

FEED RATION HOMOGENEITY DURING DISTRIBUTION OF BROILERS' AUTOMATIC FEEDERS

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ABSTRACT

The study aimed to verify the efficiency of two equipment distributors of feed for broilers. Feed samples were collected from two broiler automatic feeder dish, with similar characteristics but different manufacturers. The samples were collected from five points of distribution, namely: storage silo, hopper, the first dish, the middle and the last dish. The samples were subjected to quantitative analysis of ashes and particle size analysis. The data were subjected to analysis of variance (ANOVA), means separated by Tukey test with $p < 0.01$, and analysis of linear regression. The results of statistical ashes analyze show that there is a significant difference in granule size and the amount of ashes. Can be concluded that are segregation of the feed during distribution along the route, being that there is the accumulation of ashes in the first dishes and content decreases as the distribution. The particle size showed the opposite result of ashes, with larger granules in the last dish and smaller granule size at the first dish.

Keywords: mineral matter, particle size, segregation.

HOMOGENEIDADE NA DISTRIBUIÇÃO DE RAÇÃO EM LINHAS DE COMEDOUROS TIPO PRATO AUTOMÁTICO

RESUMO

O trabalho foi realizado com o objetivo de verificar a eficiência de dois equipamentos distribuidores de ração para frangos de corte quanto à homogeneidade na distribuição ao longo das linhas. Foram coletadas amostras de dois equipamentos tipo prato automático de características similares, porém de diferentes fabricantes. As amostras foram coletadas em cinco pontos de distribuição, sendo eles: silo de armazenagem, moega, primeiro prato, prato do meio e prato final. As amostras foram submetidas a análises quantitativas de cinzas e análise granulométrica. Os dados obtidos foram submetidos à análise de variância (ANOVA) e as médias comparadas por teste de Tukey em nível de 1% de significância e também regressão linear. Os resultados das análises estatísticas mostraram que há diferença significativa no tamanho de grânulos e na quantidade de cinzas conforme a distância percorrida pela ração e, conforme há o aumento do tamanho de grânulos, ocorre redução no teor de cinzas. Conclui-se que há segregação da ração durante a distribuição ao longo da linha, sendo que há acúmulo de matéria mineral nos primeiros pratos e este teor diminui conforme a distribuição.

Palavras-chave: matéria mineral, tamanho de partícula, segregação.

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INTRODUCTION

Brazilian poultry production has grown connected to the expansion of corn and soybean production that are the most important components of poultry feed. Other factors also interfere in the broiler production such as genetic improvement and introduction of new rearing and management technologies (TAVARES & RIBEIRO, 2007).

The size and texture of the feed ration are critical in broilers feeding behavior (COUNTS et al., 2014). According to the authors, birds have difficulty in eating either larger particles or much smaller than the size of their beak.

Abnormalities on the gastrointestinal tract (pH and gizzard size), as well as the differences in the rate of feed passage through the tract are observed by the use of different size particles. Birds fed with corn with geometric mean diameter (GMD) greater than 0.778 mm show better feed conversion and higher feed intake and weight gain than those eating feed with smaller granulometry. Diets with small particles flow faster within the proventricle to ventricle, and to the duodenum and to other parts of the small intestine, and might cause atrophy of the gizzard and

hypertrophy of the small intestine (RIBEIRO et al., 2002). Good quality feed ration present homogeneous distribution with low variation in particles size (GODOI & DETTMAMM, 2007). This concept is important when related to the absorption of the micro-nutrients such as calcium and phosphorus (GOMES et al., 2004).

The mixture of solid particles of different sizes to be transported within the automatic feeders in broiler production tends to segregate. As a result there is accumulation of fine particles on the sides of the mechanism (OWEN & CLEARY, 2009). The small particles also tend to be sifting through the empty spaces left by larger particles. This is due to physical differences between the particles (FELTRAN et al., 2006) leading to qualitative and quantitative differences in the composition of the feed along the distribution line.

This study was conducted aiming to verify the feed ration homogeneity during the distribution based on the variations of feed ashes and geometric mean diameter (GMD) of two automatic feeder commonly used for broiler chicken production.

MATERIAL AND METHODS

The research was carried out in a commercial broiler farm in Rio Grande do Sul, Brazil. The farm had two houses with similar typology with dimensions of 100 m long and 12 m wide. Both houses were equipped with automatic feeders being one from brand A and the other from brand B. Both houses reared 16 thousand broilers during the data recording. In the house using equipment from brand A, broilers were 35 days old, while the house using equipment from brand B they were 36 days old. The feed ration used was mashes and the formulation was compatible to the growth phase II. The collection of material inside the houses occurred during one day.

In both equipment, the function of the feed distributors consists in receiving

the feed ration from the farm silo to a feed hopper by polypropylene tubes. The posterior distribution is done in aluminum tubes (0.75 cm of diameter) with a helicoid device inside which are connected to the feeders. The feed ration supply was controlled by the last feed dish in the route that has a sensor that starts the system when the minimum level of feed is reached.

Equipment A and B are similar and are constituted by a silo (for holding the feed ration), the feed hopper (with capacity of 115 L), a three phases engine of 0.55 kW (with rotation of 325 RPM), and a cylinder tube of aluminum (total of Ø 45 mm being 36.7 mm external diameter and 21.7 mm internal diameter and a helicoidal

filament of 0.547mm). The flow output was 6.4 kg/min. The feeder was made of polypropylene with 330 mm in diameter and depth of 76 mm with a capacity of

carrying 3 kg of feed ration. Each equipment has two rows of distribution each one has a feed hopper.

Sampling recording

Each place for collecting the data was selected as a function of the distance between the feeder dishes, feed hopper, and silo. Each place where the recording was done was considered a treatment ($t = 4$), and in each place three samples were

recorded, considered as a repetition for the statistical analysis. The data collection places were the silo (control), the feed hopper (t1), the first feeder dish (t2), the middle feeder dish (t3), and the last feeder dish (t4) in the distribution route.

Experimental procedure

The samples of feed ration collected at each point were put in a plastic bucket and homogenized. Subsequently three small representative aliquots of the sample were collected and placed in bags, and then sealed and marked with the equipment, number of repetition, row and place of collection.

The process used for determining the feed ration ashes followed that described by IAL (2008). A total of 56 crucibles were separated and counted for each the sample. Samples were dried in a stove at 105 °C for three consecutive hours. After 20 minutes, samples were cooled cooling inside a desiccator to become balanced with the ambient temperature. Afterwards, each crucible was weighed using a precision scale of 0.0001 g. The sample weights were recorded and noted. Two samples weighting 2 g of the original samples were selected and adequately put inside a container. These were exposed to a temperature of 570 °C for 24 hours. Thereby the ashes content was recorded. To obtain the percentage of ashes of each sample the equation (1) was used.

Ashes (%) = $(A - B) / C * 100$ (1), where A= total weight (sample plus crucible), g; B = weight of the crucible, g; and C= weight of the sample, g.

To determine the feed ration mean diameter the method used was adapted from LOPEZ & BAIÃO (2004). An amount of 150g of each sample was

separated and dried in at 105 °C in order to prevent adhesion of fine particles in the meshes of the screens. After 24 hours the samples were taken from the oven and left at ambient temperature for 2 hours. A set of seven screens with different meshes (4; 2; 1.20; 0.60; 0.30; 0.15; and 0 mm) were mounted in the vibrator equipment using the crescent order of the size of mesh. Screens were weighted using a scale with 0.1g of precision, and the results were recorded. A total of 150g was placed on the top of the group of screens, the container was closed and the vibrator was turned on for 10 minutes with the rheostat at level 8. In the end, the screens were weighted individually, and the respective weights for each fraction (particle size) were recorded. After obtaining the weight percentage in the amount retained in each screen the geometric mean diameter (GMD) of the particle was determined. For that Equation 2 was applied (HANDERSON & PERRY, 1955) adapted to express the values in mm (ZANOTTO & BELLAVER, 1996).

$GMD (mm) = 104.14 * 2MF (2)$, where MF = finest module.

The finest module is an index that can assume any value within the range of zero and six. The index is positively correlated to the size of particles in the feed ration, as defined by ZANOTTO & BELLAVER (1996).

Data analysis

The treatments (4) were compared between each other and the control. The amount of Ashes found in each sample was quantified, and the sizes of the feed particles were analyzed for the granulometry (GMD). Data were subjected to ANOVA, and the average values of the treatments were compared using Tukey

test adopting a significance level of 99%. Linear regression was applied for analyzing the particles granulometry data. Statistical analysis was processed using the statistical SAS/STAT software (Version 8 of the SAS System, SAS Institute Inc., Cary, NC, USA).

RESULTS AND DISCUSSION

The amount of ashes sampled in the feed ration and deposited in each site where were collected differed ($p \leq 0.01$) indicating that both feeders segregate particles along the feed distribution route (TABLE 1). This amount left indicates that there is not uniformity in the feed ration

nutrients distribution along the house, and may cause lack of homogeneity in the flock performance. Such difficulty might lead to unbalanced growth in certain areas of the rearing area due to lack or excess of major nutrients inside feed dishes as calcium, phosphorus or sodium.

Table 1. Percentage of ashes in feed ration accumulated in each distribution local of the feed route

Place	Brand A		Brand B	
	Route I	Route II	Route I	Route II
Silo	6.389 ^a	6.389 ^{ab}	5.999 ^{ab}	5.999 ^b
Feed Hopper	5.220 ^c	6.520 ^{ab}	5.671 ^{ab}	5.770 ^c
Feeder dish 1	6.561 ^a	7.155 ^a	6.292 ^a	6.984 ^a
Feeder dish 2	5.957 ^b	5.674 ^{ab}	5.560 ^{ab}	5.969 ^b
Feeder dish 3	5.149 ^c	5.368 ^b	5.297 ^b	5.699 ^c
C.V*	2.60	8.28	5.73	0.66

Means followed by the same letters in the column do not differ by the Tukey test ($p \geq 0.01$).

*C.V = coefficient of variation.

In the four routes of the feed ration distribution results show that there was higher concentration of ashes in the first feed ration dish. In the second dish, there was a decrease as well as in the final feed dish. The amount of feed ration distributed in the silo and the rows of the equipment did not change ($p \geq 0.01$). The ashes feed ration in the silo was similar ($p \geq 0.01$) to that in dish 1 (routes I and II from brand A and route I from brand B), and in the dish 2 (route II from brand B). This result might indicate the possibility of the feed changes the way of it is mixture along the distribution, leading to the lack of homogeneity along the way. In equipment brand A route I the largest differences ($p < 0.01$) found (in relation to the feed

ration composition in the silo) where in the dish 3 and in the feed hopper, with 19.4% and 18.3% reduction of ashes percentage, respectively. No difference was found between the feed ration in the silo and that at the dish one; however, feed ration contents varied in the other distribution areas. The regression coefficient obtained between the distances the feed ration is transported and the ashes content in route I was not significant. The feed ration ashes content varied ($p < 0.01$) in route I between the dish 1 and the dish, being reduced in 25.0%.

Ashes content in dish 1 to the dish 3 differed reducing the ashes contents in 15.8%. In the dish 2 from route II and brand B it was found the smallest

difference between the ashes content (0.5% less), when compared to the silo. The highest difference found in this route was the ashes content in dish 1, which presented an increase of 16.4% with relation to the silo. Ashes content in the silo and the feed hopper did not change ($p>0.01$).

The mineral content in broilers' feed ration, represented by ashes, contains fractions of calcium, phosphorus, sodium and other micro-nutrients that are essential for the growth of the birds. The segregation of this mineral fraction may induce marginal nutrition, weak immune response and high lack of homogeneity in the flock affecting carcass yield. According to KIEFER (2005), the minerals are involved in several metabolic

functions. The macro-elements (S, Ca, P, K, Na, Cl, e Mg), for instance, are required in broilers' body structural and physiologic functions including reproduction and growth.

All studied route showed some difference in relation to the feed ration quality in the silo, which was the control. Along the ways, the size of the particles (GMD) was higher in dish 3 ($p\leq 0.01$) for brand A (TABLE 2). Equipment from brand B presented smaller particle size in dish 1 than in the other dishes. In the other hand, the size of the feed ratio particles increased until the size found in the silo by the dish 3 in both routes I and II. This behavior is similar to the pattern of mixture and re-mixture along the distribution route.

Table 2. Geometric Mean Diameter (GMD) of feed ration particle size (μm) along the distribution route

Place	Brand A		Brand B	
	Route I	Route II	Route I	Route II
Silo	1.123 ^d	1.123 ^d	1.171 ^{ab}	1.171 ^{ab}
Feed Hopper	1.352 ^a	1.264 ^b	1.126 ^{bc}	1.145 ^{bc}
Feeder dish 1	1.120 ^d	1.051 ^e	1.041 ^d	1.067 ^c
Feeder dish 2	1.174 ^c	1.190 ^c	1.098 ^{cd}	1.182 ^{ab}
Feeder dish 3	1.238 ^b	1.324 ^a	1.197 ^a	1.241 ^a
C.V*	0.39	1.32	0.57	2.70

Means followed by the same letters in the column do not differ by the Tukey test ($p\geq 0.01$).

*C.V = coefficient of variation.

The largest feed ration particle size was found in route I from brand A, located in the feed hopper (TABLE 2). Results from the particles sizes in the silo and that from dish 1 did not differ ($p>0.01$), and the size was 20.7% different from the particles sizes found in the feed hopper. The size of the particles increased as the distance from the feed hopper increases (TABLE 2). In route II from brand largest particles sizes was found in dish 3, followed by dish 2 and 1. The size of the particles found in the silo was 65% higher than that in the feed ration from dish 1, and 5.9% smaller than that found in dish 2. In the route I from brand B the size of the particles was higher in dish 3 than in the others, decreasing in dish 2 and 1. In route II from brand B, no

difference was found between the particle sizes in the silo and the dish 2. In dish 2 the particle size was higher than that found in the feed hopper ($p\leq 0.01$) (TABLE 2). In the equipment from brand B in route II the largest size of particles was found in dish 3 and changed from dish 3, feed hopper and the dish 1 ($p\leq 0.01$).

Particle sizes in dish 1 differed from the other dishes but mainly from dish 3 ($p\leq 0.01$). These results indicate that a segregation of the components of the feed ration occurs during the distribution according to the granulometry. These results of granulometry agree with the results found for the ashes evaluated for the samples in the some local, which

suggests a heterogeneous distribution of the feed ration along the routes.

According to NIR et al. (1994) the presence of particles with high GMD favors feed ration consumption as it allows the birds to choose large particles. Young broilers prefer larger particles when possible, with GMD near 700 to 900 μm . However, in experimental studies authors did not find the impact of the granulometry on feed ration consumption (LÓPEZ & BAIÃO, 2004; LÓPEZ et al., 2007). These results differ from that found by LÓPEZ & BAIÃO (2002) who observed significant increase in broilers' feed consumption when fed with large size particles. DAHLKE (2000) suggests that the feed ration ingredients in mashed, pellet and micro-pellet diets influence broilers'

absorption after ingestion and dissolving in the craw. Good nutrition allied to the intestine health is responsible for the nutrients absorption influencing performance and production costs (MIRANDA, 2011). According to CONDÉ et al. (2014) with the reduction of the feed ration particles size an increase of the surface contact with the digestion enzymes might occur increasing absorption efficiency.

Regression found for the brand A were negative, being 5.74 for route I and 5.002 for route II. This indicates that the increase of 1 μm a reduction of 5.74 and 5.002% respectively of ashes in the feed ration can be observed (FIGURE 1a and b).

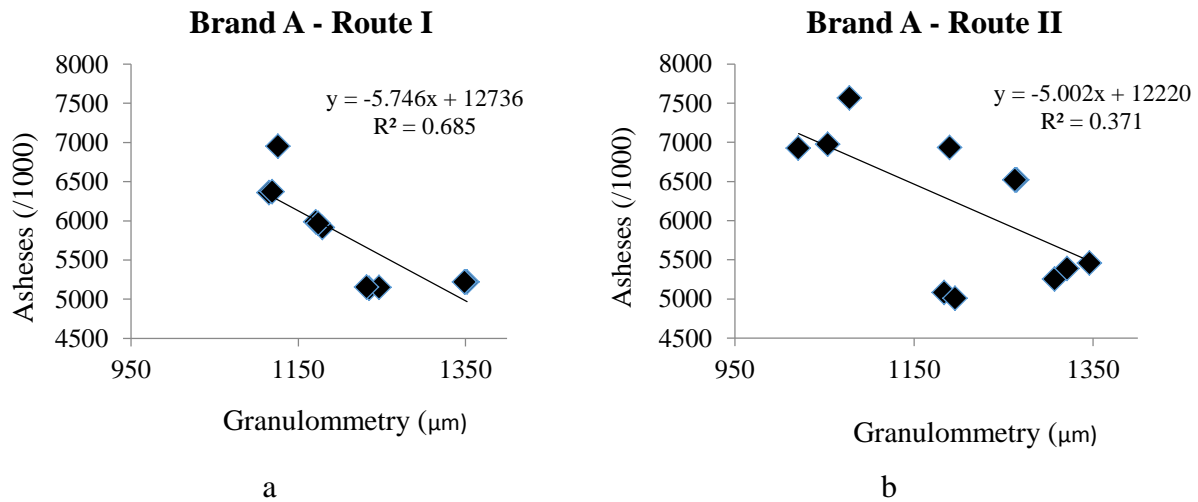


Figure 1. Regression analysis between the size of the particles (μm) and ashes (%) for brand A – route 1(a) and brand A – route 2 (b).

Regression found for brand A with negative coefficient presented values of 6.2308 and 5.9360. This indicates that the

increase of 1 μm represents a decrease of 6.230% in ashes in route 1 and 5.9360% in route 2 (FIGURE 2a and b).

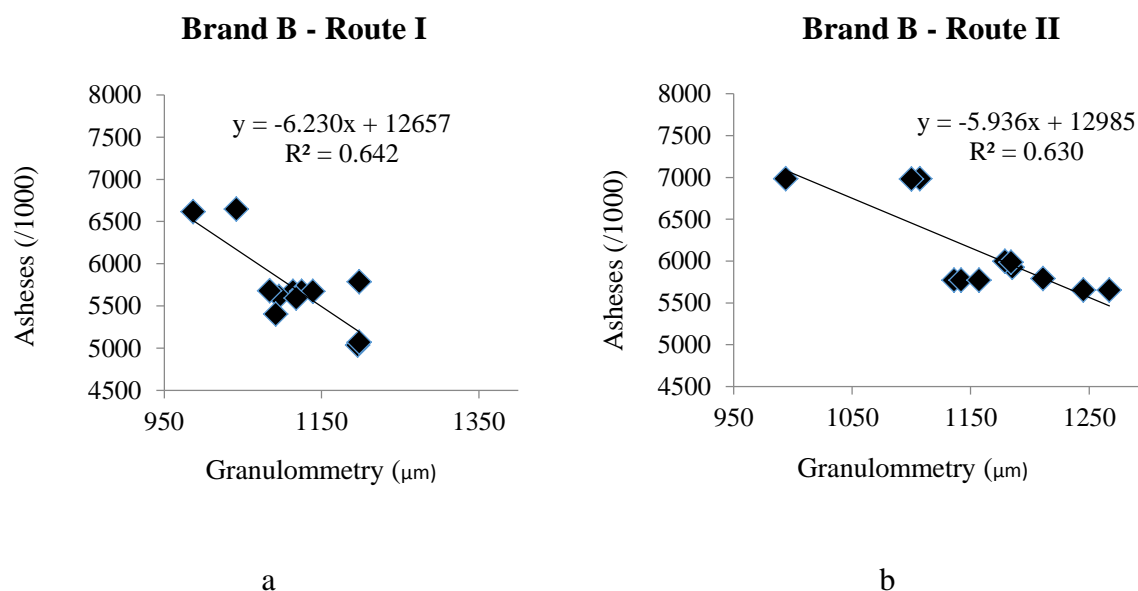


Figure 2. Regression analysis graph between the size of the particles (μm) and ashes (%) for brand B – route 1(a) and route 2 (b)

The physical form of the diet interferes in the feed pattern of broilers (CONDÉ et al., 2014). Similar findings were also observed by YO et al. (1997) in broilers 14 days old and with free choice of a particular diet. The authors found that when changing the size of the particles in the feed ration birds reduced the feeding amount during the first 24 hours. However, they return to the same consumption after three days. Therefore, the difference in particles sizes found in the present experiment might interfere in the physiologic behavior of broilers. With the reduction in the ashes the feed ration density changes. Limestone, phosphorus bi-calcium, sodium chloride and other sources of macro-minerals are heavier than

other components and tend to deposit in the first feeder dishes. This segregation of the particles as a function of the feed density changes the diet composition and as a consequence alters the ingestion of the nutrients and energy. SCHEIDELER (1995) quantified the presence of finest particle size in feed ration in approximately 35% of the diet, and this number might increase as a function of the transportation and feed distribution to 59%. Finest particle size formation might increase during the transit, and it can be around 63 to 72% in the feeders, which are above the recommended in the literature (McNAUGHTON & REECE, 1984; MAIORKA, 1998).

CONCLUSIONS

Results from this study indicate that there is segregation of feed along the distribution within the broiler houses. Further investigation is needed in order to

improve the distribution of the feed ration as it is crucial that all broilers receive the same amount of all nutrients for ensuring flock uniform growth.

REFERENCES

CONDÉ, M.S.; DEMARTINI, G.P; PENA, S. de M.; DA ROCHA JR, C. M.; HOMEM, B.G.C. Influência da granulometria do milho na alimentação de

frangos de corte. **Revista Eletrônica Nutritime**, Artigo 267, v.11, n.05, p.3637-3647, Set/Out, 2014.

- DAHLKE, F. Tamanho da partícula de milho e da forma física da ração para frangos de corte e seus efeitos sobre o desempenho, dinâmica intestinal e rendimento de carcaça. 2000. 47f. Dissertação (Mestrado em Zootecnia) - Universidade Federal do Rio Grande do Sul, Programa de Pós-graduação em Agronomia, Porto Alegre, 2000.
- FELTRAN, J.C.; CORRÊA, J.C.; BRANCALIÃO, S.R.; VILLA BOAS, R.L. Physical and chemical segregation of mixed fertilizers. **Científica**, Jaboticabal, v.34, n.2, p.188-196, 2006.
- GODOI, M.J.S.; DETTMAMM, E. Fabricação de ração: Determinação do tempo de mistura em misturador horizontal, **Revista Eletrônica Nutritime**, v.4, n° 6, p.487-490, Nov/Dez. 2007.
- GOMES, P.C.; RUNHO, R.C.; AGOSTINI, P.; ROSTAGNO, H.S.; ALBINO, L.F.T.; LOPES, P.S. Exigência de fósforo disponível para frangos de corte machos e fêmeas de 22 a 42 e de 43 a 53 dias de idade, **Revista Brasileira de Zootecnia**, v.33, n.6, p.1734-1746, 2004.
- HANDERSON, S.M.; PERRY, R.L. Agricultural process engineering. New York: John Wiley and Sons, 1955. 402p.
- IAL (INSTITUTO ADOLFO LUTZ). Métodos físico-químicos para análise de alimentos. 4ed. São Paulo: IAL, 2008. 1018p.
- KIEFER, C. Minerais quelatados na nutrição de aves e suínos. **Revista Eletrônica Nutritime**, v. 2, n. 3, p. 206-220, 2005.
- LOPEZ, C.A.A.; BAIÃO, N.C. Efeitos da moagem dos ingredientes e da forma física da ração sobre o desempenho de frangos de corte. **Arquivos Brasileiros de Medicina Veterinária e Zootecnia**, v.54, p.189-195, 2002.
- LÓPEZ, C.A.A.; BAIÃO, N.C. Efeitos do tamanho da partícula e da forma física da ração sobre o desempenho, rendimento de carcaça e peso dos órgãos digestivos de frangos de corte. **Arquivo Brasileiro de Medicina Veterinária e Zootecnia**, Belo Horizonte, vol.56, n.2, Apr. 2004.
- LOPEZ, C.A.A.; BAIÃO, N.C.; LARA, L.J.C.; RODRIGUEZ, N.M.; CANÇADO, S.V. Efeitos da forma física da ração sobre a digestibilidade dos nutrientes e desempenho de frangos de corte. **Arquivos Brasileiros de Medicina Veterinária e Zootecnia**, v.59, n.4, p.1006-1013, 2007.
- MAIORKA, A. Efeito da forma física, níveis de energia em dietas formuladas com base em aminoácidos totais e digestíveis no desempenho e composição de carcaça de frangos de corte, machos, dos 21 aos 42 dias de idade. 1998.115f. Dissertação (Mestrado em Zootecnia) - Universidade Federal do Rio Grande do Sul, Programa de Pós-graduação em Zootecnia, Faculdade de Agronomia, Porto Alegre, 1998.
- McNAUGHTON, J.L.; REECE, F.N. Factors affecting pelleting response. 1. Influence of dietary energy in broiler started diets. **Poultry Science**, v.63, n.4, p.682-685, 1984.
- MIRANDA, D.J.A. Efeito da granulometria do milho e do valor de energia metabolizável em rações peletizadas para frangos de corte. 2011, 92f. Dissertação (Mestrado em Zootecnia). Universidade Federal de Minas Gerais – Escola de Veterinária. Belo Horizonte. MG, 2011.
- NIR, I.; SHEFET, G.; ARONI, Y. Effect of particle size on performance. 1. **Corn. Poultry Science**, v.73, p.45-49, 1994.
- OWEN, P.J; CLEARY, P.W. Prediction of screw conveyor performance using the Discrete Element Method (DEM), Powder Technology, CSIRO Mathematical and Information Sciences, Clayton, Vic 3168, Australia, p.274 -288, 2009.
- RIBEIRO, A.M.L.; MAGRO, N.; PENZ, JR. Granulometria do milho em rações de crescimento de frangos de corte e seu efeito no desempenho e metabolismo.

Revista Brasileira de Ciência Avícola, v.4, n.1, p.01-07, 2002.

SCHEIDELER, S.E. Poultry Feeds: Is pelleting cost effective? *Feed Management*, v.46, p.21-26, 1995.

TAVARES, L.P.; RIBEIRO, K.C.S.; Desenvolvimento da avicultura de corte brasileira e perspectivas frente à influenza aviária. *Organizações Rurais & Agroindustriais*, Lavras, v.9, n.1, p.79-88, 2007.

YO, T.; SIEGEL, P.B.; GUERIN, H.; PICARD, M. Self-selection of dietary protein and energy by broilers grown under a tropical climate: effects of feed particle size on de feed choice. *Poultry Science*, Champaign, v.76, p.1467-1473, 1997.

ZANOTTO, D. L.; BELLAVAR, C. Método de determinação da granulometria de ingredientes para uso em rações de suínos e aves. *CT/215/EMBRAPA-CNPSA*, p.1-5, Dez, 1996.