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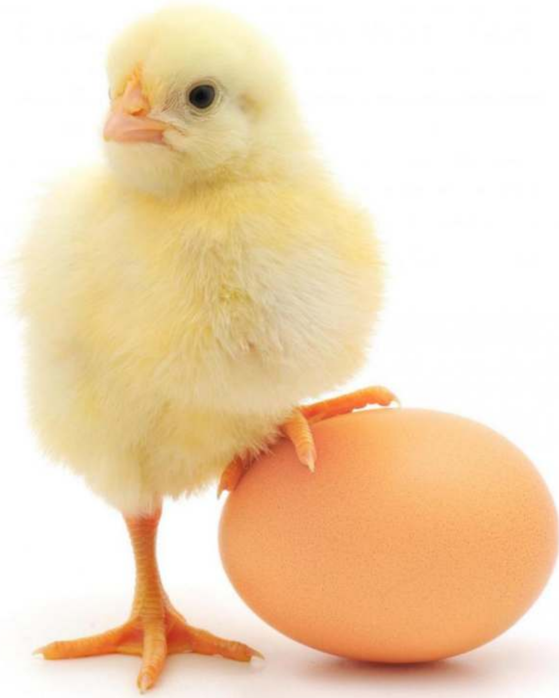

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Growth Performance and Gut Development of Japanese Quails (*Coturnix coturnix japonica*) Fed Diets with Different Ratio of Mash and Pellet

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Abstract: The experiment was conducted to investigate the effect of different ratio of pellet and mash diets on performance and gut development of Japanese quails. A total of 600 quails were used in completely randomized design with 6 dietary treatments and 5 replicates of 20 quails. Dietary treatments were included of: (A) control group (100% mash); (B) 50% mash+50% pellet; (C) 75% mash+25% pellet; (D) 25% mash+75% pellet; (E) choice feeding (pellet or mash) and (F) 100% pellet. Performance parameters were determined in different growth periods. Carcass characteristics, digestive organs weight and intestinal morphology were measured at 35 day of age by slaughtering two birds per pen. Feed consumption in diet C significantly decreased and in diet D increased ($p<0.05$). Quails fed with diet D had the maximum daily weight gain ($p<0.05$). Dietary treatments had no significant effect on feed conversion ratio. The best carcass yield, greatest villus height and crypt depth in jejunum was observed in quails in diet D. Small intestine length, pancreas and proventriculus weight were not significantly affected by dietary treatments. In conclusion, feeding quails by 25% mash+75% pellet diets improved growth performance and morphometric characteristics of small intestine.

Key words: Japanese quail, pellet, mash, performance, gut development

INTRODUCTION

Different feed forms (pellet, mash or Crumble) that to be supplied to broiler are the most important factor which directly influence the cost of mixed feed and growth performance of poultry (Lotfipour and Shakeri, 2013). Mash diet gives greater unification of growth and less death loss and is more economical. However, ground feed is not so palatable and does not retain their nutritive value so well as ungrounded feed (Jahan *et al.*, 2006). Pellet system of feeding is really a modification of the mash system. It consists of mechanically pressing the mash into hard dry pellets (North and Donald, 1994). Compared to mash diet, the feeding of pellets improves growth performance (Karahan *et al.*, 2011), however the incidence of sudden death syndrome was significantly higher for broilers fed on crumble-pellet or ground crumble-pellet form diet than for birds fed on mash (Ghazi *et al.*, 2012).

Gut development, HCl production and endogenous enzymes secretion maybe influenced by feed form and diet composition (Gonzalez-Alvarado *et al.*, 2007). One of the effective factors on composition and carcass traits of poultry is physical form of diet (Sabeghi, 1996). Gizzard promotion is a key point that can gain by feed size management (Engberg *et al.*, 2004). The beneficial effects of pelleted feed on digestibility of nutrients may arise from their influence on intestinal morphology (Amerah *et al.*, 2007). Zang *et al.* (2009) reported that birds fed pellet diet in comparison with birds fed mash diet had more intestinal villus height and less crypt depth.

There are extended trials about pellet and mash diets but limited research work has been performed to investigate the effect of feeding combination of pellet and mash diets in poultry. The present experiment was conducted to investigate the effect of different ratio of mash and pellet diets on performance and gut development of Japanese quails.

MATERIALS AND METHODS

In this experiment, 600 day-old Japanese quails mixed sex were allocated to 6 treatments and 5 replicates of 20 quails in completely randomized design for 1 to 35 d. Feed and water were provided *ad libitum* throughout the trial. Dietary treatments included of: (A) control group (100% mash); (B) 50% mash+50% pellet; (C) 75% mash+25% pellet; (D) 25% mash+75% pellet; (E) choice feeding (pellet or mash) and (F) 100% pellet. The composition of diet and calculated nutrients are presented in Table 1 (NRC, 1994). Feed intake (FI), daily weight gain (DWG) and Feed conversion ratio (FCR) were measured weekly and in overall growth period.

At the end of the experiment (35 d) two birds close to the mean body weight of the pen were individually weighed

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and slaughtered. Carcass and abdominal fat were excised, weighed and finally calculated as a percentage of live body weight. Moreover, in order to evaluate the digestive organs, proportions of liver, gizzard, pancreas, proventriculus, duodenum, jejunum, ileum and cecum to live body weight were calculated. The length of intestinal segments included of duodenum, jejunum and ileum also were measured separately.

Intestinal morphology was evaluated by sampling on day 35, when two birds of each pen were slaughtered and intestinal samples were taken immediately from the jejunum and ileum. Samples were taken to evaluate the villus height, crypt depth and villus height to crypt depth ratio.

The data were subjected to analysis of variance procedures suitable for a completely randomized design using the General Linear Model procedures of SAS Institute (1998). Means were compared using LSD. Statements of statistical significance were based on $p<0.05$.

RESULTS AND DISCUSSION

As Table 2 indicates, in overall growth period quails fed diet D (25% mash+75% pellet) had the greatest feed intake ($p<0.05$). By physical feed processing, nutrient availability increase and lead to more feed intake, also, quails tend to consume coarse particle size than fine particle size. These results are in accordance with the results of Ghasemi Nezhad (2013) on broiler chicks. In another experiment Jerry and Ibtisam (1989) announced that broilers fed by pellet diet had higher feed intake, because they preferred coarse particle size to mash diets. Likewise, Lemme *et al.* (2006a) showed that feed intake of broilers fed with high quality pellet was higher than mash diet. Totally, broiler chicks used to select coarse particle size and by this habit they pick up bigger particle size. Unlike present experiment, Parsons *et al.* (2006) stated that broiler chicks fed mash diet achieved more nutrient than broilers fed pellet or pellet combination with mash. According to Table 2, dietary treatments had significant effect on daily weight gain in overall growth period ($p<0.05$) and quails fed with diet D (25% mash+75% pellet) had the greatest daily weight gain. Most of the mentioned treatment included of pellet and pellet contains more nutrients and energy. Also, heat and pressure in pellet production provide an appropriate condition for growth. Some researchers believe that diet in pellet form contain more energy and protein; energy consumption for feed harvest is less and finally feed intake is higher (Galobart and Moran, 2005; Van biljon, 2005; Lemme *et al.*, 2006b; Huang and De Beer, 2011). Ghazi *et al.* (2012) declared that ideal performance in broiler chicks were gotten when they fed pellet diet, while feeding mash diet decreased their feed intake, live body weight but feed conversion ratio increased. Above results are agree with present results

Table 1: Ingredients and composition of diet

Ingredients (%)	
Corn (8.5%)	52.1
Soybean meal (44%)	42
Soybean oil	2.3
Carbonate calcium	1.3
Dicalcium phosphate	1.4
Salt	0.25
Vitamin premix[1]	0.25
Mineral premix[2]	0.25
DL-Methionine	0.15
L-Lysine.HCl	0.1
Calculated composition	
Metabolizable energy (Kcal/kg)	2916
Crud protein (%)	22.9
Methionine+Cystein (%)	0.87
Lysine (%)	1.34
Calcium (%)	0.93
Available phosphorous (%)	0.33

[1]Each 2.5kg of vitamin premix contained: vitamin A, 14000000 IU; vitamin D3, 6000000 IU; vitamin E, 40000mg; vitamin K3 2640mg; thiamine, 3000mg; riboflavin, 6800mg; pantothenic acid, 20g; niacin, 50g; pyridoxine, 6800mg; cyanocobalamin, 15mg; biotin, 200mg; folic acid, 1900mg; choline chloride, 240g. [2] Each 2.5kg of mineral premix contained: Mn, 100g; Zn, 100g; Fe, 51g; Cu, 15g; I, 1000mg; Se, 300mg

Table 2: Effect of dietary treatments on growth performance of quails in overall growth period (1-35 d)

Dietary treatments*	DFI g/d/bird	DWG g/d/bird	FCR
A	11.2^{bc}	4.0^{ab}	2.82
B	11.1^{bc}	4.1^{ab}	2.69
C	10.6^{c}	3.9^{b}	2.71
D	12.4^{a}	4.2^{a}	2.93
E	11.9^{ab}	4.0^{ab}	2.92
F	11.3^{ab}	4.1^{ab}	2.74
SEM	0.151	0.041	0.035

a-c: values in the same column not sharing a common superscript differ significantly ($p<0.05$). DFI: daily feed intake; DWG: daily weight gain, FCR: feed conversion ratio. *(A) control group (100% mash); (B) 50% mash+50% pellet; (C) 75% mash+25% pellet; (D) 25% mash+75% pellet; (E) choice feeding (pellet or mash) and (F) 100% pellet. SEM: Standard error of mean

but disagree with the finding of McAllister *et al.* (2000). Feed conversion ratio of quails were not affected significantly by dietary treatments (Table 2). However quails in treatments B (50%mash+50% pellet), C (75% mash+ 25% pellet) and F (100% pellet) had not significantly lowest feed conversion ratio ($p>0.05$). Jahan *et al.* (2006) and Greenwood (2004) believed that improvement in feed conversion ratio by feeding pellet diet was because of yield energy improvement. Allred (1975) announced that feed conversion ratio in pellet diet was better than mash diet, because in pellet processing gelatinization and compacting happen and feed efficiency improved.

The effects of experimental diets on digestive organs weight and carcass traits are presented in Table 3. The greatest carcass yield was belong to diet F (100% pellet)

Table 3: Effect of dietary treatments on carcass traits and digestive organ weight (percentage of live weight) of quails at 35 d

Dietary treatments*	Carcass	Abdominal fat	Gizzard	Pancreas	Proventriculus	Liver
A	65.88^{b}	0.58^{a}	2.65^{a}	0.4	0.48	2.97
B	67.21^{ab}	0.44^{b}	2.49^{abc}	0.39	0.46	2.92
C	66.54^{ab}	0.39^{b}	2.57^{ab}	0.34	0.46	2.85
D	66.95^{ab}	0.50^{ab}	2.21^{c}	0.36	0.46	2.65
E	67.35^{ab}	0.49^{ab}	2.23^{c}	0.36	0.49	2.79
F	67.48^{a}	0.57^{a}	2.34^{bc}	0.34	0.5	2.8
SEM	0.75	0.053	0.21	0.12	0.11	0.22

a-c: values in the same column not sharing a common superscript differ significantly ($p<0.05$). *(A) control group (100% mash); (B) 50% mash+50% pellet; (C) 75% mash+25% pellet; (D) 25% mash+75% pellet; (E) choice feeding (pellet or mash) and (F) 100% pellet. SEM: Standard error of mean

Table 4: Effect of dietary treatments on weight and length of different segment of small intestine at day 35

	Weight (percentage of live weight)				Length (cm)			
Dietary treatment*	Cecum	Duodenum	Jejunum	Ileum	Intestine	Duodenum	Jejunum	Ileum
A	0.93^{a}	1.52	1.7	1.06	57.6	13^{ab}	23.2	21.4^{ab}
B	0.91^{abc}	1.42	1.76	1.05	57.22	11.9^{b}	24.4	20.9^{ab}
C	0.92^{ab}	1.38	1.74	0.92	58.5	13^{ab}	25.7	19.8^{b}
D	0.73^{bc}	1.38	1.59	0.86	58.5	13^{ab}	25	20.8^{ab}
E	0.75^{abc}	1.45	1.77	1.07	60.2	13^{ab}	24.1	23.1^{a}
F	0.72^{c}	1.49	1.69	0.94	59.33	13.56^{a}	25.5	20.2^{b}
SEM	0.029	0.027	0.048	0.035	0.825	0.200	0.479	0.407

a-c: values in the same column not sharing a common superscript differ significantly ($p<0.05$). DFI: daily feed intake; WG: weight gain, FCR: feed conversion ratio. *(A) control group (100% mash); (B) 50% mash+50% pellet; (C) 75% mash+25% pellet; (D) 25% mash+75% pellet; (E) choice feeding (pellet or mash) and (F) 100% pellet. SEM: Standard error of mean

and had significant difference to control (100% mash). Munt *et al.* (1995) evaluated the effect of pellet, mash and combination of them on broiler performance and reported that broiler fed pellet diet had heavier carcass weight comparison with other diets. Ocak and Erner (2005) stated that interaction of feed restriction and feed form had no significant effect on growth performance and carcass traits, while birds fed with crumble diet showed higher value for carcass weight rather than mash diet. Quails fed diet A (100% mash) and F (100% pellet) had no significant discrepancy for abdominal fat but other diets had significant discrepancy ($p<0.05$). These results are not according to Shafiee Sarvestani *et al.* (2006), who reported that weight of edible muscles, abdominal fat and heart was significantly higher in broilers fed pellet in comparison with mash diet. Leenstra (1986) stated that using pellet diet cause to increase abdominal fat, reason of this phenomenon is more energy consumption in pellet diet than mash diet. Gizzard weight contrary to pancreas weight, proventriculus and liver was significantly influenced ($p<0.05$). It means that quails fed diet A (100% mash) had higher gizzard weight and in diet D (25% mash+ 75% pellet) had lowest gizzard weight. Mohamed and Talha (2013) reported that all of digestive organs, except relative gizzard weight was not significantly influenced by physical form of diet and their experiment showed that mash diet with significant impact increased gizzard weight in comparison with pellet and combination of pellet and mash. In another report Amerah *et al.* (2007, 2008) reported that weight of gizzard and proventriculus increased in mash diets and agree with present results but these results are in contrary to Nir *et al.* (1994) who stated that fine particle size consumption because of shrinking crop size and extra enlargement of intestine produced by microbial fermentation reduced. Again Nir *et al.* (1994) observed pelleting lead to proventriculus, gizzard and small intestine weight reduction. Ebrahimi *et al.* (2010) reported that feed particle size had no impact on carcass, breast, bone, liver, gizzard and heart.

Effect of dietary treatments on weight and length of different segment of small intestine are presented in Table 4. Only cecum weight was significantly influenced by dietary treatments. So that, highest cecum weight is related to diet A (100% mash) and lowest cecum weight is related to diet F (100% pellet). Numerically weight of different parts of intestine for diet E (choice feeding) is lower than diet A (100% mash) and agree with the findings of Dahlke and Riberrio (2003) who reported that pellet diets is cause to small intestine weight reduction. Duodenum and ileum length had significant difference ($p<0.05$) but significant difference between jejunum and intestine length was not observed. Highest duodenum length was for diet F (100% pellet) and the shortest duodenum length was for diet B (50% mash+50% pellet), there was no significant difference between other treatments. In jejunum significant difference between treatments was not observed, while in ileum maximum length was for diet E (choice feeding) and shortest duodenum length was for diet B, there was no significant difference between other treatments. In jejunum area significant different between treatments

Table 5: Effect of dietary treatments on jejunum morphology of quails at 35 d

Dietary treatments*	Villus height (µm)	Crypt depth (µm)	Villus height to crypt depth ratio
A	531[c]	116[b]	4.58[b]
B	597[b]	131[ab]	5.55[b]
C	508[c]	122[b]	4.16[b]
D	596[b]	121[b]	4.92[b]
E	658[a]	122[b]	5.39[a]
F	589[b]	143[a]	4.12[b]
SEM	8.99	2.40	0.38

a-c: values in the same column not sharing a common superscript differ significantly (p<0/05). *(A) control group (100% mash); (B) 50% mash+50% pellet; (C) 75% mash+25% pellet; (D) 25% mash+75% pellet; (E) choice feeding (pellet or mash) and (F) 100% pellet. SEM: Standard error of mean

Table 6: Effect of dietary treatments on ileum morphology of quails at 35 d

Dietary treatments*	Villus height (µm)	Crypt depth (µm)	Villus height to crypt depth ratio
A	427[ab]	126[b]	3.39[a]
B	451[a]	132[b]	3.42[a]
C	447[ab]	129[b]	3.46[a]
D	417[ab]	130[b]	3.21[a]
E	412[b]	131[b]	3.14[a]
F	370[c]	154[a]	2.40[b]
SEM	5.83	2.55	0.25

a-c: values in the same column not sharing a common superscript differ significantly (p<0.05). *(A) control group (100% mash); (B) 50% mash+50% pellet; (C) 75% mash+25% pellet; (D) 25% mash+75% pellet; (E) choice feeding (pellet or mash) and (F) 100% pellet. SEM: Standard error of mean

was not observed, while in ileum area maximum length was for diet E and lowest length was for diet C (75% mash+25% pellet) and diet F (100% pellet). Dietary treatments had significant effect on ileum length of quails, therefore maximum ileum length was related to diet E (choice feeding) and the least was for diet C (75% mash+25% pellet) and diet F (100% pellet) and other diets had not significant difference together ($p>0.05$).

The effects of dietary treatments on intestinal morphology are summarized in Table 5 and 6. The effect of treatments on villus height and crypt depth in jejunum and ileum are showed respectively in Table 5 and 6. Ileum morphology affected by diet E (choice feeding) and have maximum villus height ($p<0.01$), also lowest villus height for diet C (75% mash+25% pellet) was observed and other treatments had no significant difference ($p>0.05$). Highest crypt depth of jejunum was belong to diet F (100% pellet) and lowest was for diet A (100% mash). Diet D (25% mash+75% pellet), diet F (100% pellet) after diet E (choice feeding) caused highest villus height than diet A (100% mash) and diet C (75% mash+ 25% pellet), that is correspond with Zang *et al.* (2009) which that they reported pellet feeding significantly increased villus height and crypt depth of birds than others fed with mash diet. Amerah *et al.* (2009) reported villus height increase to crypt depth in broilers fed pellet diet can reduce small intestine mucosa, reduce maintenance need and increase bird growth. Against present results Choi *et al.* (1986) reported that feed mash increased jejunum villus height of broilers, gastro intestinal tract weight and jejunum villus height of broilers fed mash diets increased. Most ratio of villus height to crypt depth in jejunum related to diet D (25% mash+75% pellet), diet F (100% pellet), the least villus height to crypt depth related to diet C (75% mash+25% pellet), diet F (100% pellet) and not complying Choi *et al.* (1986) that expressed mash diet increased villus height to crypt depth, present results according to Sugunle *et al.* (2013) who stated that crypt depth and villus height in ileum and jejunum in pellet feeding increased.

Conclusion: Most daily feed intake, maximum body weight, greatest villus height to crypt depth (after choice feeding) in jejunum obtained from 25% mash+75% pellet. In general, 25% mash replacement with pellet can increase villus height, absorption surface and gut development that finally improved growth performance of quails.

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