Starch	97.7[a]	96.7[b]	96.6[b]	94.6[c]	2.5	0.0001	0.29
AME	3298.8[a]	3196.1[a]	3069.6[b]	3068.7[b]	124.2	0.001	0.71
Ileum(day 44)							
Protein	78	77.4	75.3	76.5	3.13	0.30	0.6
Fat	86.2[a]	86.3[a]	82.7[b]	83.4[b]	3.1	.04	0.84
OM	81.2	80.4	81.6	81.6	2.2	0.60	0.61
AME	3423	3364.7	3298.1	3311.9	125.1	0.07	0.52
Excreta (days 41-43)							
Protein	70.6	70.1	70.2	70.4	4.5	0.99	0.70
Fat	89	88.5	87.9	87.2	2.9	0.30	0.08
OM	84.6	85.2	82.1	82.1	2.9	0.22	0.73
Starch	97.7	97.8	97.5	97.1	0.62	0.12	0.06
AME	3518.1	3573.7	3513.1	3452.9	119.3	0.23	0.20

*Means within rows with different letters are significantly different ($P<0.05$). ** Standard error of mean

Grinding size and grinding method and interaction with pelleting for wheat-based broiler chicken diets

B. Svihus[*], O. Zimonja and K. H. Kløvstad Viken, Norwegian University of Life Sciences, P.O. Box 5003, N-1432 Ås, Norway, E-mail: birger.svihus@umb.no

Abstract
A hard wheat was ground by the use of hammer mill fitted with a 3 or 6.1 mm sieve, or to the same geometric mean diameter by the use of a roller mill. When diets containing 573.5 g ground wheat/kg were pelleted, wet sieving revealed that the proportion of fine particles smaller than 0.2 mm in size increased substantially. In addition, the pelleting process tended to even out differences in particle distribution between diets. When diets were fed to broiler chickens either as mash or after pelleting, extent of grinding had no conclusive effect on performance. Pelleting increased performance, and increased apparent metabolisable energy (AME) of the diets from 11.6 to 11.8 MJ/kg. The increase in AME was however not reflected in a higher starch digestibility. The results indicate that pelleting will even out differences in particle distribution, and that coarse grinding of wheat has no negative effect on broiler performance.

Introduction
Although grinding represents a considerable cost in terms of energy consumption and feed mill capacity, cereals used for poultry are usually finely ground in a hammer mill fitted with a screen between 3 and 4.5 mm in size. It has been shown that coarse particles are completely ground in the gizzard (Hetland et al., 2002), and that this grinding does not affect passage rate through the intestinal tract (Svihus et al., 2002). This indicates that from a nutritional point of view the cereals used for poultry can be ground more coarsely than current practice. Roller mills are not commonly used in feed production, despite the fact that they grind with a lower energy consumption per ton feed (Nir et al., 1990), gives less dust during grinding and are less noisy (Heimann, 2002). It has also been shown that roller mills grind cereals more uniformly and produce a lower amount of fines than hammer mills (Nir et al., 1990; 1995). As roller mills are considered to be particularly effective for coarse grinding, the advantages of roller mills will increase when a coarse grinding is used. The consensus is that pelleting increases performance due to a higher feed intake and an increased feed efficiency. It is not clear, however, whether the increased feed per gain is caused solely by reduced maintenance requirements, or whether pelleting in itself may improve digestibility. In fact, recent results indicate that pelleting decreases digestibility of starch compared to mash feeding, despite an improvement in feed per gain (Svihus and Hetland, 2001). Thus, this cast doubt on the hypothesis that pelleting increases feed utilization.

The purpose of the current experiment was to compare coarse and fine grinding of wheat using a hammer mill and a roller mill, and to study the interactions between grinding, pelleting and nutritional value for broiler chickens.

Materials and Methods

Grinding and feed processing was performed at Centre for Feed Technology, Ås, Norway. A batch of unground wheat of a hard variety was mixed and split in 5 different parts each consisting of approximately 250 kg. Two batches of wheat were ground using a hammer mill (Münch-Edelstahl, Wuppertal, Germany, licensed by Bliss, USA). A series of test grindings was performed on a double pair roller mill (Model DP 900-12, Roskamp, Indiana, USA) to study the relationship between roll distances and particle distribution, and to find the roll distances which gave the same geometric mean diameter as the two different hammer mill grindings. The distance selected was 0.1 mm for both pair of rolls for the grinding reflecting 3 mm hammer mill grinding (RM3), while the distance was 0.35 mm for both pair of rolls in the grinding reflecting 6.1 mm hammer mill grinding (RM6). In addition, a batch of wheat was coarsely ground with a distance between the upper and lower pair of rolls of 1.5 mm and 1 mm, respectively (RM9). A mixture of non-wheat ingredients was split in 5 parts and mixed with each batch of ground wheat using a Dinnisen (Pegasus Menger 400 l, Sevenum, Holland) twin shaft high-speed mixer for 5 min to produce a broiler chicken diets formulated according to requirements. Half of these diets were conditioned in a double conditioner (Münch-Edelstahl, Wuppertal, Germany) at 75°C for 60 seconds, followed by pelleting and cooling (Miltenz Counter flow cooler, Auckland, New Zealand, 2000 kg/h capacity).

At 11 days of age, randomly selected birds were placed in individual cages (22 cm X 38 cm X 38 cm) with mesh-wire floor covered by soft rubber tubes in two rooms with constant temperature (28 °C from 10 to 17 days and 25 °C thereafter) and with 4 hours darkness twice during the night. Each of the 10 diets was weighed out to 20 birds. Feed was removed from the birds on the 21st day of age and weighed. After 6 hours starvation, each bird was weighed, and clean trays were placed under the cages. Excreta were collected on day 22 and 23. At the 24th day of age, feed and individual birds were weighed, and excreta were quantitatively collected from the trays after 6 hours starvation. At 30 days of age, birds and feed were weighed, and birds were slaughtered by cervical dislocation followed by bleeding. Weight of the carcass after removal of viscera, feathers, head, wing tips and feet was recorded. The gizzard was cleaned of fat and was weighed with and without contents.

Dry sieving was performed on the ground wheat by sieving approximately 100 g through a series of sieves while vortexing (amplitude 1.5 mm) on a Retsch AS 200 (F. Kurt Retsch GmbH & Co., Haan, Germany) for one minute. Mean particle size and standard deviation was calculated as described by Behnke (1983). Wet sieving was performed on the mash and pelleted diets by sieving 100 g (soaked in water for two hours) through a series of sieves under excess water. Sieving time was 3 x 3 min and vortexing amplitude was 1.5 mm. Particle size distribution was calculated based on proportion of dry matter left on each sieve after drying overnight at 104 °C. Gross energy content of diets and faeces was determined on a Parr 1281 adiabatic calorimeter (Moline, Illinois, USA). Apparent metabolisable energy (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). Starch content of diets and faeces was determined enzymatically as described by McCleary et al. (1997). Two-way analysis of variance with feed form and type of grinding as factors were performed using SAS software (SAS Institute Inc., Cary, USA). The square root of means square error in the analysis of variance (residual standard deviation, RSD) was used as a measure of random variation.

Results and Discussion

The grinding data confirm previous reports that roller grinding gives a lower amount of fines than hammer grinding (Reece et al., 1985; Nir et al., 1995). However, the wet sieving indicates that the pelleting process will even out differences in particle distribution

The lack of a negative effect of using coarsely ground wheat on bird performance, although the number of birds in this experiment was limited, confirms numerous previous reports and is not surprising, considering the considerable ability of broilers to use even unground wheat (Svihus et al., 2004). The AME and starch digestibility indicate that wheat ground through a roller mill has a higher digestibility than wheat ground to the same mean diameter by the use of a hammer mill. It is possible that the roller grinding to a higher extent than hammer grinding disrupts the entire cereal structure. This could be due to the fact that grinding in the roller mill is an effect of squeezing of the kernel, as opposed to the collision fragmentation that occurs in the hammer mill.

Current results confirm previous findings showing an increased performance when diets are pelleted (Nir et al., 1995). This effect is to a major extent related to a higher feed intake which in turn increases weight gain and thus reduces the proportion of energy used for maintenance in relation to gain. However, the significant increase in AME, which corresponds with results observed by Farrell et al. (1983), indicates that pelleting may also improve digestibility in the diet. Although starch has been observed to have a low digestibility in wheat and thus could be thought to benefit from processing (Svihus, 2001), no effect of pelleting on starch digestibility was seen. Since an improvement in starch digestibility as a consequence of processing is related to gelatinisation of starch (Holm et al., 1988), the lack of improvement in starch digestibility could be explained by the very low extent of gelatinisation after pelleting (data not shown). Svihus and Hetland (2001) found that starch digestibility increased when pellets were crushed into mash and fed to broilers, and it was concluded that this was related to differences in feed intake. Although there were large differences in feed intake between diets fed as mash and as pellets, no differences in starch digestibility was detected in the current experiment. It is possible that the much lower concentration of starch in the diets in the current experiment is the cause of these differences. It is also possible that processing and the effect of feed intake influence the starch digestibility of pelleted diets in different directions, and thus that no overall effect is seen.

Table 1. Performance (11 to 30 days of age), organ weights (30 days of age) and digestibility (21 to 24 days of age) in the broiler experiment[1]

		HM3	HM6	RM3	RM6	RM9	Average	P-value	RSD
N	M	18	19	17	20	20	94		
	P	20	19	20	20	20	99		
Feed consumption, g	M	1840	1849	1720	1695	1845	1790^{B}		
	P	2133	2149	2095	2118	2076	2114^{A}	<0.001	179.8
Weight gain, g	M	1076^{ab}	1089^{ab}	1029^{ab}	993^{b}	1135^{a}	1065^{B}		
	P	1361	1348	1333	1350	1315	1341^{A}	<0.001	124.7
Feed/gain	M	1.72	1.70	1.68	1.71	1.64	1.69^{A}		
	P	1.57	1.60	1.58	1.57	1.58	1.58^{B}	<0.001	0.096
Rel. carcass weight[2]	M	60.9	61.2	61.0	60.7	60.8	60.9		
	P	60.6	61.8	61.8	60.1	62.5	61.4	0.258	2.85
Rel. empty gizzard[2]	M	1.44^{b}	1.76^{a}	1.49^{b}	1.62^{ab}	1.75^{a}	1.62^{A}		
	P	1.21	1.24	1.11	1.18	1.25	1.20^{B}	<0.001	0.227

Rel. gizz. contents[3]	M	0.51^{b}	0.84^{b}	0.54^{b}	0.75^{b}	1.17^{a}	0.77^{A}		
	P	0.15^{b}	0.43^{a}	0.19^{ab}	0.26^{ab}	0.33^{ab}	0.27^{B}	<0.001	0.362
AME[4], MJ/kg	M	11.3^{b}	11.6^{ab}	11.9^{a}	11.7^{ab}	11.4^{ab}	11.6^{B}		
	P	11.6	11.8	11.8	12.0	11.7	11.8^{A}	0.026	0.66
Starch digestibility[5]	M	0.94^{c}	0.97^{ab}	0.97^{ab}	0.97^{ab}	0.95^{bc}	0.96		
	P	0.95^{b}	0.94^{b}	0.97^{a}	0.97^{a}	0.94^{b}	0.96	<0.001	0.023

[1]M and P denote mash and pelleted diets, respectively, HM and RM denote hammer mill and roller mill grinding, respectively, and the numbers 3,6 and 9 denote the coarseness of grinding.

References and a full description of this work can be found in Animal Feed Science and Technology 117, 281-293.

Performance of Broilers Fed on Low Protein Diets Fortified with Graded Levels of Methionine

M. Torki[1], [1]Animal and Poultry Science, Agricultural Faculty, Razi University, Imam Avenue, Kermanshah, P. O. B. 67155, Iran. E-mail: mmtorki@yahoo.com*

Abstract

In a 2 × 3 factorial arrangement, the effect of dietary protein and methionine (Met) levels on performance of Ross broiler chicks form 7 to 49 days of age were evaluated. Two hundred and fifty two 7-day old chicks as a mixture of both sexes were utilized. The chicks were randomly allocated to 18 pens containing 14 chicks each with three replicates and assigned to receive one of the six iso-energetic (3000 Kcal/Kg) dietary groups. Dietary treatments consisted of three levels of protein (21.56, 19.40, and 17.25 in starter, 18.75, 16.87, and 15 in grower, and 16.87, 15.19, and 13.50 g/Kg in finisher period) and two levels of Met (0.47 and 0.56 in starter, 0.36 and 0.43 in grower, and 0.3 and 0.36 g/Kg in finisher period). The results of this study showed that reducing dietary protein by 10% could have no adverse effect on broiler performance. In addition, increasing Met level by 20% above the NRC recommendation could be effective in improving broiler performance.

Introduction

There has been great interest in reducing N concentration in poultry litter in recent years. Lowering crude protein is effective in decreasing N excretion in poultry production (Blair *et al.,* 1999). Excess dietary protein also increases heat production and water consumption which increases moisture content of litter (Alleman and Leclercq, 1997). Reducing CP diets by 2% in starter period did not affect body weight gain (Moran and Stiborn, 1996). Some researchers have shown that reduced crude protein-amino acid supplemented diets support good growth and feed consumption of broilers (Yamazaki *et al.,* 1998; Aletor *et al.,* 2000). However, other researches evaluating the impact of low crude protein-amino acid supplemented diets have demonstrated negative effects on broiler productivity (Bregendahl *et al.,* 2002). Addition of Met over and above the recommended requirement of broilers improves their performance in terms of body weight gain and food conversion efficiency (Simon *et al.,* 1995 and Ohta and Ishibashi, 1995). Recent research has suggested that levels of lysine and Met in excess in NRC (1994) recommendations may result in enhanced performance (Schutte and Pack, 1995).Therefore the objective of this study was to evaluate the Met and protein level effects on performance with recommended level protein and other diets lower in protein than the recommended level, with various Met supplements equal and above requirements recommended by NRC (1994).