken (Niigata Jidori) and Chunky broiler. Day old chicks were reared under identical environmental conditions in the same house for 2 weeks with free access to feed (commercial broiler grower containing 22 % CP and 3050 kcal ME/kg DM) and water. Twenty birds of 14-days-old (10 Niigata Jidori and 10 Chunky broilers) were individually housed in battery cages with wire-mesh flooring and had free access to feed and water during the 2week experimental period. The birds were kept under 24h lighting programs throughout the experiment. The temperature was maintained at 29˚C on the first day, and lowered by 1˚C every 3 days, to a final temperature of 24˚C. Body weight gain (BWG), and feed intake (FI) were recorded weekly and feed efficiency (FE) was calculated from BWG divided by FI. Growth performance, nitrogen retention, concentrations of free amino acids in muscles, as well as mRNA expression of liver IGF-1, breast muscle atrogin-1, and proteasome C2 subunit were determined. Body weight gain, feed intake, and feed efficiency were significantly higher in broilers than that of Niigata Jidori. Muscle weights (breast and thigh) and nitrogen retention were significantly higher in broilers than that of Niigata Jidori. Concentrations of free amino acids, viz., Asp Glu, Ala, Cys, Tyr, Lys, and Arg in breast muscle were significantly higher in broilers than that of Niigata Jidori. However, there were similar concentrations for Thr, Ser, Gly, and Val, Met, Ile, Leu, Phe, and His in broilers and Niigata Jidori. No significant differences were found in mRNA expressions of liver IGF-I, breast muscle atrogin-1, and proteasome C2 subunit between broilers and Niigata Jidori. The growth performance of broiler and Niigata Jidori varied significantly, mRNA expression related to protein metabolism between the two breeds were same.

In conclusion, rice could be considered as an alternative material of corn in broiler and native chicken diet without detrimental effect on growth performance. The growth performances in broiler was significantly higher due to their genotype. These researches could be beneficial for poultry industries and rural households who are involved in commercial and native chicken production. However, further research is needed to identify the factors which are responsible for enhancing growth performances, nitrogen retention, concentrations of free amino acids in muscles, as well as mRNA expression of liver IGF-1, breast muscle atrogin-1, and proteasome C2 subunit in broiler and native chickens.

# GENERAL INTRODUCTION

Chicken is the cheapest and key contributor of animal protein in human diet. Meat and eggs from native chickens are preferred widely by consumers, because of their good pigmentation, better taste, leanness and their suitability for special dishes (Horst, 1991). There are two major sources of chicken meat indigenous chicken (native chicken) and commercial hybrid genotypes (broiler chicken). Traditionally, native chickens is reared in small groups under scavenging system in low input and low output but profitable in Bangladesh (Chowdhury, 2012; Huque *et al.,* 1990; Sazzad, 1986). Due to high demand indigenous chicken is being produce under intensive or semi-intensive management system of production based on fully commercial diet. However, reports available on meat yield and quality attributes of native chicken fed on commercial diets of varying ingredients and nutrient compositions are scarce.

The world production of poultry meat is based on raising fast-growing broiler chickens, i.e., commercial hybrids intended solely for meat production (Yang and Jiang, 2005). The intensive breeding work together with optimized feeding and housing conditions have considerably shortened the rearing period of fast-growing chickens, but a problem has arisen with the maturity of meat and its sensory and technological quality (Bianchi *et al.,* 2006; Kijowski and Kupińska, 2013). With the growing demand for poultry products from extensive systems, an opportunity arises to increase the importance of raising native chicken breeds. The experience of many countries, in which native breeds of slow growing chickens provide good quality meat, which is in increasing demand (Fanatico *et al.,* 2005 a, b; Youssao *et al.,* 2009; Smith *et al.,* 2012; Yin *et al.,* 2013; Choo *et al.,* 2014; Walley *et al.,* 2015). In practical production, meat under extensive systems was initially produced using native chicken breeds almost exclusive (Yang and Jiang, 2005). Today, meat from extensive farming is mainly obtained from hybrids of native breeds and fast-growing lines (Youssao *et al.,* 2009; Miguel *et al.,* 2011; Sarica *et al.,* 2014). Compared to the native breeds, such hybrids are characterized by higher rate of growth, better feed conversion and greater dressing percentage. Consumer interest in favor of some meat from slow-growing chickens is increasing in many countries of the world despite of its relatively high price. From the nutritional stand-point, the meat of slow-growing birds is healthier (less fat and higher content of n-3 PUFA) and thus might better with the consumer's expectations of organic products (Sirri *et al.,* 2011).

Consumers believe that poultry meat from extensive systems gives more flavor because the diet of hens contains many additional nutrients that birds consume on the free range, which has a positive effect on the flavor, aroma as well as color of the meat. Color is an important attribute by which consumers judge the carcass. Native chicken breeds show lower weight gain and a smaller proportion of breast muscle in the carcass compared to broilers. The body weight as well as the muscling of laying and multipurpose hens differ from those of broiler chickens; they are closer to those in slow-growing chickens and depend on bird genotype, feeding system and length of productive life (Mu-rawska *et al.,* 2005; Murawska and Bochno, 2007). Native chickens have traits of fighting cocks including strong and tough muscles, characteristics regarded as quality when compared with the over-tenderness of broiler meat Jaturasitha (2000). It is also an alternative for consumers preferring low fat and antibiotic-free white meat. Native chickens are raised by small farmers. Their low growth efficiency and poor performance is attributable to lack of proper feed and management. While world poultry meat production is dominated by white-feathered broilers owing to their rapid growth and high feed efficiency.

In regions where corn and soybean production do not meet demand, the best alternative to seek industry or agribusiness processing outputs that can replace part or all of these ingredients, as an option to reduce production costs without compromising breeding performance and economic viability (Etuk *et al.,* 2012). After corn, rice is the second most produced cereal in worldwide, but its use in poultry diets is unusual, due to its higher cost compared to corn. However, one of the by-products of rice milling, broken rice, has a much lower market value, making it possible to use it in animal feeding when its price is lower than that of corn. Broken rice is a high-energy feed that provides 3279 kcal kg-1 dry matter, and has a crude protein content of approximately 8.5% (Cancherini *et al.,* 2008; Rostagno *et al.,* 2011). These characteristics enabled its use in quail diets consisted as a replacement for corn (Cardoso *et al.,* 2011; Quevedo Filho *et al.,* 2013). Rice byproducts, such as broken rice, may serve as an alternative to costly corn due to their low cost and high availability in Bangladesh.

Rice is one of the most important agricultural product and it has surplus production in Bangladesh. It could be a good alternative of corn because of similar protein and metabolizable energy contents (Digher, 2008). As a potential energy source, broken rice has been used for feeding trials in laying hen diets and has achieved similar efficiency with respect to energy utilization as corn (Jadhao *et al.,* 1999). Furthermore, in recent years, rice byproducts have received increased attention as functional foods due to their phenolic base compounds and for their high amounts of vitamins, minerals, and fiber, which can help lower cholesterol and support antilatherogenic activity. The inclusion of broken rice in broiler diets has been evaluated and no effects on feed intake, weight gain and feed conversion of birds were observed (Cancherini *et al.,* 2008). Similarly, working with Japanese quails, Sethi *et al.,* (2006) and Cancherini *et al.,* (2008) asserted growth performance is not affected by the replacing 50% of dietary corn by broken rice. When evaluating the replacement of corn by broken rice in broiler diets at the levels of 0%, 20%

and 40% ( Brum *et al.,* 2007) did not find any significant effects ($p>0.05$) on feed intake, weight gain, or feed conversion ratio. Swain *et al.,* (2006) concluded that broken rice could substitute corn only at 5% inclusion level. However, for growing phase quails, Sethi *et al.,* (2006) suggested that broken rice could replace up to 50% of dietary corn without affecting quail growth performance.

Nanto *et al.*, (2012) obtained higher final weight in broilers when corn was totally replaced by dehulled paddy rice in the diets. Similarly, Gonzalez-Alvarado *et al.,* (2007) obtained better performance in broilers diet containing dehulled paddy rice as main energy source compared with corn. Tester *et al.*, (2006) stated that the best performance of birds fed diets containing dehulled rice can be explained by its smaller particle size and lower amylose and non-starch polysaccharide contents. Rice is well known as the major staple food in most developing countries in the world, especially in Asia. Asian countries contribute approximately 92% of the total world rice production, mostly of the Oryza sativa species, which has been cultivated widely in warm climates. Some varieties of rice have been rejected for human consumption because of their low eating value resulting from the lack of certain nutrients required by humans. Thus, these varieties are planted for use as feedstuffs for ruminants and monogastric animals. All parts of processed rice are exploited as feedstuffs, such as rice polishing (Rahman, 2005) rice bran (Wang, 1997) and the rice grain that is undesirable for human consumption (Alias, 2008). Brown rice was discovered to be the most suitable form of rice for the production of feed (Alias, 2008).

There are approximately fifty recognized breeds of native chicken in Japan and most of them were breed for their special plumage and fighting traits. Hinaidori is one of the famous Japanese memorial native chickens. Since eating memorial native chickens in Japan is prohibited, $F_1$ of Hinaidori and Rhode Island Red called HinaiJidori, is consumed instead.

The meat of HinaiJidoriis palatable and delicious in local dishes, like Kiritampo. Fujimura *et al.,* (1991) have shown that the meat of Hinai Jidori is tastier than that of broiler chickens. Likewise, the meat of Niigata Jidori is also much tastier than broiler chicken meat. Market price of Niigata Jidori is higher than that of broiler owing to its good taste. In a number of studies, growth trend parameters have been found to be highly heritable (Mignon *et al.,* 1999, 2000 and Lamont, 2002). However, extensive research has not been done to determine the production parameters, meat characteristics and financial viability of raising Japanese as well as Bangladeshi native chicken breeds. Therefore, the study was conducted to

i. determine and compare the effect of rice replacement of corn on growth performance of broiler and Bangladeshi native chicken, and

ii. determine and compare the growth performance, tissue weights, nitrogen retention, free amino acids concentration in breast muscle, mRNA expression of IGF-I in liver, atrogin-1 and proteasome C2 sub unit in breast muscle of broiler and Niigata Jidori.

# Experiment 1: Growth performance of rice fed broiler and native chickens


**ABSTRACTS**

The study was conducted to evaluate the effects of rice in different level (0%, 50% and 100% instead of corn) on growth performance, feed intake and feed conversion ratio of slow growing (native chicken) and fast growing broiler (Cobb 500) diet. A total of 360 (180 Native and 180 Cobb 500) one-day-old mixed-sex chickens were randomly allotted to three treatments, $T_1$ (0 %), $T_2$ (50%), and $T_3$ (100%), and three replicates for each treatment (20 birds per replicate) in a 2×2 factorial design. The experimental birds were fed ad libitum with formulated diet and free access to drinking water. Initial (one-day-old) body weight of broiler chicken were 42.33, 41.67, 43.33g and native chicken were 29.67, 31.00, 30.33g for $T_1$, $T_2$, and $T_3$ feeding group respectively. Five weeks body weight were 1251, 1266, 1287g in broiler and 297.67, 314.33, 317.67g were $T_1$, $T_2$, and $T_3$ feeding group respectively at same period. Body weight gain in broiler for $T_1$, $T_2$, and $T_3$ feeding group were 1208.67, 1224.33, 1244.67g and 268, 283.33, 287.34g were for native chicken respectively. The average daily gain (ADG) during five weeks period were 34.5, 34.98, and 35.53g in broiler group for $T_1$, $T_2$, and $T_3$ feeding group Whereas 7.65, 8.09 and 8.20g in native chicken respectively. Feed intake of broiler chicken for five weeks were 2126, 2132, 2147g for and Native chicken were 1001, 1057, 1051, 2147g for $T_1$, $T_2$, and $T_3$ feeding group respectively. FCR were 1.76, 1.74, 1.72 for broiler chicken and 3.78, 3.73, 3.65 for native chicken in different feeding treatment respectively. At five weeks, the results showed that broiler chickens were significantly higher feed intake, FCR, and subsequently higher body weight gain and ADG. Native chicken groups were lower feed intake, FCR, and subsequently lower body weight gain and ADG in feeding treatments.


## INTRODUCTION

Poultry industries is the most promising sector in Bangladesh and within the poultry species chicken is the major contributor. In Bangladesh, there are two major sources of chicken meat those are from slow growing indigenous (native chicken) and fast growing (broiler chicken). Native chicken are reared in scavenging system with low inputs and management system (Chowdhury, 2013). Meat of indigenous chicken compared to broiler are preferred widely by consumers because of good taste, lean meat, better pigmentation and also suitable for preparing different dishes (Chowdhury, 2013), although the price is higher than commercial broilers. The taste and preference of consumer to indigenous chicken, production systems is being transferred to intensive or semi-intensive system based on fully commercial diets due to higher demand. The quality of indigenous chicken meat produced in scavenging system is of distinct characteristics, its quality on commercial diet is rarely reported. There are very few reports available on meat yield and quality attributes of slow growing indigenous chicken fed on commercial diets of varying ingredients and nutrient composition worldwide.

Commercial hybrid broiler is the fast growing meat type chicken those are fully grown on commercial diet under intensive system of production. The birds with high growth rate and higher egg production suffer more in tropical climate than that of slow growing (Fox, 1980; Bohren, 1982). On the other hand native chicken thrive under harsh nutritional and environmental conditions, and resistant to common diseases. Native birds may differ in size, shape and production levels. Each bird produces a maximum of 1.5kg meat under traditional scavenging system (Barua and Howlider, 1990; Barua and Yoshimura, 1997; Islam *et al.*, 2003). Reports also indicate that their scavenging feeds are deficient in energy and protein but high in fiber (Rashid *et al.*, 2005), a key reason for their low productivity. The major feed sources for village chickens are earthworms, insects, seeds, broken rice, kitchen waste, green leaves and other plant materials found in household yards. The nutrients available to local scavenging chickens feeds are generally deficient; not only does their availability vary with the seasons of the year and the localities, as reported in studies carried out in some developing countries such as Sri Lanka (Gunaratne *et al.*, 1993), Ethiopia (Dessie, 1996), Bangladesh (Huque 1999), and Tanzania (Mwalusanya *et al.*, 2002), but the scavenged nutrients also vary to some extent by the foraging habit which may differ with the type of bird (genotype and physiological status) as observed, for instance by Mwalusanya *et al.*, (2002).

According to Ukil (1992), scavenging feed is far from balanced and especially deficient in protein. Therefore, the increased productivity of native chicken may not be obtained solely on scavenging feed. Study on the impact of "Smallholder Livestock Development Project (SLDP)" in the rural community of Bangladesh revealed that supplementation of a balanced diet to chicks in confinement increase the overall production potential of native (desi) chickens and reduce chick mortality (Sarkar *et al.*, 2005; Sarkar and Bell, 2006). From economic analysis of improved management system, Sarkar and Golam (2009) concluded that management and dietary interventions of native chickens appear to be effective tools for increasing productivity. Sonaiya (1995) suggested the productivity of scavenging chickens could be improved by interventions in management systems by supplying the quality and quantity of feed. To increase meat and egg production in the village level, native chickens need a type of diet that is adequate in terms of quality and quantity. Native chicken may be more productive with improved diets when reared in confinement (Chowdhury *et al.,* 2006) but growth target or weight at marketing is yet to be determined as per demand of the consumers.

Nutritional manipulation to develop native chicken as a meat type bird is to be carried out with diets of adequate nutrient density by rearing them both in confinement and under traditional scavenging system. Indigenous chicken is always thought to be better in term of carcass composition than commercial broilers due to its low fat content (Ganabadi *et al.*, 2009). It is common hearing that broiler meat is less tasty than that of slow growing indigenous chicken. But the attempt of enriching the taste of broiler meat to that of the attributes of indigenous chicken is very limited. Systematic studies suggest that meat quality parameters are highly influenced by dietary compositions (Wood *et al.*, 2008; López-Ferrer *et al.*, 2000).

Corn is the principal cereal grain among major poultry feed stuffs and constitutes about 50-60% in most poultry diets (Kumaravel and Natarajan, 2014) and has a greater acceptance in poultry feeds (Panda *et al.*, 2010). But its production is not sufficient to meet the ever increasing demand of poultry industry. Also, its price is increasing continuously due to intense competition for its usage by man or other livestock species (Agbede *et al.*, 2002; Hamzat *et al.*, 2003 and Bala at al 2017). For the last one and half decades, corn production for fuel and poultry industries has been expanding, resulting in higher cost of corn and limiting its utilization in the feed industry (Vicente *et al.*, 2008; Czech *et al.*, 2014). The cost of production and logistic costs are increasing the corn price day by day, especially during off-season periods (Moura *et al.*, 2010). Rising cost of poultry feeds have continued to be a major problem in developing countries as feed cost is about 65-70% (Nworgu *et al.*, 1999) and 70-75% (Opara, 1999) of the total cost of production compared to about 50-60% in developed countries (Tackie and Flenscher, 1995). Similarly, there has been a steady increase in the cost of other conventional feed ingredients such as wheat, groundnut cake, soybean meal and fish meal in the past years and this has led to increase in the prices of animal protein sources (Adejinmi *et al.,* 2007). Many researchers have emphasized the need for utilizing alternative feed ingredients removed from human and industrial uses (Fanimo *et al.,* 2007; Nsa *et al.,* 2007; Alagawany and Attia, 2015).Thus, it is imperative to search for suitable alternative sources of energy in poultry feeds to reduce the cost of production and availability. Among cereal grains, broken rice (*Oryza sativa*) is the relatively cheaper promising grains that can be successfully utilized as a component of poultry rations. Broken rice has been used for feeding trials in laying hen diets, and has achieved similar efficiency in regard to the utilization of energy (Jadhao *et al.,* 1999). Sittiya and Yamauchi 2014 demonstrated that paddy rice can probably be used as a good alternative cereal grain source in poultry diets (Sittiya, and Morokuma 2011). Bangladesh is an agricultural country, and surplus of rice in recent year. So rice may be an alternative to corn due to their availability, in addition of presenting similar protein and metabolizable energy contents (Daghir, 2008). The inclusion of broken rice in broiler diets has been evaluated and no effects on feed intake, weight gain and feed conversion of birds were observed (Cancherini *et al.,* 2008). Similarly, working with Japanese quails, Sethi *et al.,* (2006) asserted growth performance is not affected by the replacing 50% of dietary corn by broken rice. Moreover brown rice is applied in raising pigs, and can replace yellow corn, even up to 100% (Piao *et al.,* 2002), broken rice inclusion in Japanese quail layer diets (Swain *et al.,* 2006; Oliveira *et al.,* 2007), but little information has found on the evaluation of this feedstuff for meat-type slow and fast growing chicken genotypes. However, the above reviews show a clear gap to investigate the effects of rice inclusion in corn based commercial diet of the slow and fast growing chicken genotypes.

Objectives of work:

To investigate the growth response of rice fed native chicken and broiler.

# MATERIALS AND METHODS

All animal experiments were conducted in compliance with the protocol reviewed by the Animal Care and Use Committee of Bangladesh Agricultural University.

Experiments were conducted to investigate the growth performance of rice fed slow (native chicken) growing and fast (broiler) growing chicken genotypes, receiving diets of different level $T_1$ (0%), $T_2$ (50%) and $T_3$ (100%) of rice instead of corn. The experiments was carried out at the farm, Sylhet Agricultural University, Sylhet. Details of the experimental materials such as chicks, feeds etc. as well as the methodology for experimentations are presented in this chapter.

## 2.1 Layout of the Experiment:

**Table 1**: Layout of the experiment

| **Treatment** | **Replication** | **No. of birds** | |
|---|---|---|---|
| | | **Native Chicken** | **Broiler Chicken** |
| $T_1$ | $R_1$ | 20 | 20 |
| | $R_2$ | 20 | 20 |
| | $R_3$ | 20 | 20 |
| $T_2$ | $R_1$ | 20 | 20 |
| | $R_2$ | 20 | 20 |
| | $R_3$ | 20 | 20 |
| $T_3$ | $R_1$ | 20 | 20 |
| | $R_2$ | 20 | 20 |
| | $R_3$ | 20 | 20 |
| Total | | 180 | 180 |

The treatments consisted $T_1$ (0%), $T_2$ (50%) and $T_3$ (100%) of rice instead of corn in diets.

## 2.2 Experimental Birds

Two types of birds were used in this experiment slow growing (native chicken) and fast growing (Cobb 500 broiler) strain. Day old native chicken were purchased from Bangladesh Livestock Research Institute and Cobb 500 broiler chick were obtained from a local hatchery.

## 2.3 Preparation of Experimental House

All the equipment were removed from the house before starting experiment and cleaned thoroughly by using disinfectant (Virkon solution 5g/litter). Feeders, drinker, brooder and necessary equipment were washed properly and subsequently disinfected and enter into the house prior to set up experiment. Eighteen pen of equal size were made by wire net, bamboo and wood materials. Area of each pen was thirty square feet (10ft × 3ft). The house were properly fumigated before one day arrival of the chick into the house.

## 2.4 Birds Husbandry, Diets and Experimental Design

Three hundred sixty (180 Native chicken and 180Cobb 500 broiler) were reared under identical environmental condition in same house with free access to diet (Commercial broiler grower containing 22 %CP and 2950 kcal ME/kg) and water. The day-old chicks were reared in a common brooder house for the first week then randomly selected and divided into two groups, each group constituting three treatment with three replicates (20 birds per replicate) per treatment in a 2×2 factotial design. Iso-caloric dietary treatments will consist of an arrangement of 3 diets containing standard commercial broiler diet based on corn without rice ($T_1$), 50% corn replaced by rice in diet ($T_2$), and 100% the corn replaced by rice ($T_3$). The contents of CP, ME, calcium (Ca) and phosphorus in standard commercial diet will be fitted with the nutrient requirements suggested by the Cobb 500 broiler recommendation. Sufficient number of feeders and drinkers were placed in to the experimental house. Temperature of the house was maintained with the help of electric brooder and bulb. To reduce detrimental effect of heat stress, electrolytes were added to drinking water when required.  Temperature of the house were taken during the farm trial at 6 A.M., 12 noon and 6 P.M. Humidity was measured through thermo-hygrometer. During the experimental period, humidity level was higher than the requirement. Humidity of the house were taken during the farm trial at 6 A.M., 12 noon and 6 P.M.

A vaccination schedule was followed against ND for native Chicken and ND and IBD for broiler. Necessary hygienic measure was taken to ensure bio-security. The birds were kept under24 h lighting programs throughout the experiment.

**Table 2. Vaccination schedule for chicks.**

| Age of bird (day) | Name of the vaccine | Name of the diseases | Route of administration | Dose | Manufacturer |
|---|---|---|---|---|---|
| $4^{th}$ | BCRDV | ND | Intraocular | 1 drop | Animal Vaccine Research Centre, Mohakhali |
| $14^{th}$ | D-78 | IBD | Intraocular | 1 drop | Intervet international B. V. Boxmer, Holland |
| $20^{th}$ | D-78 | IBD | Intraocular | 1 drop | Intervet international B. V. Boxmer, Holland |
| $27^{th}$ | BCRDV | ND | Intraocular | 1 drop | Animal Vaccine Research Centre, Mohakhali |

### 2.5 Collection of Feed Ingredients

Corn, rice, rice polish, soybean meal, protein concentrate, di-calcium phosphate, limestone and other micronutrients were procured from local market. Samples were temporarily stored for chemical analyses.

### 2.6 Ration Formulation

Corn, rice, rice polish, soybean meal, protein concentrate, di-calcium phosphate and limestone etc. were used for feed formulation considering chemical composition and market price. DM, CP, EF, CF, and Ash were determined by AOAC (2000) method. Calcium and Phosphorus were determined by spectrophotometer. The diet were formulated to meet or exceed the nutrients recommendation for Cobb 500 broiler strains. The experimental diets are presented in Table 3.

**Table 3.** Composition and nutrient content of experimental diets.

| Ingredients | Rice Inclusion level | | |
|---|---|---|---|
| | T1 (0% Rice) | T2 (50% Rice) | T3 (100% Rice) |
| Corn | 550 | 275 | 0 |
| Rice | 0 | 275 | 550 |
| Soybean meal | 253 | 257 | 160 |
| Protein concentrate | 50 | 60 | 130 |
| Oil | 5 | 40 | 55 |
| Dicalcium phosphate | 15 | 15 | 15 |
| Rice polish | 105 | 60 | 80 |
| Salt | 3 | 3 | 3 |
| Lysine | 2 | 2 | 2 |
| Methionine | 2 | 2 | 2 |
| Limestone | 12 | 8 | 5 |
| Vitamine Premix | 3 | 3 | 3 |
| Total | 1000 | 1000 | 1000 |
| CP | 20.16 | 20.11 | 20.12 |
| Lys | 1.2 | 1.2 | 0.573 |
| Ca | 1.09 | 1.034 | 1.22 |
| Met+Cys | 0.8 | 0.796 | 0.829 |
| ME(kcal/kg) | 2950 | 2950 | 2950 |

Provided the following (per 1000 kg of diet): Mn, 100ng; Zn,100ng; Fe, 40ng; Cu,15ng; I, 1mg; Vitamine A, 130 IU; Vitamine D, 35,000IU; Vitamine E, 80IU; Vitamine K, 4mg; Thiamine monohydrate,4mg; riboflavin, 9mg; Vitamin B6, 64mg; Vitamine B12, 0.02mg; pantothenate,15mg; nicotinamido, 60mg; folic acid, 2mg; biotino.15mg

## 2.7 Performance Data

Data were recorded in terms of initial body weight, weekly body weight and weekly feed consumption during the study periods. Necessary calculations were made for weekly body weight gain, daily body weight gain, daily feed consumption, and FCR.

## 2.8 Calculated Data

Weight gain was measured by deducting initial weight from live weight. Feed was weighed using a top loading balance (Camry Emperors, China) each time before introducing into the feeding trough and again weighed at the end of the day, and the difference was determined and recorded as the feed consumed each day for each group. The mean feed consumption per bird was determined by dividing the total amount of feed consumed per group by the number of birds in each group. Feed conversion ratio was measured by dividing the feed intake by the body weight gain for a given period.

## 2.9 Statistical Analysis

Data of various parameters were subjected to statistical analyses using analysis of variance (ANOVA) in a factorial design. Significant differences of mean values were determined by least significant difference (LSD) (SAS, 2008).

# RESULTS

The growth performance of the native and broiler chickens are shown in Table 4.

**Table 4: Growth performance of native and broiler chickens**.

| **Breed** | **Feed** | **Initial body wt.** | **Body wt. (5 wks.)** | **BWG (g/birds)** | **ADG (g/birds/d)** | **Feed Intake** | **FCR** |
|---|---|---|---|---|---|---|---|
| Broiler Chicken | T1 | 42.33±0.29 | 1251±10.47 | 1208.67±10.28 | 34.5±0.27 | 2126±11.75 | 1.76±0.38 |
| | T2 | 41.67±0.41 | 1266±10.90 | 1224.33±10.28 | 34.98±0.27 | 2132±15.85 | 1.74±0.38 |
| | T3 | 43.33±0.29 | 1187±10.90 | 1244.67±10.28 | 35.53±0.27 | 2147±11.21 | 1.72±0.38 |
| Native chicken | T1 | 29.67±0.60 | 297.67±15.57 | 268±21.52 | 7.65±0.29 | 1001±24.83 | 3.78±0.40 |
| | T2 | 31.00±0.60 | 314.33±15.52 | 283.3±21.52 | 8.09±0.29 | 1057±32.28 | 3.73±0.41 |
| | T3 | 30.33±0.60 | 317.67±15.90 | 287.34±21.52 | 8.20±0.29 | 1051±24.83 | 3.65±0.40 |
| ANOVA ( P - Values) | | | | | | | |
| Source of Variations | | | | | | | |
| Breed | | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.001 |
| Feed | | 0.619 | 0.124 | 0.111 | 0.093 | 0.019 | 0.026 |
| Breed × Feed | | o.422 | 0.039 | 0.028 | 0.021 | 0.060 | 0.047 |

Standard commercial broiler diet based on corn without rice ($T_1$), 50% corn replaced by rice commercial diet ($T_2$), and 100% the corn replaced by rice ($T_3$).

### 3.1 Growth Performance

Average initial body weight of broiler chicken were 42.33, 41.67 and 43.33g for $T_1$, $T_2$, and $T_3$ feeding group respectively. Whereas the average initial body weight of native chicken were 29.67, 31.00 and 30.33g for $T_1$, $T_2$, and $T_3$ feeding group respectively. Initial body weight were significantly (P>0.01) higher in broiler chicken than native chicken. Body weights at five weeks of age were 1251, 1266, 1287g for $T_1$, $T_2$, and $T_3$ feeding group in broiler and 297.67, 314.33, 317.67g were $T_1$, $T_2$, and $T_3$ feeding group in native chicken respectively at same period. Body weight gain of broiler were 1208.67, 1224.33, 1244.67g for $T_1$, $T_2$, and $T_3$ feeding group respectively. Body weight gain of native chicken were 268, 283.33, 287.34g for $T_1$, $T_2$, and $T_3$ feeding group respectively.

Body weight gain at five weeks were significantly ($P>0.01$) higher in broiler than native chicken. The average daily gain (ADG) were 34.5, 34.98, and 35.53g in broiler for $T_1$, $T_2$, and $T_3$ feeding group respectively. Whereas 7.65, 8.09 and 8.20g in native chicken in $T_1$, $T_2$, and $T_3$ feeding group respectively at five weeks. Average daily gain (ADG) Significantly ($P>0.01$) differed at five weeks between broiler and native chicken. The replacement of corn for different proportions of rice in dietary treatments had no significant impact on the body weight and body weight gain of broilers and native chicken. Breeds and dietary feed interaction had no significant impact on the body weight or body weight gain among the groups.

### 3.2 Feed intake

Average feed intake of broiler were 2116, 2131, 2147g for $T_1$, $T_2$, and $T_3$ feeding group respectively for five weeks (Table 4). Native chicken consumed 1001,1057,1041g feed in $T_1$, $T_2$, and $T_3$ feeding group respectively which were half of the feed intake of broiler chicken. Feed intake increased slightly with the replacement of corn by rice during five weeks within the breeds but not statistically significant. Feed intake showed significant ($P>0.01$) differences between broiler and native chicken.

### 3.3 Feed Conversion Ratio (FCR)

Feed Conversion Ratio (FCR) of broiler chicken were 1.76, 1.74, and 1.72 for $T_1$, $T_2$, and $T_3$ feeding group respectively at five weeks. Feed Conversion Ratio (FCR) of native chicken were 3.78, 3.73, and 3.65 for $T_1$, $T_2$, and $T_3$ feeding group respectively. Feed conversion ratio (FCR) significantly ($P>0.01$) differed between broiler and native chicken (Table 4). Feed conversion ratio did not defer significantly ($P<0.01$) within the breed.

# DISCUSSION

## 4.1 Growth Performance

Growth performance were different in native and broilers chickens (Table 4). Growth is influenced by genotype of the birds, and by nutrition, hormones, tissue specific regulatory factors and other aspects of the bird's environment. In a stress-free environment, given adequate intake of essential nutrients, growth will increase until a genetically determined upper limit is reached. Results can be explained that the breed continued to influence on growth rate particularly native chicken has limitations in feed utilization (Punja, 1999; Thammabut and Choprakarn 1982).

Leotarague *et. al* 1997 reported that ADG of broiler were better in comparison to native chicken which were supported to our present findings. The low growth rate of village birds indicates that they had a low response to improved feeding management systems. Indigenous chickens in Malaysia under intensive systems of management showed lower live weights compared to the report of Jalaludin *et.al*, (1985) these were 380 g at 8 weeks and 1170 g at 15 weeks, that could be attributed to the level of protein in the feed (Yeong, 1992). Slow growth rate of desi (native) chicken as reported by Rao and Pillai (1986) and Paul *et al.,* (1990) may possibly be explained by inadequate nutrient availability to the birds. Growth also depends on both environment and heredity (Jull, 1952 and Reddy *et al.*, 1965). Piao *et al.,* (2002) evaluated the use of Chinese brown rice as an alternative energy source in pig feed, and showed that the nutrient digestibility was not significantly different in most nutrients and brown rice appeared to be a good alternative energy source that can replace yellow corn up to 100% in growing pigs. This is consistent with the results of current studies on broilers. Li *et al.,* (2004) reported the utilization rate of Chinese stored brown rice in pig feed, and found that neither extrusion nor enzyme supplementations are necessary for stored brown rice to be used in pig diets. A similar study also showed that brown rice is better than corn in apparent ideal digestibility, as well as in the metabolizable rate of amino acids and gross energy (Li *et al.,* 2002).

The starch content is higher in rice than in corn, and the amylose proportion as well as non-starch polysaccharide content are lower than in corn; moreover, the size is smaller than that of corn. Therefore, rice has better performance than corn (Mateos *et al.,* 2007; Vicente *et al.,* 2008) that is agreed to our present study. Nanto *et al.,* 2012 show that the rice-fed group had comparatively better growth performance in comparison to corn-fed group. This finding implies that rice may contain unknown growth factors, as was previously shown by Mateos *et al.,* (2007) who reported that the use of broken rice as a substitute for corn increases nutrient digestibility and improves performance in piglets. Similar findings reported by Nanto *et al.,* 2012, observed dehulled rice-fed group had better growth performance than the control, corn-fed group, which is in agreement with previous results (Panigrahi *et al.,* 1992; Jadhao *et al.,* 1999; GonzálezAlvarado *et al.,* 2007). The fact might be dehulled rice has more starch, less fiber and a lower moisture content than corn, and that rice starch has a smaller granule size (3 to 8 μm), lower amylose content, and less nonstarch polysaccharides than corn starch (Tester *et al.,* 2006), could be related to a better utilization by the chicks of nutrients contained in the dehulled rice compared with those contained in corn. Nanto *et al.,* (2012) observed that the final weight of broilers was higher when dehulled paddy rice was totally replaced corn in the diets. Also, Gonzalez-Alvarado *et al.,* (2007) found that broilers fed a diet containing dehulled paddy rice as main energy source yielded better performance as compare with those fed corn and belonged this impact to the lower fiber and higher starch contents in rice.

Regarding the effect of rice, our results are supported by Brum *et al.,* (2007), and even total replacement of corn with broken rice was found to have no negative impact on broiler performance (Shih *et al.,* 2014). Corn can be replaced with up to 100% broken rice in diets for laying Japanese quails without losses in productive performance reported by Sethi *et al.,* (2006) demonstrated that broken rice could replace up to 50% of dietary maize corn with no bad effects on quails growth performance. Present results agreed with Sittiya *et al.,* 2014 and revealed that rice can totally replace of corn in laying hen diets without harming egg production performance and quality. Similar results were observed in chicken, when corn was totally replaced by broken rice (Rao *et al.,* 2000). Our results are in agreement with Korver *et al.,* (2004) who found that genotype influenced body weight, feed intake and FCR. Genetic variation, between the strains could have resulted in body weight gain. Brum *et al.,* (2007) did not find any significant impact ($P>0.05$) on BWG when evaluating the replacement of corn by broken rice in broiler diets at the levels of 0%, 20% and 40%.

### 4.2 Feed Intake

Feed intake were different in native and broilers chickens (Table 4). In general, the nutrient requirements of birds are influenced by genotype and body size. Large sized birds tend to require more dietary nutrients than their small sized counterparts. The broiler group was significantly higher ($p< 0.01$) feed intake than in the native chicken group. In general, BWG increased by increasing feed intake, therefore, increased BWG in the broiler group could be attributed to higher feed intake. As regards to over all means of feed intake, it is obvious that the amount of feed consumed by broiler was significantly higher than native chicken throughout the experimental period. This is a logical result because broiler chickens are heavier than native chicken.

It is well-known that heavier strains consume more feed than lighter ones due to their increase maintenance requirements and appetite. In this respect EL-Hossary and Dorgham (1992) reached to the same conclusion. Differences in feed intake were reported by many investigators (EL-Kaiaty and Hassan 2004, Hassan *et al.,* 2006 and Fujimura *et al.,* 1995). Brum *et al.,* (2007) did not find any significant impact on feed intake when evaluating the replacement of corn by broken rice in broiler diets at the levels of 0%, 20% and 40%.

### 4.3 Feed Conversion Ratio

Feed was converted to meat efficiently when level of protein in the diet was increased. It is clear that FCR were significant (P>0.05) difference between two groups (Table 4.). The overall mean of broiler strain was significantly (P>0.05) higher than native chicken. This means that broiler was more efficient in converting the feed to growth during the experimental period which was supported by Fujimura *et al.,* (1991). Our findings were similar to results of Zhong (1995) who found that FCR differed within gender and strain. However, FCR value obtained in the present study were differ with that of Zhong *et al.,* (1995) and agreement with previous researchers (Palvink and Hurwitz, 1989; Cahaner Leenstra 1991), who reported that genotype and gender influenced overall FCR. Gonzales *et al.,* (1998) reported that genotype influence FCR. The FCR values of the native chicken of experimental diet were 3.65, 3.72 and 3.78 at 5 weeks which were lower than the result of Dou *et al.,* (2009) that was reported 4.41 for Chinese local breed Cushi and Fotsa *et al.,* (2007) reported 4.34-5.34 for different local breeds of Cameroun at 16 weeks of age. Native chicken as obtained the FCR of Betong chicks at 12 weeks of age (Nguyen *et al.,* 2010), this finding on FCR was in agreement with the result of the present study. Khan (2006) found that Bangladeshi indigenous grower chick's FCR was 4.08 at 10 weeks after feeding a commercial diet containing 19% crude protein and 2850 kcal ME/kg DM which was slightly higher than the result of our present findings. The differences in the FCR values of different types of indigenous chicks of different regions were quite logical.

Although no significant differences in feed conversion ratio (FCR) were noticed at five weeks of age of broiler with different treatments. This means replacement of corn by rice can be used in broiler diet. Ashour *et al.*, (2015), showed broken rice replaced (0, 10, 20, 30, 40 and 50 %) with maize on birds performance, feed utilization the improvement in effects FCR. On the other hand, Nanto *et al.*, (2015) reported that feeding broiler chicks with 43% whole-grain paddy rice with 6% soybean oil caused a normal performance. The results of the current study are in similar with the findings of Vicente *et al.*, (2008). Brum *et al.*, (2007) did not find any significant impact (P>0.05) on FCR when evaluating the replacement of corn by broken rice in broiler diets at the levels of 0%, 20% and 40%.

In conclusion rice could be considered as a valuable material in replacement of corn in broiler and native chicken diet without detrimental effect on growth performance. More studies are needed to investigate the effect of rice on growth performance of broiler and native chicken

# *CHAPTER II*

# Experiment 2: Differences in Growth Performance and Protein Metabolism Related Parameters of Broiler Chickens and Native Chickens (Niigata Jidori)

## ABSTRACT

This study was conducted to compare broilers and local chickens (Niigata Jidori) in terms of growth performance and protein metabolism-related parameters. Twenty 14-day-old chicks were housed individually in wire cages, fed experimental diets, and provided water adlibitum for 2 weeks. Growth performance, nitrogen retention, concentrations of free amino acids in muscles, as well as mRNA expression of liver IGF-1, breast muscle atrogin-1, and proteasome C2 subunit were determined. Body weight gain, feed intake, and feed efficiency were significantly higher ($P<0.01$) in broilers than in Niigata Jidori. Muscle weights (breast and thigh) and nitrogen retention were significantly higher ($P<0.05$) in broilers than in Niigata Jidori. Concentrations of free amino acids, viz., Asp ,Glu, Ala, Cys, Tyr, Lys, and Arg in breast muscle were significantly higher ($P<0.05$) in broilers than in Niigata Jidori. No significant differences were found in concentrations of Thr, Ser, Gly, and Val, Met, Ile, Leu, Phe, and His. There were no significant differences in mRNA expressions of liver IGF-I, breast muscle atrogin-1, and proteasome C2 subunit between broilers and Niigata Jidori. The growth performance of broiler and Niigata Jidori varied significantly but there was no change in mRNA expression related to protein metabolism between the two breed.

Keywords: Niigata Jidori; broiler; growth performance; gene expression

# INTRODUCTION

There are approximately fifty recognized breeds of native chicken in Japan and most of them were breed in Japan for special plumage and fighting traits. The Japanese native chicken Niigata Jidori is not included within those recognized breeds but available at Niigata prefecture of Japan. Niigata Jidori (Niigata chicken) is produced by $F_1$ (Tomaru × Nagoya ) × Plymouth Rock (Miyakoshi *et al.,*2005) like Hinai Jidori in Hinai area in north Akita prefecture of Japan. Hinaidori is one of the Japanese memorial native chickens. Since the memorial native chicken in Japan is prohibited to eat, $F_1$ of Hinaidori and Rhode Island Red is named as Hinai Jidori. The meat of Hinai Jidori is palatable and delicious for local dishes, Kiritampo. Fujimura *et al.,* (1991) have proved that the meat of Hinai Jidori is more tasteful than that of broiler. Broiler chicken have been genetically selected to improve the performance of meat production and genetic selection has led to high growth rate, feed efficiency and meat yield (Arthur and Albers, 2003).The body weight gain of broiler might be maximized at the period of 28 to 42 days of age (NRC, 1984) ; Hinaidori might be maximized by 42-56 days of age and the growth rate of Hinaidori was 20% slower than broiler at five weeks of age (Muramoto *et al.,* 1994) and three times slower than broilers (Fujimura *et. al.,*1994). Body weight gain (g/14 days) of Hinai Jidori male and female were 132.2 and 114.7 respectively (Muramato *et al.,* 1996). The meat and egg of indigenous chickens are widely preferred by consumers because of their lean meat (less fat and cholesterol), more protein content, taste, pigmentation and suitability for special dishes which even if they fetch premium prices compared to the products from exotic chickens (Horst, 1991; Islam and Nishibori, 2009).

Therefore, consumers feel no hesitation to pay more money for the indigenous chicken products and was almost double than that in broiler from chicken (Islam and Nishibori, 2009). The discrepancy in market price of these two types of chickens is still increasing in trend. Surprisingly meat of Niigata Jidori is seems too tasty as like Hinai Jidori as compared to broiler. Market price of Niigata Jidori is higher than broiler due to good taste.

Corn is the principal energy source in poultry diets, and it is also an important cereal for humans. In recent years, industry and human consumption of corn has been expanding rapidly, leading to inadequate supplies and high prices. This trend has necessitated a search for feedstuffs that could be used as an alternative of corn in poultry diets. Many studies have been published in replacing corn with alternative feedstuffs in layer diets such as water yam, Agwunobi, (1999) pearl millet (Abd-Elrazig and Elzubeir, 1998) as well as sweet potato and cassava meal (Aina and Fanimo 1997). One alternative is paddy rice (Momiroman; feed-type rice), which has been advocated for cultivation in Japan and is therefore available for use as a replacement for corn in poultry diets.

Similarly rice is one of the major cereals in the world, especially in Southeast Asia. Rice is utilized not only for human food but also for domestic animal feed. Recently, some researchers reported that dietary rice improved the growth performance of weaning piglets (Mateos *et al.,* 2006; Vincente *et al.*, 2008; Yagami &Takada 2017) and chicks (Gonzalez-Alvarado *et al.,* 2007; Ebling *et al.,* 2015) compared to dietary corn. Feeding rice to pigs and chicks is a common practice in many countries, but not in Japan. However, recently, the use of rice in broiler diets has been gaining attention in Japan. The size of rice starch granules is 3–8 lm, while that of cornstarch granules is 2–30 lm (Tester *et al.,* 2004). The level of non-starch polysaccharide (NSP) in rice grain is lower than that in corn, whereas rice has a higher starch content than corn (Choct 2002). Therefore, rice starch is expected to have more available substrates for digestive enzymes than corn starch. A study of feeding brown rice to broiler chicks suggested that brown rice could be used as an alternative to corn

(Gonzalez-Alvarado *et al.,* 2007). Gonzalez-Alvarado *et al.,* (2007, 2008) indicated that chicks fed rice had a larger empty body weight (BW) and smaller digestive tracts than chicks fed corn. Ebling *et al.,* (2015) reported that feeding white or parboiled rice to broiler chicks improved their growth performance. However, limited information is available on the use of rice as a feedstuff for broiler chicks. Recently, regulations have been proposed to reduce environmental load caused by broiler production. Nitrogen and phosphorus are main causative agents of environmental pollution in poultry production; it is crucial to decrease the amounts of these harmful agents.Since rice is a potential energy source, broken rice has been used for feeding trials in laying hen diets, and has achieved similar efficiency in regard to the utilization of energy (Jadhao *et al.,* 1999). In addition, brown rice is applied in raising pigs, and can replace yellow corn, even up to 100% (Piao *et al.*, 2002). Moreover, the price of brown rice is relatively lower than corn by approximately two-thirds (Piao *et al.,* 2002). Systematic studies suggest that meat quality parameters are highly influenced by dietary compositions (Wood *et al.,* 2008; López-Ferrer *et al.,* 2001). Ganabadi *et al.,* (2009) reported that indigenous chicken is always thought to be better in term of carcass composition than commercial broilers due to its low fat content.

Although information is not available about Niigata Jidori but recently, some researchers reported that dietary rice improved the growth performance of weaning piglets (Mateos *et al.,* 2007; Vicente *et al.,* 2008; Yagami and Takada 2017) and chicks (Gonzalez-Alvarado *et al.,* 2007; Ebling *et al.*, 2015, Fujimoto *et al.*, 2017) compared to dietary corn. Fujimura *et.al*., (1996) reported that there were no significant difference in amino acid content of Hinai Jidori and broiler, except cysteine and methionine. The levels of free amino acids in the thigh meat of eight weeks broiler were significantly higher than those of twenty two weeks Hinai Jidori chicken (Rikimaru and Takahashi, 2010).

IGF-I is known to be produced in liver, stimulates protein synthesis and inhibit protein breakdown. Saneyasu *et al.,* 2016, reported that the mRNA (IGF-I and atrogin-1) levels of protein metabolism-related factors in the breast muscle of 7 to 49 day-old broiler chickens.

In contrast atrogin-1 and proteasome C2 subunit, is proteolysis related factors gradually increased with age at mRNA levels (Saneyasu *et al.,* 2016). Insulin and Insulin like growth factor-I(IGF-I) are important positive regulators in protein synthesis (Glass, 2005; Tesseraud *et al.,* 2007;Sandri, 2008; Schiaffino *et al.,* 2013). IGF-I is known as one of the more predominant hormones necessary to support normal growth in chickens (Scanes, 2009; Boschiero *et al.,* 2013). Furthermore, IGF-I is also involved in growth hormone secretion and regulation (Piper and Porter, 1997; Spencer *et al.,* 1997; Rousseau and Dufour, 2007). In previous studies, the chicken IGF-I has been revealed to involve as many as 70 amino acids (Ballard *et al.,* 1990). IGF-I is a complex system of peptide hormones that bind to the insulin-like growth factor I receptor (IGFIR), in order to activate their intrinsic tyrosine kinase domain activities (Denley *et al.,* 2005). Additionally, the effect of IGF-I was observed on the protein synthesis of chicken embryo myoblast, cultured in a serum free medium (Kita and Okumura, 2001). Zhou *et al., (*2005) and Amills *et al.,* (2003) reported that polymorphism of the IGF-I gene in the promoter and 5′-untranslated region (5′-UTR) was directly associated with chicken growth rate. There were dramatically higher IGF-I concentrations in the high growth rate line chickens, than those in the low growth rate line chickens (Beccavin *et al.,* 2001).

Commercial chicken feed are mainly composed of locally grown or imported corn and soybean meals. The global demand for corn to be used in the production of animal feed and fuel is increasing rapidly. For the last one and half decades, corn production for fuel and poultry industries has been expanding, resulting in higher cost of corn and limiting its utilization in the feed industry (Vicente *et al.,* 2008; Czech *et al.,* 2014). It is necessary to seek lower cost by finding alternative energy sources instead of corn in poultry diets. Several studies have demonstrated that rice have potentials to offset this demand as a substitute for corn in poultry feed (Gonzalez-Alvarado *et al.,* 2007; Ebling *et al.,* 2015). Sittiya and Yamauchi (2014) demonstrated that paddy rice can probably be used as a good alternative cereal grain source in poultry diets (Sittiya, *et al.,* 2011).

Replacing the corn in part with rice might be a strategy to produce new type of diet of locally available ingredients. The effect of feeding rice to produce the consumer preferred chicken meat is already established by the researchers (Filgueira *et al.,* 2014; Miah, 2016). Better growth performance and nutrient digestibility could be obtained in broiler chickens if corn would be replaced by rice without any negative effect. Replacing the corn by rice might be a new strategy both in the indigenous and hybrid broiler chickens. Until today, there are limited reports available on the effect of feeding rice on growth performance, protein metabolism and meat characteristics of broiler and indigenous chicken. However, extensive research has not been done to determine the production potential of Japanese native chicken breeds. Their growth and other production parameters have not been adequately studied.

The present study was aimed to determine and compare the growth performance, tissue weights, nitrogen retention, free amino acids concentration in breast muscle, mRNA expression of IGF-I in liver, atrogin-1 and proteasome C2 sub unit in breast muscle of broiler and Niigata Jidori.

# MATERIALS AND METHODS

All animal experiments were conducted in compliance with the protocol reviewed by the Institutional Animal Care and Use Committee and approved by the President of Niigata University (Permit Number: Niigata Univ. Res.229-3).

## 2.1 Bird Husbandry, Diets and Experimental Design

Two types of chicken were used in this experiment Niigata—Jidori and Chunky broiler strain. One-day-old Niigata Jidori was purchased from Niigata Prefectural Animal Industry Research Center. Chunky broiler chicks were obtained from a local trading company. Thirty six day-old chicks were (18 Niigata Jidori and 18 chunky broiler) were reared on litter in a common brooder under identical environmental condition in same house for two weeks with free access to diet (Commercial broiler grower containing 22 %CP and 3050 kcal ME/kg) and water. Fourteen days old twenty birds (Ten Niigata Jidori and Ten Chunky broiler) were individually housed in a battery cages wire-mesh floor with free access to diet and water during the two weeks experimental period. The birds were kept under24 h lighting programs throughout the experiment. The temperature was maintained at 29˚C on the first day, and lowered by 1˚C every 3 days, to a final temperature of 24˚C. Body weight gain (BWG), and feed intake (FI) were recorded weekly and feed efficiency (FE) was calculated from BWG divided by FI. The composition of basal diet is presented in Table 1. The diet was formulated to meet or exceed nutrient recommendations for Ross-broiler chickens (Ross 308, 2014). The composition of basal diet is presented in Table 5.

**Table 5:** Composition and nutrient content of basal diets

| Ingredients | Ratio |
|---|---|
| Corn | 0.2455 |
| Rice | 0.2500 |
| Soybean meal | 0.3800 |
| Protein concentrate | 0.0300 |
| Oil | 0.0500 |
| Dicalcium phosphate | 0.0174 |
| Rice polish | 0.0121 |
| Salt | 0.0050 |
| Lysine | 0.0020 |
| methionine | 0.0040 |
| limestone | 0.0010 |
| vitamine Premix | 0.0020 |
| Total | 1.0000[1] |
| CP | 24.55 |
| Lys | 1.42 |
| Ca | 0.96 |
| Met+Cys | 1.15 |
| ME(kcal/kg) | 3128 |

[1]Provided the following ( per kg of diet ) :Mn, 100ng; Zn,100ng; Fe, 40ng; Cu,15ng; I, 1mg; Vitamine A, 130 IU; Vitamine D, 35,000IU; Vitamine E, 80IU; Vitamine K,4mg; Thiamine monohydrate,4mg; iboflavin, 9mg; Vitamin B6 64mg; Vitamine B12, 0.02mg; pantothenate,15mg; nicotinamido 60mg; folic acid, 2mg; biotino.15mg

### 2.2 Sample Collection and Weight Measurement

Data were recorded in terms of initial body weight, weekly body weight and weekly feed consumption during the study periods. Necessary calculations were made for weekly body weight gain, daily body weight gain, and daily feed consumption and feed efficiency parameters. The excreta were collected during the last five days of the experimental period and stored at -30˚Cuntil for the analysis of nitrogen retention. At the end of the experiment BW and FI were measured.Weight gain was measured by deducting initial weight from live weight. Feed was weighed using a top loading balance each time before introducing into the feeding trough and again weighed at the end of the week, and the difference was determined and recorded as the feed consumed each week for each bird. The mean feed consumption per bird was determined by dividing the total amount of feed consumed per birds in week. Feed conversion ratio was measured by dividing the feed intake by the body weight gain for a given period. Mortality of chickens was recorded and survivability was calculated. All birds were killed by exsanguinations and dissected. Right side breast and thigh muscle weights, and liver weights were recorded. A part of liver and breast muscle were immediately removed and stored at -80˚C until analysis.

### 2.3 Nitrogen Retention Analysis

Nitrogen balance trials were performed by a total collection procedure. Before analysis, excreta samples were thawed, dried at 60˚C for 24 h and finely ground. The total nitrogen content in the samples was measured using a carbon/nitrogen analyzer (Sumika Nc-90a, Sumitomo Chemical Co., Ltd, Tokyo, Japan). Nutrient retention (g/bird) was calculated as nutrient intake (g/bird) minus nutrient excretion (g/bird). Nutrient retention (%) indicates the percentage of nutrient retained by the bird as a function of nutrient intake, and it was calculated as follows:

Nutrient retention (%) = [nutrient retention (g/bird)/ nutrient intake (g/bird)]*100

## 2.4 Concentration of Free amino acids

For analyzing the concentration of free amino acids (FAA) in the breast muscle, 1.0g of muscle tissues were finely cut using scissors and kept on icein9 ml of 3.5% sulfosalicylic acid and homogenized using a polytron-type homogenizer. Then the mixtures were refrigerated for 48h. The mixtures were centrifuged at 23,000×g for 30 min at 4˚C, and the top clear layer of the mixture was removed using a syringe and filtered through a 0.45 µm cellulose nitrate filter. The samples were stored at -30˚C in a freezer until analysis. Free amino acids concentrations in the breast muscle were analyzed via HPLC (LC-10A system, Shimazu, Kyoto) using shim-Pak amino-Na column.

## 2.5 mRNA Isolation and Real Time PCR Analysis

mRNA expression of liver IGF-I, breast muscle atrogin-1 and proteasome C2 subunit were measured in liver and breast muscle samples. Total RNA was extracted using TRIzol Reagent (Invitrogen Life Technologies, USA) according to the manufacturer's protocols. cDNA was synthesized from 200 ng/µl of total RNA using ReverTra Ace qPCR RT Master Mix with gDNA Remover (TOYOBO). The sequences of the forward and reverse primers are shown in Table 6. Gene expression was measured by realtime PCR using an MJ Mini Personal Thermal Cycler (Bio-rad) with SsoFast EvaGreen Supermix (Bio-rad). Glyceraldehyde-3phosphate dehydrogenase (GAPDH) expression was used as an internal control.

**Table 6:** Gene and related primers

| Genes | Primer sequence |
|---|---|
| IGF-I | F: 5'-GCTGCCGGCCCAGAA-3' |
| | R: 5'-ACGAACTGAAGAGCATCAACCA-3' |
| Atrogin-1 | F:5'-ACGAACTGAAGAGCATCAACCA-3' |
| | R:5'-ACGAACTGAAGAGCATCAACCA-3' |
| Proteasome C2 subunit | F:5'-AACACACGCTGTTCTGGTTG-3' |
| | R:5'-CTGCGTTGGTATCTGGGTTT-3' |
| GAPDH | F:5'-CCTCTCTGGCAAAGTCCAAG-3' |
| | R:5'-CATCTGCCCATTTGATGTTG-3' |

### 2.6 Statistical Analysis

Data were presented as means ± SEM. Data were analyzed using t-test. P-value <0.05 was considered statistically significant and a tendency toward significant was considered when the $p$-value > 0.05 but < 0.10.

# RESULTS

## 3.1 Growth Performance

The result of growth performance is presented in Table 7. The initial weight of Niigata Jidori was less than that of broiler (165 and 248 g, respectively), even though all chickens were of the same age when experiment started which affected the final body weights. Body weight gain per day for 0-1 weeks and 1-2 weeks in broiler group were significantly higher (*p*<0.01) than those of Niigata Jidori.The average daily gain (ADG) for 0-1 weeks, 1-2 weeks and 0-2 weeks were 66±3, 89±4, and 78±3 in broiler group. The average daily gain (ADG) for 0-1 weeks, 1-2 weeks and 0-2 weeks of Niigata Jidori group were 18±1, 22±1 and 20±1 g/d. The average daily gain (ADG) for 0-1 weeks, 1-2 weeks and 0-2 weeks in broiler group were significantly higher (*p*<0.01) than those of Niigata Jidori.

**Table 7:** Differences of growth performance in broiler (n=10) and Niigata Jidori (n=10)

| Parameters | Broiler (Mean**± SE** ) | Jidori (Mean**± SE** ) | *p-value* |
|---|---|---|---|
| Initial body wt. | 248±6 | 165±1 | <0.001 |
| Body Weight Gain (g/d) | | | |
| 0-1wk | 66±3 | 18±1 | <0.001 |
| 1-2wk | 89±4 | 22±1 | <0.001 |
| 0-2wk | 78±3 | 20±1 | <0.001 |
| Feed Intake (g/d) | | | |
| 0-1wk | 74±3 | 41±3 | <0.001 |
| 1-2wk | 119±6 | 45±3 | <0.001 |
| 0-2wk | 96±3 | 43±2 | <0.001 |
| Feed Efficiency (gain/feed) | | | |
| 0-1wk | 0.92±0.05 | 0.45±0.04 | <0.001 |
| 1-2wk | 0.75±0.03 | 0.50±0.03 | <0.001 |
| 0-2wk | 0.86±0.05 | 0.47±0.02 | <0.001 |

### 3.2 Feed Intake

The result of feed intake is presented in Table 7. The feed intake of Niigata Jidori was less than that of broiler throughout the experimental period. Feed intake for 0-1 weeks, 1-2 weeks and 0-2 weeks in broiler group were 74±3,119±6 and 96±3 g/day, respectively. Feed intake of Niigata Jidori for 0-1 weeks, 1-2 weeks and 0-2 weeks were 41±3, 45±3 and 43±2 g/day, respectively. The feed intake in the broiler group was significantly higher ($p<0.01$) during all periods than the Niigata Jidori .

### 3.3 Feed Efficiency

The result of feed efficiency is presented in Table 7. The feed efficiency (FE) of Niigata Jidori at 0-1 weeks and 1-2 weeks was lower than broiler. Feed efficiency for 0-1 weeks, 1-2 weeks and 0-2 weeks in broiler group were 92±0.05, 75±0.03 and 86±0.05 g/day respectively. Feed intake of Niigata Jidori for 0-1 weeks, 1-2 weeks and 0-2 weeks were 45±0.04, 50±0.03 and 47±0.02 g/day respectively. The FE was also significantly ($p<0.01$) higher in broiler group compared to Jidori group and it was about two times higher in broiler than the Niigata Jidori. Growth performance in terms of body weight gain, ADG, FI and FE of Niigata Jidori were inferior to that of broiler.

### 3. 4 Tissue Weight

Muscle weight (breast and thigh) and liver weights are shown in Table 8. Breast muscle weight of broiler and Niigata Jidori were 73±3.9 and 9.4±0.43g respectively. Thigh muscle weight of broiler and Niigata Jidori were113±4.9 and 35±1.2g respectively. Liver weight of broiler and Niigata Jidori were 32±1.1 and 13±0.53g respectively. In our study we found breast muscle and thigh muscle weights were significantly higher ($P<0.01$) in the broiler group than in the Niigata Jidori at 4 weeks of age.

Similarly significant (p< 0.01) difference was found in liver weight between broiler and Niigata Jidori in present study.

**Table 8**: Tissue weights in broiler and Niigata Jidori

| Parameters | Broiler | Jidori | P-value |
|---|---|---|---|
| Liver weight (g) | 32±1 | 13±1 | <0.01 |
| Breast muscle | 73±4 | 9±0.4 | <0.01 |
| Thigh muscle | 113±5 | 35±1 | <0.01 |

Mean+SE, n=10

### 3.5 Nitrogen Retention

Table.9 shows the results of nitrogen retention in broiler and Niigata Jidori. Nitrogen retention percent in the broiler and Niigata Jidori group were 72.66 and 57.1 respectively. Nitrogen retention in g/b/day in the broiler and Niigata Jidori group were 3.32 and 0.98 respectively. Nitrogen retention in percentthe broiler group was significantly higher (P< 0.05) than that in the Jidori group (*p*<0.05) and also in g/b/day the broiler group was significantly higher (P< 0.01) than that in the Jidori.

Table 9: Nitrogen retention in broiler and Niigata Jidori

| | Broiler | Jidori | *p-value* |
|---|---|---|---|
| Nitrogen retention ( % ) | 72.66129 | 57.1 | *<0.05* |
| Nitrogen retention ( g / days) | 3.32 | 0.98 | <0.001 |

Mean+SE, n=10

### 3.6 Concentration of Free Amino Acids

Free amino acids concentration in breast muscle of broiler chicken and Niigata Jidori are shown in Table 10. Seventeen amino acids were considered. The concentrations of aspartic acid, glutamic acid, alanine, cysteine, tyrosine, lysine and arginine were significantly ($p$<0.05) higher in broiler than in Niigata Jidori. On the other hand, no significant difference was found in the concentration of threonine, serine, glycine, valine, methionine, isoleucine, leucine, phenylalanine, tryptophan and histidine.

**Table 10:** Free amino acids concentration in breast muscle of broiler and Niigata Jidori (μmol/g)

| Free amino acids | Broiler | Jidori | p-value |
|---|---|---|---|
| Asp | 0.65±0.07 | 0.40±0.07 | <0.05 |
| Thr | 0.92±0.14 | 0.98±0.02 | |
| Ser | 1.23±0.16 | 0.88±0.16 | |
| Glu | 2.35±0.32 | 1.44±0.26 | <0.05 |
| Gly | 0.97±0.22 | 0.53±0.10 | |
| Ala | 2.41±0.25 | 0.80±0.12 | <0.01 |
| Val | 0.18±0.03 | 0.25±0.04 | |
| Cys | 7.63±1.48 | 1.34±0.32 | <0.05 |
| Met | 0.10±0.01 | 0.15±0.02 | |
| Ile | 0.11±0.02 | 0.13±0.02 | |
| Leu | 0.20±0.04 | 0.18±0.03 | |
| Tyr | 0.48±0.05 | 0.23±0.05 | <0.01 |
| Phe | 0.19±0.02 | 0.16±0.02 | |
| Trp | 0.08±0.01 | 0.08±0.01 | |
| His | 0.08±0.02 | 0.11±0.01 | |
| Lys | 0.33±0.03 | 0.95±0.32 | <0.05 |
| Arg | 0.17±0.04 | 0.53±0.11 | <0.05 |

Note: Amino acid concentrations were calculated as an equivalent to 1g weight/ml.

Mean+SE, n=10

### 3.7 mRNA Expression

Figure 1 shows the gene expression (mRNA) of IGF-I in liver of broiler and Niigata Jidori. Broiler showed higher IGF-I as compare to Niigata Jidori but difference was not significant. Figure 2 shows the gene expression (mRNA) of Atrogin-1 in breast muscle of broiler and Niigata Jidori. Broiler showed higher Atrogin-1 as compare to Niigata Jidori but no significant difference were found. Figure 3 shows the gene expression (mRNA) of breast muscle proteasome C2 subunit in broiler and Niigata Jidori the difference was not significant.

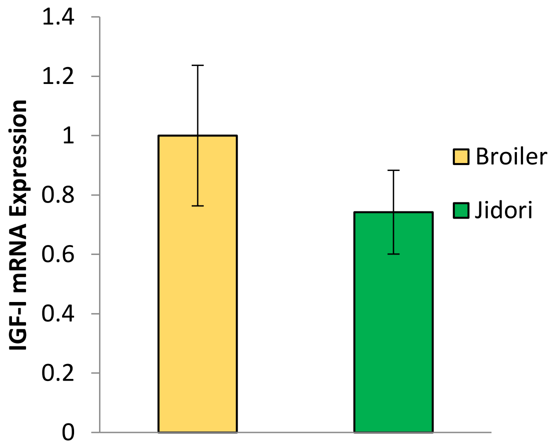


Figure 1 IGF-1 mRNA expression in broiler and Niigata Jidori.
Values are mean ±SE, n=10

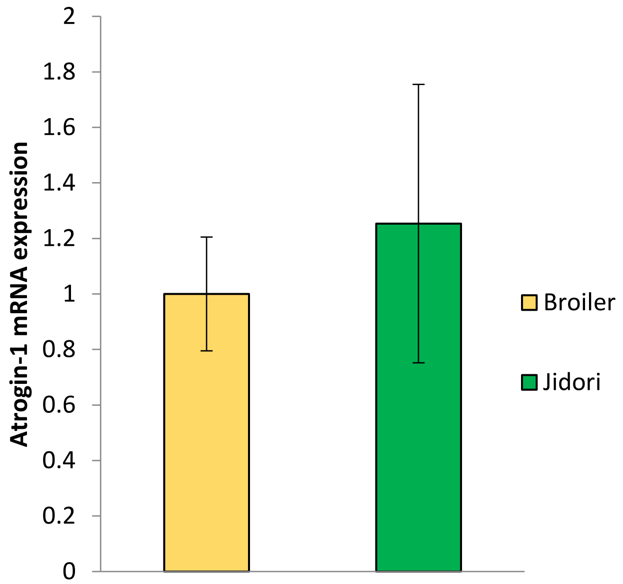


Figure 2 Atrogin-1 mRNA expression in broiler and Niigata Jidori.
Values are mean ±SE, n=10

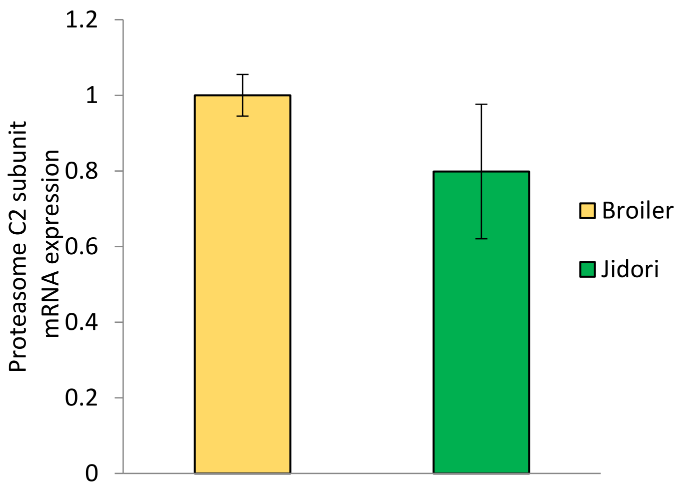


Figure 3 Proteasome c2 subunit mRNA expression in broiler and Niigata Jidori. V alues are mean ±SE, n=10

# DISCUSSION

## 4.1 Growth Performance

In the present study, growth performance were clearly different in broiler and Niigata Jidori (Table 7). BWG at 0-1 weeks and 1-2 weeks were significantly higher ($P<0.01$) in broilers than that of the Niigata Jidori. The body weight of two and four weeks broiler were significantly higher ($P<0.01$) than that of the Niigata Jidori in our study which were higher than the results of Jaturasitha *et al.,* (2002) and Yeong, (1992). The increase in body weight of hybrid appeared to be associated with an increase in feed and water intake (Marks, 1979; Siegel and Wisman, 1966). Growth is influenced by genotype of the birds and low growth rate of village birds indicates that they had a low response to improved feeding management systems (Mupeta *et al.,* 2003).Similar findings showed by Punja, (1999); Thammabut and Choprakarn (1982) and explained that the breed continued to influence on growth rate particularly native chicken has limitations in feed utilization. The average daily gain (ADG) at 0-2, weeks of Native chicken was inferior ($p<0.01$) compared to that of broiler reported by Jaturasitha *et al.,* 2002. Leotarague *et.al* (1997) found that the average daily gain of broiler were better in comparison to native chicken. Which were supported to our present study. Slow growth rate of desi (native) chicken as reported by Rao and Pillai (1986) and Paul *et al.,* (1990) may possibly be explained by inadequate nutrient availability to the birds. Growth also depends on both environment and heredity (Jull, 1952 and Reddy *et al.*, 1965). Jalaludin *et.al.*, (1985) showed lower growth rate of indigenous chickens compare to broiler in Malaysia under intensive systems of management.

## 4.2 Feed Intake

The average amount of feed intake is shown in Table 7. For all periods, feed intake of the broiler were significantly higher ($p < 0.01$) than that of the Niigata Jidori. In general, body weight gain increases with increasing feed intake, therefore, increased body weight gain in the broiler group may be attributed to higher feed intake. The nutrient requirements of birds are influenced by genotype and body size. As regards to over all means of feed intake, it is obvious that the amount of feed consumed by broiler was significantly higher than that of the Niigata Jidori chicken throughout the experimental period. This is a logical result because broiler chickens are heavier than Niigata Jidori chicken. It is well-known that heavier strains consume more feed than lighter ones due to their increase maintenance requirements and appetite. In this respect EL-Hossain and Dorgham (1992) reached to the same conclusion. Also differences in feed intake were reported by many investigators (EL-Kaiaty and Hassan 2004, Fujimura *et al.,* 1995).

## 4.3 Feed Efficiency

Feed efficiency of broiler was better ($p < 0.01$) than that of Niigata Jidori. This means that broiler was more efficient in converting the feed to growth during the experimental period which was supported by Fujimura *et al.,* (1994). Jaturasitha *et al.*,(2002) and Mupeta *et al.*,(2003) observed hybrid chickens were significantly more efficient in feed conversion at all phases of growth than village chicken in Zimbabwe and this report were supported to our present findings. This can be explained by generally that the breed continued to influence on growth rate particularly native chicken has limitations in feed utilization (Punja,1999;Thammabut and Choprakarn 1982) and hence FCR and ADG of broiler were better in comparison to native chicken (leotarague *et al.,* 1997 and Theeraphanthuwat *et al.,* 1988). For Growth performance in terms of BWG, FI and FE Niigata Jidori were inferior to that of broiler. The overall mean of broiler strain were significantly higher ($p< 0.01$) than Niigata Jidori.

Lower BWG, FI, and FE in Niigata Jidori may be explained by the following; native chickens such as Niigata Jidori, which are not bred with focus on the growth rate, show limited feed utilization (Thammabut and Choprakarn 1982), hence, FE and BWG of broilers were better than those of native chickens (Leotaragul,1996). Slow growth rates of native chickens have been previously reported by Rao and Pillai (1986) and Paul *et al.,* (1990) and may possibly be explained by inadequate nutrient availability for these birds. With regards to FI, it is obvious that the amount of feed consumed by broilers was significantly higher than that consumed by Niigata Jidori. This is an expected observation because broiler chickens are heavier than Niigata Jidori. Additionally, it is well-known that, owing to their higher maintenance requirements and appetite, heavier strains consume more feed than do lighter ones. Concerning FE, it is clear that there was a significant difference between broilers and Niigata Jidori. The overall mean FE in broilers was significantly higher than that in Niigata Jidori. This means that broilers were more efficient in converting the feed to growth during the experimental period.

### 4.4 Tissue Weight

Weights of breast muscle, thigh muscle, and liver were also higher ($P< 0.01$) in broilers than in Niigata Jidori (Table 8). In our study, the main factor affecting weights of breast and thigh muscles appear to be the genotype of a chicken. Muscle weights (breast and thigh) of broilers were significantly higher ($P<0.01$) than those of Niigata Jidori. These findings are similar to those of previous reports (Rikimaru *et al.,* 2009, Brake *et al.*, 1993, Poltowicz and Doctor, 2012). Poltowicz and Doktor (2012) reported lower breast and leg meat yields in native chickens when compared with broilers those are agreed with our findings. Broiler performed more in terms of breast and thigh meat yield than indigenous chicken reported by Hossain *et al.,* 2012. Similarly liver weight of broiler was significantly higher than those of Niigata Jidori which is consistant with Rikimura *et al.,* (2009), Jaturasitha *et al.,* (2002), Hossain *et al.,* (2012).

**4.5 Nitrogen Retention**

Nitrogen retention have a close relationship with the efficiency of protein utilization. Dietary protein have a positive correlation with protein consumption, while nitrogen retention influenced by protein consumption. Nitrogen retention in the broiler group was significantly higher than that in the Niigata Jidori (Table 9) suggesting that feed intake broilers not only improves BWG, but also had positive effects on nitrogen metabolism. This is similar to the findings of Mbajiorgu *et al.,* (2011), Labadan *et al.,* (2001) and Ng'ambi, *et al.,* (2009). Grana *et al.,* (2013) reported more or less similar (61.5%) nitrogen retention in broiler. Nitrogen retention is also influenced by dietary energy supply. It was still supported by the finding of Suthama (2010), when dietary energy is not available enough, although protein as a substrate is available, it can inhibit the utilization of nitrogen or nitrogen retention process. Because of higher nitrogen retention, higher breast and thigh muscle weights were detected in broilers than in Niigata Jidori, and this may be due to increased protein synthesis and decreased protein (amino acids) degradation in broilers than in Niigata Jidori.

### 4.5 Concentrations of Free Amino Acids

Concentrations of free amino acids (FAA) and inosine monophosphate are thought to be correlated with the palatability of chicken meat (Matsuishi *et al.*, 2005, Karasawa and Hirakata 1989, Nishimura *et al.*,1988). Among the FAA, alanine and tyrosine concentrations were significantly higher (P< 0.01) and aspartic acid, glutamine and cysteine concentrations were also significantly higher (P< 0.05) in tissues of broilers than in tissues of Niigata Jidori (Table 10) which were agreed with Rikimaru and Takahashi (2010). No significant difference was found in the concentration of threonine, serine, glycine, valine, methionine, isoleucine, leucine, phenylalanine, tryptophan and histidine. However, serine, glycine, leucine and phenylalanine were slightly higher in Niigata Jidori as supported by Fujimura *et al.*, (1996). Serine and alanine were above its threshold level**.** In the fraction of essential amino acids, the predominant amino acids were the tryptophan and threonine whereas alanine was superior found in the non-essential fraction, followed by serine while lowest values were reported for arginine among treatments. Glutamic acid which is one of the most important amino acid in chicken meat regarding of enhancing the flavor of meat either combination with other test-associated compounds or it's by self (Kurihara, 1987). Glutamic acid in native chicken was higher than broiler that is agreed with the study conducted by (Ahn and Park, 2002). Ali, *et al.,* (2019) reported umami or savory amino acid, glutamic acid content in 2A (Native chicken) was highest among the all groups. The flavor related amino acids, valine, isoleucine, leucine, phenylalanine, arginine, and proline were significantly higher in Native chicken among the groups (Ali, *et al.,* 2019). The Korean native chickens are superior in flavor than broiler supported by (Choe *et al.*, 2010). It is however, tasty amino acids, asparagine, threonine, serine, glutamic acid, glycine, and alanine contents were significantly higher in Native chicken than broiler (Ali, *et al.*, 2019). Moreover, broiler had higher cysteine which is sulfur containing amino acid but lower content of methionine than other groups reported by Ali, *et al.*, (2019). Subsequently Niigata Jidori contained more flavor producing amino acid than broiler.

**4.7 mRNA Expression**

However, no significant difference was found in mRNA expression of liver IGF-I between broiler and Niigata Jidori. Similarly no significant difference was found in mRNA expression of IGF-I in liver that was reported by Ballard *et al.*, (1990). A significant and positive correlation between mRNA expression levels and steady-state IGF-I gene expression was reported in liver tissue of domestic fowl (Rosselot *et al.*, 1995). It has also been reported that IGF-I stimulated muscle protein synthesis and suppressed proteolysis Fang *et al.*, (1998 and Hong *et al.*, 1994). Thitima *et al.*, (2017) compare the expression of Insulin like growth factor-1 (IGF-1) in Thai indigenous chicken and commercial broiler found significant difference between the broiler and Indigenous chicken those were disagreement with our present findings. The brain tissue IGF-1 gene expression was higher in Thai indigenous chicken than commercial broiler ($P < 0.05$), but no significant difference in the other tissues. They also demonstrated that IGF-1 expression has no effect with growth performances in Thai indigenous chicken and commercial broilers but might affect with muscle fiber type.

The IGF-1/Akt/mTOR pathway is a crucial regulator of skeletal muscle hypertrophy and can prevent muscle atrophy in vivo (Bodine *et al.*, 2001b). The Akt/mTOR pathway has a prominent role in increased protein synthesis associated with muscle hypertrophy and is also thought to have a role, when chronically deactivated, in the progression of muscle atrophy (Bodine *et al.*, 2001b).

Li *et al.,* (2019) reported that thigh muscle tissue of commercial broiler chicken has revealed lower expression of E3 ubiquitin ligase muscle atrophy F-box (MAFbx or Atrogin-1) compared with Red Jungle Fowl (RJF) ancestor. Given the crucial role of Atrogin-1 in the degradation of myogenic factors, they speculate that the differential expression pattern of this gene might in part account for the skeletal muscle mass in the broiler. Lower levels of Atrogin-1 in broiler could be associated with lower muscle catabolism and more muscle mass. Subsequently, they also performed an expression analysis of Atrogin-1 in the five different breeds, the expression of Atrogin-1 in RJF and broiler were the highest and lowest, respectively. Besides that, the expression of Atrogin-1 in local chickens was also higher than in broiler chickens.

On the contrary, both atrogin-1 and proteasome C2 subunit are proteolysis stimulating factors. In this experiment, however, mRNA expressions of these factors did not differ significantly between broiler and Niigata Jidori. These results, therefore, suggest that protein metabolism between broilers and Niigata Jidori is not so different.

# CONCLUSION

Growth performance between broiler and Niigata Jidori differed significantly. Some free amino acids concentrations in breast muscle were significantly different between broiler and Niigata Jidori. These differences in FAA concentrations might lead to difference in taste in meat of Niigata Jidori. Higher nitrogen retention was found in broiler than Niigata Jidori. However, no significant difference was observed in mRNA expression in IGF-I, atrogin-1 and proteasome C2 subunit between broiler and Niigata Jidori, suggesting that protein metabolism between broiler and Niigata Jidori is not so different.This study may have notable contribution to the growth performance of Niigata Jidori

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