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CAUSES FOR OVER CONSUMPTION IN BROILER CHICKENS

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ABSTRACT
The experiment was conducted to investigate the causes of over consumption in broiler chickens (Ross, 308). 128 broiler chickens were classified in two feed intake class levels (low & high) and housed randomly in individual cages in two rooms. Broilers were fed ad libitum (6:00 - 24:00) Pelleted Ground Wheat (PGW), Pelleted Whole Wheat (PWW), and Mash Ground Wheat (MGW) diets from 10th-32 days of age. The experiment thus had a 2×3 factorial design. AMEn experimental data analysis showed that no over consumer broilers were found between low and high feed intake classes. Diets had a significant ($P<0.0001$) effect on weight gain, feed intake, and feed/gain, but there was no effect on relative weight of gizzards and DM crop contents. Diets feed form had a higher effect on broilers performance than of ground and whole wheat based diet. A significantly higher ($P<0.05$) feed intake, higher weight gain and better feed/gain were found for broilers fed PGW and PWW diets than for broilers fed MGW diet. Broilers fed PWW diet had lower ($P<0.05$) pH in gizzard contents than PGW and MGW diets fed, but there was no significant difference between PGW and MGW diets. Small quantity of feed was stored in crop temporarily, but gizzard stored larger quantity of feeds. It is difficult to conclude whether feed over consumption may cause reduced nutrient utilization from this study, since no feed overconsumption was observed. It can be concluded, however, that in some situations, broilers aren't over consumers.

KEY WORDS: Broiler chickens, Over consumption, AMEn, Diets, Performance.

INTRODUCTION

Broiler chickens are kept for meat production and they consume feeds until their digestive tract maximum capacities fill (Denbow, 1994; Bokkers and Koene, 2003; Nielsen, 2004). Modern breeds of broilers are fast growers that call for high feed intake and lead to excess feed consumption beyond metabolic need (Nielsen, 2004) especially in *ad libitum* feeding (Weeks and Kestin, 1997). Barbato *et al.* (1984) observed broilers as over consumers, and Svihus and Hetland (2001) also found a few *ad libitum* fed broilers showed habit of overconsumption in wheat based diet. Similarly, Svihus (2011) found 40 % of *ad libitum* fed birds showed some indications of feed over consumption based on finely ground pelleted wheat diet distinguished with a normal weight gain, higher than mean feed intake and an AME value below 10.3 MJ/kg. Svihus (2010a) also reported that feed overconsumption was observed under certain conditions in broilers. Extra costs for heat increment and unwanted fat deposition were negative effects resulted from excess feed intake in broilers (Emmans, 1994). Hence, currently feed cost constitutes 60 to 65% (Cutlip *et al*., 2008) out of the total cost of commercially broiler production and therefore, excess feed consumption decreased profitability of the broiler industry. Svihus (2011) indicated that the consequence of overconsumption of feeds resulted in lower starch digestion because of higher passage rate. Similarly, Svihus (2010a) reported that a rapid feed passage through small intestine was observed occasionally in broiler chickens. This was due to overconsumption of feeds, thus led to nutrient utilization to be decreased. Nielsen (2004) also reported the causes for overconsumption of feeds and uncontrollable feeding behavior in broilers could be changes in satiety mechanisms in the brain. According to the report, this excess feed consumption can be solved by combination of standard broiler diets processing and genetic selection.

To optimize poultry feed processing for broiler chickens, two characteristics of poultry will have a strong relevance for understanding how feed processing should be optimized. These are feeding behaviour and the unique role of the gizzard as an integral part of the bird's digestive system. Broiler chickens can pick pelleted diets more easily than mash diets; moreover, mash diets composition of nutrient and its palatability may be poor that hindered to attain maximum body weight gain with minimum cost in short period to reach slaughtering weight. Svihus and Hetland (2001) and Hetland and Svihus (2001) found large difference in feed intake being fed as mash and pellet form in broiler chickens in which feed intake was significantly decreased when diets were fed in mash form. Thomas and van der Poel (1996) reported that broilers performance increased when fed pelleted diets. This was because of nutritional superiority of pelleted feeds over mashes. Besides, pelleted diets allowed higher feed intake and increased weight gain by reducing the amount of energy used for maintenance in relation to gain.

Feed overconsumption was observed in broiler chickens by experiments; however, no previous experiments were conducted to investigate the causes of feed over consumption. Thus, this research was conducted to identify the causes of this problem with the objectives to investigate the causes of feed overconsumption in broiler chickens, to determine the effect of diets on broiler chickens performance, and to determine the effect of diets on anterior digestive tract organs and contents of crop and gizzard. The hypothesis of this research was large feed consumption of broiler chickens was result of those birds which, develops a habit of overconsumption feed. Thus, high feed consumption was not a consequence of poor digestibility, but rather a causative factor for poor digestibility due to the fact that feed was pushed through the digestive tract too fast. Further, our hypothesis was that over consumption can only develop as a consequence of poorly developed gizzard. A well functioning gizzard will have a strong regulatory effect on feed flow and thus will make feed over consumption impossible.

MATERIALS AND METHODS

Experimental diets production

Three diets with identical composition: a pelleted diet with ground wheat (PGW), a pelleted diet where the wheat was unground prior to pelleting (PWW), and the pelleted ground wheat diet crushed to mash (MGW) on a RM were produced (table 2) at Fortek Center for Feed Technology, Norwegian University of Life sciences, Ås, Norway. The pelleting production parameters were also described in table 1. The diets in the experiment were based on finely ground wheat or whole wheat, fish meal, and wheat gluten, pelleted through a pellet press fitted with a die and effective thickness specified in table 1 after gentle conditioning. Whole wheat was ground using a HM (Münch-Edelstahl,Wuppertal, Germany).

TABLE 1. Pelleting production parameters of diets produced

Pelleting conditions	**PGW**	**HM3**	**PWW**
Density	g/l	590	800
Grinding			
Screen size	mm	3.0	3.0
Conditioning			
Temperature in the conditioner PT 100	ºC	60.0	60.0
Die Specification			
Die diameter	mm	3.0	3.0
Die length	mm	42.0	42.0
Pelleting Process			
Production Capacity	kg/h	400	400
Feeder	%	20	15
Steam working pressure	bar	2.8	2.8
Motor load	%	22	24
Amperes Motor 1	amp	14	15
Amperes Motor 2	amp	13.5	14.0
Average Ampers motor	amp	13.75	14.50
Energy Consumption	kW	8.46	8.92
Specific Energy Consumption	kWh/kg	0.0211	0.0223
Temperature at the pellet die outlet			
Steam	kg/h	20.8	18.9
ISO - Box	ºC	74.5	75.6

Broilers' selection, Housing, Temperature, Lighting and Feeding

300 day-old male broiler chicks (Ross 308) were kept in brooder cages of wire floor in a separate room 13 chicks per group cage, and were fed a commercial starter diet in *ad libitum* until 10th d of age. Water was supplied in groups in *ad libitum* way until 10th d of age. Light was on for 24 hours and daily temperature was set 34 °C (actual mean 31.1^{o}c) from day old until 10th d of age. Starting 10thd of age till end of experiment the mean temperature was 24.5 ^{o}C although it was set 26 ^{o}C in both rooms. At 10th d of age morning all broilers were weighed, the 20 % lightest broiler chickens from the average weight (less than 290g) were discarded. Then 204 birds were randomly selected among the rest in which 102 broilers were placed per room having ventilation in excessive in individual cages (Length 38 cm, Width 22 cm, Height 22 cm) of wire floor in two rooms. Light was on for 24 hours from 10th-13th d of age to encourage feeding, however, from 14th d of age morning, light was switched off from 24:00 until 06:00. Broilers and feeds given were weighed at 10th d of age. The birds were given a diet *ad libitum* based on finely ground wheat (in HM), fish meal and wheat gluten, pelleted through a 3 mm die after gentle conditioning. Diets were supplied in feeder paper boxes in individual cages in *ad libitum* way from 10th d of age until termination of the experiment. Similarly, water also supplied using the drinker line having nipple for the whole experimental period. On the 14th d of age, feed and birds were weighed again successively. Then the 64 normal

weight birds with the highest feed intake (in room 1>170 g and in room 2 ≥ 195 g) based on feed consumption data taken from 10th -14th d of age were selected and divided in room 1 and 2 (32 broilers in each room). The 64 normal-weight birds with the lowest feed intake were placed in a similar way in room 1 and 2. The same experimental diet as used previously was weighed out to the birds using individual feeders in both rooms. On the 17th d, feed and birds (8:00 am) were weighed. Thereafter, 21 randomly selected birds (a total of 128 chickens) in each room were weighed out to one of the following three diets with identical composition as previously used ground wheat (PGW), whole wheat (PWW), or MPGW. These feeds were given *ad libitum* until termination of the experiment, but birds and feeds were weighed at the 24th d of age. A total of 128 broilers were equally distributed in each room and feed intake class. On the 28th d and 31st d of age, birds and feeds were weighed. On the 32 d of age from 108 chickens, 105 were killed by a cranial blow followed by cervical dislocation. During the whole experimental period, chickens found as outliers were discarded. A plastic strap was placed around the neck of each bird immediately following cervical dislocation to avoid regurgitation, and the contents from the crop were thereafter collected, followed by immediate placing to freezer.

TABLE 2. Feed composition of experimental diets (as-fed basis) fed to Ross 308 broilers from 10th to 32 d of age.

Ingredients	Diet 1 (PGW HM3 mms)	Diet 2 (PWW)
Wheat	73.5	73.5
Fish meal	9	9
Wheat gluten	8.8	8.8
Animal fat	3	3
Soybean oil	1	1
Mono calcium phosphate	1.4	1.4
Limestone	1.3	1.3
Sodium chloride	0.25	0.25
Mineral premix	0.15	0.15
Vitamin ABKD premix	0.09	0.09
Vitamin A	0.02	0.02
Vitamin E	0.06	0.06
Titanium dioxide	0.5	0.5
D,L-methionine	0.2	0.2
L-lysine	0.4	0.4
L-Threonine	0.2	0.2
Choline chloride	0.13	0.13

Diet 3 (MGW diet) production: from 400 kg of PGW diet produced, 100 kg of PGW were reground through RM in order to produce MGW. All diets were produced with conditioning temperature of 60 ^{o}c. Diameter of pellets was 3 mm and 1.5 mm roll-die distance. PGW (from 10th -32 d), and PWW and MGW (17th - 32 d) of age were fed to the broiler chickens.

Digestive tract samples collection

At the end of the experiment (32 d), all samples of crop with contents, gizzard with its contents/empty proventriculus were dissected out and collected from each broiler. Ileal materials were also collected. Then immediately all samples collected were frozen at -18 ^{o}C until all samples were analysed late of three months.

Faecal material collection

To determine AME, faecal materials were collected in two periods throughout the whole experiment. Before fecal materials collection started, empty plastic box were weighed. During faecal material collection in both periods, care was taken to avoid inclusion of unwanted materials such as feathers from faeces.

The first period of faecal materials was collected when broiler chickens fed PGW diet. On the 14th d of age PGW diet was weighed to total of 128 birds (64 broilers in each low and high feed intake in both rooms). Then 128 clean trays were placed in the afternoon at 14:00 under the cages 6 hours after having access to feed that is chickens were without feed from 8:00 up to 14:00. To determine AME, faecal materials were collected 6 hours after weighing feed once per day at 14:00 on 15th, 16th and 17th d of age for three consecutive days. Only 108 faecal materials were analysed in the laboratory.

The second period of faecal material was collected from chickens fed three diets with similar procedure as done in the first period. On the 28th d of age of birds, 108 clean trays were placed under individual cages and then faecal materials were collected on 29th, 30th and 31st d of age as described above. Out of 128 broilers, 7 chickens were dead and the rest outliers were discarded since the experiment started in different times. All faecal materials collected were frozen at -18 °C until all samples were analysed late of three months.

Gizzard and Crop samples in lab analysis

Gizzards with contents/proventriculus were taken together during dissection and samples were categorized according feed intake class and diet type. Gizzards with contents (wet in g), were weighed full and empty after the removal of fat and empty proventriculus (fat removed) were also weighed. All the wet crop contents were placed in oven at 105°C for overnight (for 15 hours) to determine the DM contents.

Determination of gross energy of diets and faecal energy

Dried faecal material energy and gross energy of three diets were determined by Parr 1281 bomb calorimeter (Moline, Illinois, USA) using the standard procedure. AME content for the birds in each cage was corrected for nitrogen retention by assuming that weight gain consisted of 200 g protein/Kg, that protein consisted of 160 g nitrogen/kg, and that the energy equivalent was 34.36 KJ/g nitrogen gained (Bourdillon *et al*., 1990). Empty cleaned and dried crucibles were weighed. Faecal materials with their plastic containers without the lid were weighed. Empty plastic box faecal material container and gross weight of faeces and container together were weighed using standard weighing balance found at the department lab. To take representative samples in to crucible, faeces were mixed first with spoon followed by clean stirring (mixer) machine to make homogenous in each sample. Thereafter, mixer apparatus was washed and dried before the next sample started. Then representative wet faecal samples were filled to the crucible and immediately weighed together with the crucible. The wet faecal materials were dried for overnight in oven for 15 hours at 105°c. The dried samples were taken out of oven and stabilized in desiccators until it cooled down and then weighed gross dried samples. Likewise two samples per each diet were measured to know the average gross energy (MJ/Kg) value of diets fed to broilers.

Statistical Analyses and Calculations

The experimental data were statistically analyzed using the GLM procedure of the SAS software (SAS Institute, Cary, NC). Two way analysis of variance with two feed intake class levels and three diets factors (2 × 3 factorial design) were used for determination of variables of performances, anterior digestive tract organs and contents at (P=0.05) from 97-105 broilers read and used. Some dissected birds with ascites were excluded from performance data analysis. The significance differences among diets and feed intake class levels, comparison differences between means of diets were determined by using the Ryan-Einot-Gabriel-Welch multiple *t*-Tests (LSD) at 0.05 level of significance and Pair-wise comparisons were performed using the least significant difference t-test. SAS system of the correlation procedure (Pearson Correlation Coefficients) was used to analyze the degree of correlation between variables of performance data collected in two periods during fecal collection.

Calculations

$$F/G = \frac{\text{Feed consumed (g)}}{\text{Weight gain (g)}}$$

The AME values were calculated using the formula explained here under after the proper corrections made for differences in DM content:

$$AME_{n\ (MJ/Kg)} = \frac{\text{Gross energy of diet - (Faecal energy + corrected energy for nitrogen)}}{\text{Feed intake}}$$

Corrected energy for Nitrogen= ((weight gain*0.2)/6.25)*34.36

AME_n: Apparent Metabolizable Energy corrected for nitrogen (MJ/Kg of diet)

RESULTS

Broilers performance and anterior digestive tract organs

17th to 32 d of age

Weight gain of broiler chickens was significantly (P<0.0001) affected by diets. No significant difference in weight gain was found by feed intake class (P=0.5833) and feed intake class*diet interaction (P=0.3168). Broilers fed PGW and PWW diets had a significantly higher (P<0.05) mean weight gain than broilers fed MGW diet (table 3). No significant difference was found in weight gain of broilers fed PGW and PWW diets (P<0.05). No significant difference in mean weight gain was found between low (947.82 g) and high (954.65 g) feed intake class levels.

Feed intake of broiler chickens was significantly (P<0.0001) affected by diets. Feed intake class (P=0.396) and feed intake class*diet interaction (P=0.4827) were not significantly affected feed intake of broilers. Average feed intake was significantly higher (P<0.05) broilers fed PGW and PWW diets than broilers fed MGW diet (table 3). No significant difference in mean feed intake was found broilers fed diets PGW and PWW. No significant difference in mean feed intake was found between low (1585.77 g) and high (1618.21 g) feed intake class levels.

Feed/gain of broiler chickens was significantly (P<0.0001) affected by diets and feed intake class (P=0.0188). Feed intake class*diet interaction (P=0.2153) was not significantly affected feed/gain of broiler chickens. Broilers fed PGW and MGW diets didn't show significance difference in feed/gain, but those broilers fed MGW diet was significantly different in feed/gain than both pelleted diets (table 3). Thus, broiler chickens fed PGW and PWW diets increased feed efficiency in feed/gain than broilers fed MGW diet. No significant difference in mean feed/gain was found between low (1.69) and high (1.79) feed intake class levels.

TABLE 3. Mean results of broilers performances, relative digestive organs weights and contents for 17 to 32 d age fed three wheat based diets

Variable	PGW	PWW	MGW	mean
Weight gain, g	1155.57[a]	1136.54[a]	582.223[b]	
Feed intake, g	1821.59[a]	1859. 86[a]	1128.96[b]	
Feed /gain, (g/g)	1. 58[a]	1. 64[a]	2.014[b]	
pH of gizzard contents	3.25[a]	2. 32[b]	3.14[a]	
Relative empty gizzard weight[2]	0.0091275[a]	0.010347[a]	0.0117925[a]	
Relative empty proventriculus weight[2]	0.003504[a]	0.003382[b]	0.0044505[a]	
Gizzard wet contents, g	4.76456[a]	16.17136[b]	4.30383[a]	
AMEn, MJ/Kg DM:				
AME_1	13.64			
AME_2				
Low feed intake	13.577[a]	13.971[a]	13.788[a]	13.77867
High feed intake	14.079[a]	13.882[a]	13.753[a]	13.90467
Crop (mean) DM (g)	3.37[a]	4.36[a]	3.05[a]	3.59
Low feed intake (g)	3.52	5.74	2.86	4.04
High feed intake (g)	3.22	2.98	3.24	3.15
DM (%)	24.0745[a]	28.0755[a]	23.8265[a]	25.33
Low feed intake (%)	24.616	29.557	20.601	24.925
High feed intake (%)	23.533	26.594	27.052	25.726

[abc] Means without common superscript in row have significant difference (P<0.05).
[2] Proportion of bird weight (g/g body weight)
$_1$ and $_2$ in subscript indicated periods of fecal material collected and performance variables measured. MGW diet is mash form crushed by RM from PGW diet.

TABLE 4. Mean results of broilers performances for 17 to 32 d of age broiler chickens fed three wheat based diets in diet type and feed class

		Weight gain		Feed intake		Feed/gain	
Diets	Feed class	Mean (g)	Range(g)	Mean (g)	Range(g)	Mean	Range
PGW	1	1130.83	888.7–1279.4	1768.42	1420–2092	1.57	1.4–1.7
	2	1175.95	930–1407.9	1865.38	1563.5–2196	1.59	1.44–1.81
PWW	1	1165.41	1010.5–1309.6	1865.66	1644–2068	1.6	1.54–1.68
	2	1113.75	806–1303	1855.28	1501–2082.5	1.68	1.51–1.98
MGW	1	603.32	397–891	1123.25	862–1454	1.91	1.63–2.24
	2	563.61	226.3–782	1134.01	740–1525	2.11	1.68–3.36

1 and 2 indicated low and high feed intake class levels respectively.

Broiler performance and AME_2 of 28th -31st d of age

Data collected and the statistical analysis done (105 chickens) for three consecutive days from 28th -31st d age of broilers showed as described here in the table below.

TABLE 5. Mean results of broiler performances and AME_2

Variables	Diets		
	PGW	PWW	MGW
Weight $gain_2$ (g)	281.68[a]	288.62[a]	**179.37[b]**
Feed intake $_2$(g)	451[a]	472.05[a]	**310.75[b]**
Feed/gain $_2$(g/g)	1.66061[a]	1.66039[a]	1.84899[a]
AME $_2$ (MJ/Kg DM)	13.8444[a]	13.8659[a]	13.7258[a]

[ab] Means with in row without common superscript letter differ significantly (P<0.05) in Ryan-Einot-Gabriel-Welsch Multiple Range Test.
$_2$ in subscript indicated second period (28 th _ 31st d of age) of fecal material collection and other performance variables measured.

In addition to the results explained in the table above, some other results found in these three consecutive days are summarized as follows. Diet showed a significant effect (P<0.0001) on weight gain and feed intake of broilers. However, diets didn't show significant effects on AME_2 (P=0.5997) and somewhat a tendency was found (P=0.0575) its effect on feed/gain. Broilers fed PGW and PWW diets were higher (P<0.0001) in feed consumption and weight gain; however, MGW diet reduced feed intake and resulted in lower (P<0.0001) weight gain. No significant effect on weight gain was found from feed intake class and feed intake class* diet. No significant difference was found in mean results of weight gain between low (252.61 g) and high (254.38 g) feed intake class levels. Mean data results of feed $intake_2$ was not significantly different between feed intake classes. Diet comparison difference between means of PGW and PWW diets were insignificant in weight $gain_2$ and feed $intake_2$ but MGW were significantly different from both diets.

Diet (P=0.0209) and feed intake class * diet interaction (P=0.0110) were significantly affecting to feed/$gain_2$ while feed intake class showed non-significant effect (P=0.1066). The comparisons differences of diets between means for feed/gain 28th to 31st d of age were insignificant between PGW and PWW diets fed birds, but MGW diet resulted in significant difference from both diets (P<0.05). No significant difference was found in mean results of feed/gain (28th to 31st d of age) between low (1.64473 g) and high (1.72318 g) feed intake class levels.

Correlation results of two (start & termination) periods

Broilers were fed PGW (14th -17th d of age) diet and during this period diet and feed intake class showed a significant effect (P<0.0001) on weight $gain_1$. At the end of 17 th d of age, diet showed a significant difference (P<0.0001) in feed intake of broilers.

TABLE 6. Comparison of broilers performance in two periods

Variable	Mean	Range
Weight $gain_1$,g	173.39	82-238.6
Weight $gain_2$,g	246.97	28.8-429.5
Feed $intake_1$,g	242.5	169.2-301.6
Feed intake $_2$,g	407.26	130.3-576.7
Feed/gain $_1$	1.42	1.81-2.06
Feed/gain $_2$	1.73	0.9978-4.52
AME_1	13.64	9.83-14.70
AME_2	13.81	10.53-15.37

[1] in subscript indicated first period (14th to17th d of age fed MGW diet) of fecal material collection and other performance variables measured.

[2] in subscript indicated second period (28 th to 31st d of age fed three diets) of fecal material collection and other performance variables measured.

TABLE 7. Significant Pearson Correlation Coefficients results of two periods

	r-value	P- value
Weight $gain_1$ vs Feed $intake_1$	0.85	<0.0001
Weight $gain_2$ vs Feed $intake_2$	0.91	<0.0001
AME_1 vs AME_2	0.35	0.0003
Feed $intake_1$ vs Feed $intake_2$	0.19	0.05
Weight $gain_1$ vs Feed/$gain_1$	-0.78	<0.0001
Weight $gain_2$ vs Feed/$gain_2$	-0.64	<0.0001
Feed $intake_1$ vs Feed/$gain_1$	-0.38	<0.0001
Feed $intake_2$ vs Feed/$gain_2$	-0.40	<0.0001
Feed/$gain_1$ vs AME_1	-0.45	<0.0001
Feed/$gain_1$ vs AME_2	-0.22	0.0229
Feed $intake_1$ vs AME_1	-0.21	0.0321

vs = symbol for versus.

Other correlations of performance variables not mentioned above were insignificantly correlated. $_1$ and $_2$ indicated above were broilers fed PGW diet between 14th-17th d of age and three diets between 28th-31st d of age respectively.

The gross energy of the experimental diets had mean of 17.34 MJ/Kg of diet. All results of AMEn values of the current experiment were higher than 10.3 MJ/Kg except one bird out of 105 broilers dissected. No significant difference was observed in the average AMEn values between first and second experimental periods.

Anterior Digestive tract (Crop, Proventriculus & Gizzard) results

Crop DM content

Crop DM contents were not significantly affected by diets, feed intake class, and feed intake class*diet factors (table 8). Thus, the mean DM (%) and DM (g) crop contents were not significantly different among the three diets fed broilers (P<0.05) (table 3). Similarly, DM crop mean results between low (25.186 %, 3.136 g) and high (25.232 %, 4.228 g) feed intake class levels were not also significantly different.

TABLE 8. Crop DM content at 32 d of age

	DM (%)	DM (g)	
Source	P-value	P-value	Significance
Diet	0.5415	0.6979	NS
Feed intake class	0.9726	0.3556	NS
Feed intake class*Diet	0.2817	0.4964	NS

* indicated both parameters taken together

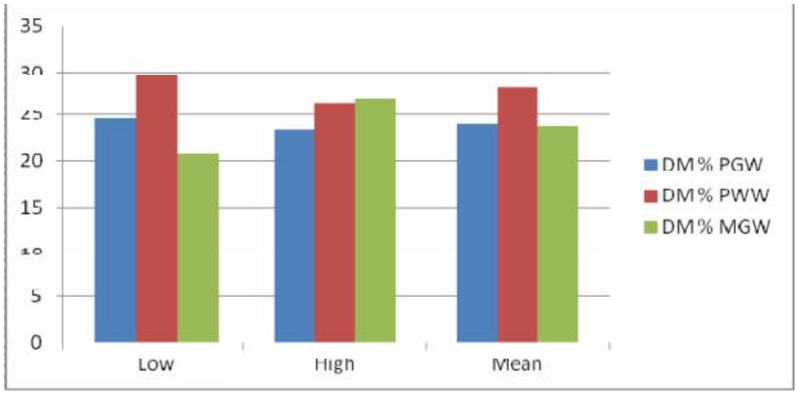

FIGURE 1. Comparison of crop DM % content of three diets fed broiler chickens in two feed intake class levels.

Gizzard wet contents

Gizzard wet contents were significantly affected by diets (P<0.0001) and feed intake class (P=0.0298), while the effect of feed intake class*diet interaction (P=0.2566) was not significant on weight of gizzard contents. PWW diet fed broilers had a significantly higher (P<0.05) mean weight wet gizzard contents than broilers fed diets PGW and MGW (table 3). No significance difference was found in mean weight of gizzard contents between broilers fed diets PGW and MGW. There was a significance difference in mean weight of wet gizzard contents between feed intake class levels. Thus, high feed intake class level broilers retained higher (P<0.05) mean weight gizzard contents (9.7814 g) than low feed intake class levels (7.045 g).

Relative empty gizzard weight

Feed intake class (P=0.3164), feed intake class * diet (P=0.8230) and diets had not significant effect on empty relative gizzard weight (table 3). The difference between means of diets comparisons effect on empty relative gizzard weight were non-significance (P<0.05) (table 3). Mean data results of relative empty gizzard weight between low (0.010243) and high (0.010602) feed intake classes were not significantly different. As observed, PWW diet fed broilers had somewhat better developed and larger gizzard size followed by PGW diet fed broilers. MGW diet fed broilers had underdeveloped and smaller gizzard size than both PWW and PGW diets fed. There were no differences observed in gizzard development and size between feed intake classes and feed intake classes* diet interactions.

DISCUSSION

In the current study, modern Ross 308 broilers were not feed over consumers under *ad libitum* feeding condition and diets processed. These results contradict with our hypothesis and expectations in broiler chickens. Because all broiler chickens had AMEn value higher than 10.3. Therefore, data of AMEn analysis indicated that broiler chickens didn't show excess feed consumption under the current study condition. Hence, this result is not consistent with (Svihus *et al*., 2002; Svihus, 2003; Svihus, 2010a) findings where overconsumption of feeds was observed sometimes in broiler chickens. The feed intake situation that was categorized as high and low feed intake class levels at the start of the experiment end up with non-significance difference in AMEn value. Those broiler chickens that showed high feed intake in PGW diet at 17th d of age didn't continue as higher feed consumers even those broilers that continued with the PGW diet. Similarly, those broilers shifted their diet from PGW diet to PWW and MGW diets were not over consumers. Moreover, no significant differences (P<0.05) in AMEn value were found in diet differences (pellet or mash form and ground or whole wheat inclusion) and feed intake class* diet interactions.

Causes of differences from previous findings such as (Weeks and Kestin, 1997; Svihus and Hetland, 2001) and the current results may be unknown broiler feeding behavior related to physiology of birds and duration light hours access to feed. Moreover, differences ingredients inclusion and their proportion in the composition of experimental diets could be the cause of difference. The duration of the experiment in eg. Svihus and Hetland (2001) was 16 to 21 d age which is somewhat longer than in the present experiment. Furthermore, broilers that showed high feed intake at the start may vary their feed demand as their age and body weight increased. It may be also due to factors such as strain difference, pelleting temperature, and degree of disturbance for the chickens and distance of each broiler individually housed. As broilers lived close to each other, higher feed competition may happen that will lead to excess feed consumption that is related with the stimulation of appetite for feed. The way water was supplied as group and individual may have also contribution to determine feed consumption levels and thereby determine feed passage rate (fast or slow) in broilers. Nielsen (2004) report suggested a possible cause for overconsumption is changes to satiety mechanisms in the brain.

Broiler chickens had higher feed intake and weight gain when fed pelleted diets than mash diet in the current study. Thus, broiler chickens fed PGW and PWW diets had higher weight gain than broilers fed MGW diet. These results are almost similar with many research findings published previously showing the superiority of pelleted diets over mash diets for broiler performances (Reece, 1986b; Svihus and Hetland, 2001; Fairfield, 2003; Svihus *et al*., 2004 a, b; Kidd *et al*., 2005; Parsons *et al*., 2006; Cutlip *et al*., 2008). Non-significance difference in weight gain between broilers fed PGW and PWW diets in the current experiment is in harmony with Hamilton and Proudfoot (1995) because of improvement in nutrient digestibility. This was contrary to Hetland *et al*. (2002) finding where ground wheat based diet showed better weight gain than whole wheat based diet in broilers. In addition, feed consumption increased significantly in PGW and PWW diets but decreased in MGW diet in line with (Svihus and Hetland, 2001; Hetland and Svihus, 2001; and Amerah *et al.,* 2007).

Broilers feed PWW and PGW had better feed conversion than those fed MGW diet. There was a significant difference found particularly in feed/gain fed MGW diet from both pelleted diets. However, broiler chickens fed PGW and PWW diets had not significant difference in feed/gain in this experiment which is in accordance with the previous results of Svihus *et al*. (2004a) but contradicting with the recent Svihus (2010b) results. Whole wheat based diet before pelleting had no performance difference than ground wheat based diet. Thus, whole wheat in a diet prior to pelleting will not have negative impact in performance but with the advantages of decreased grinding costs and lowers dusts problem to the surrounding environment. Therefore, this will draw our feed processing direction more towards whole wheat based diet prior to pelleting although it has been started. Obviously, grinding of cereals increased energy consumption during milling (Amerah *et al*., 2007).

Broilers crop stored small quantity (3 – 4.3 g) of DM of feed in *ad libitum* feeding strategy (access to feed/light for 18 hours/day) consistent with (Svihus, 2010a). Even in the rural scavenging local chickens, crop served as storage of feed although the amount of feed stored can vary with the availability of feed in the area (Mwalusanya *et al*., 2002). In the current experiment, broilers chickens that had 18 hours access to light and feed were able to store small quantity of feed in the crop. Therefore, crop served as temporary storage organ in Ross 308 broiler chickens which is similar to (Svihus, 2011; Svihus, 2010a). Feed was stored for short time in the crop, thus diets fed as pellet/mash, ground/whole wheat or low and high feed intake class levels didn't show significant difference in DM crop content in broiler chickens. Similarly, Svihus (2010b) found small quantity on average 10.8 g in 30 minutes were stored in the crop of Cobb broiler chickens in *ad libitum* feeding strategy since beginning of feeding. Besides, up to 30 g feed were found after 30 minutes starvation and 15 g after 3 hours last feeding (Svihus *et al*., 2002) in crop. Buyse *et al*. (1993) also found significant quantity of feed stored in broiler crop in five hours interval of feeding per day. Therefore, feeds especially whole cereals can be moistened in crops and this will facilitate to the next digestion process in gizzard.

No significance difference in empty relative gizzard weight found in the current experiment broilers fed different diets. This is not in accordance with finding of Svihus *et al*. (2004b) whereby significant difference observed in empty relative gizzard weight between ground wheat and whole wheat. Gizzard weight increased when whole cereals used in diets by (Nir *et al*., 1994b; Svihus and Hetland, 2001; Dahlke *et al*., 2003; Hetland *et al*., 2003b; Gabriel *et al*., 2003, and Svihus *et al*., 2004a; Svihus *et al*., 2010b) that was not found in the current experiment in broilers fed PWW diet.

Whole wheat based diet before pelleting showed somewhat a better stimulating effect on gizzard development and size almost similar with Svihus *et al*., (2004a). A well developed gizzard has greater contribution in digestion process and feed flow controlling than of poorly developed gizzard. This may be due to presence of small quantity of larger micro particle sizes in the diet and longer diet retention in gizzard. PWW diet fed broilers differed in gizzard development and size from other diets. Thus, effect of micro particle size after pelleting of PWW diet contributed relatively for better gizzard development and size.

Svihus (2010a) indicated that large quantities of feed were stored in crop under intermittent feeding. Wet weight of gizzard contents was higher broiler fed PWW diet than of PGW and MGW diets. This indicated PWW diet was retained longer time than PGW and MGW diets. The current results of wet weight of gizzard contents could not be compared with previous findings of DM basis. However, Svihus *et al*. (2004a) and Svihus *et al*. (2010b) found weight of DM gizzard contents were increased when ground wheat was replaced by whole wheat.

CONCLUSION

It is difficult to conclude whether feed over consumption may cause reduced nutrient utilization from this study, since no feed over consumption was observed. It can be concluded, however, that in some situations, broilers aren't over-consumers. Therefore, further research is warranted to conduct at what conditions broiler chickens become feed over consumers. Crop as an intermediary storage organ stored small quantity of feeds while gizzard stored larger quantity of feeds under *ad libitum* feeding. Broilers performance was better in pelleted diets than MGW diet. The PWW diet did not differ on broilers performance compared to PGW diet, except that it reduced in pH of gizzard contents.

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Abbreviations

AME- Apparent Metabolizable Energy
d- day
DM-Dry Matter
g-gram
HM- Hammer Mill
Kg-kilogram
KJ-kilojoule
MGW -Mash Ground Wheat
MJ-Megajoule
PGW -Pelleted Ground Wheat
PWW-Pelleted Whole Wheat
RM- Roller Mill

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