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WATER ADDITION TO RATIONS FOR PIGS IN FINISHING PHASE

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ABSTRACT

To evaluate the effects of water addition to mash rations on nutrients and energy digestibility, water intake, excrement quality and carcass traits in pigs in the finishing phase, twelve commercial hybrid barrows with an initial weight of 64.0 ± 4.8 kg were used for the digestibility trial, and distributed into randomized blocks, based on the animals' weight. Eighteen barrows and eighteen hybrid females, with an initial weight of 60.0 ± 3.6 kg, were used for the performance test, and distributed into a completely randomized design. Treatment one consisted of a dry diet formulated to meet the animals' requirement. Treatments two and three consisted of the same diet with the addition of the same proportion of water and the double of water, respectively, the proportional unit used was kg. There was no statistical difference among treatments for the coefficients of apparent dry matter digestibility, gross energy, ether extract, calcium and phosphorus, and for the variables of performance, moisture, fecal nitrogen and phosphorus, and carcass characteristics. There was a reduction of 27.97% of fresh water intake for animals receiving liquid diet. The addition of water to the diet of pigs in the finishing phase does not influence apparent nutrient digestibility, or animal performance when they are fed twice a day. Moreover, it does not influence carcass composition, but decreases fresh water intake, lessening the waste when the animals go to the drinker, and it reduces phosphorus excretion, reflecting positively on the volume and polluting power of the excrements.

KEYWORDS: Liquid feeding; performance; pig production; waste.

ADIÇÃO DE ÁGUA EM RAÇÕES PARA SUÍNOS EM TERMINAÇÃO

RESUMO

Para avaliar a adição de água em rações fareladas na digestibilidade de nutrientes e de energia, o desempenho, a qualidade dos dejetos e as características de carcaça, para suínos em terminação, foram utilizados 12 suínos machos, castrados, híbridos comerciais, com peso inicial de 64,0 ± 4,8 kg, em um ensaio metabólico, distribuídos em delineamento em blocos ao acaso, com base no peso inicial. Outros dezoito suínos machos, castrados, híbridos comerciais e dezoito fêmeas, híbridas comerciais, com peso inicial de 60,0 ± 3,6 kg, foram utilizados no ensaio de desempenho, distribuídos em delineamento inteiramente casualizado. Formulou-se uma ração para atender às exigências dos animais, a qual consistiu no tratamento seco. O segundo e terceiro tratamentos consistiram da mesma ração, com a adição de igual proporção e do dobro de água, respectivamente. Não houve diferença estatística entre os tratamentos para os coeficientes de digestibilidade aparente da matéria seca, energia bruta, extrato etéreo, cálcio e fósforo, para as variáveis de desempenho, umidade, nitrogênio e fósforo fecal e características de carcaça. A redução da ingestão de água por animais que recebem dieta líquida foi de 27,97 %. A adição de água em rações de suínos na fase de terminação não influencia a digestibilidade aparente dos nutrientes da dieta nem o desempenho dos animais, quando o arraçoamento é realizado duas vezes ao dia. Além disso, não influencia na composição da carcaça, porém diminui a ingestão de água, levando a um menor desperdício quando os animais vão ao bebedouro e reduz a excreção de fósforo, podendo refletir, de forma positiva, no volume e no poder poluente dos dejetos.

PALAVRAS-CHAVE: Dejetos; desempenho; dieta líquida; suinocultura.

INTRODUCTION

The liquid feeding system is characterized by dilution of solid ingredients into liquid components. The supply of liquid diets can be accomplished in different ways, such as by adding water (HAN et al., 2009; PEDERSEN & STEIN, 2010; SILVA et al., 2011), by incorporating liquid fermented (PLUMMED-FERRER & WRIGHT, 2009; MISSOTTEN et al., 2010; PEDERSEN & STEIN, 2010) or unfermented (CANIBE & JENSEN, 2003) industrial residue, and by including acidifying components (DUNG et al., 2009).

Several advantages are attributed to this system, including the use of food industry by-products, positive effects on the composition of the animal's gastrointestinal microbiota, alternative to increase feed intake during hot season, improved performance, reduction of ration waste by reducing the amount of powder, and greater animal comfort (BERTOL & BRITO, 1995; JENSEN & MIKKELSEN, 1998). Other benefits are the reduction of feeding costs, facility of feeding two or three times a day, and the possibility of providing the food at the fresher hours of the day, especially in hot regions. It also allows the promotion of more appropriate conditions for the use of probiotics and / or enzymes in the diet, and the possibility of reducing environmental pollution caused by pigs, since this system allows the appropriate utilization of nutrients by animals, increasing digestibility and reducing waste volume (BROOKS et al., 2003; PLUMMED-FERRER & WRIGHT, 2009; MISSOTTEN et al., 2010).

BEAL et al. (2002) and FARZAN et al. (2006) reported that liquid feeding system can also present sanitary benefits, especially because it aids at reducing the risk of microbial contamination by the animals. PLUMMED-FERRER & WRIGHT (2009) stated that pH changes caused by liquid foods, especially fermented ones, represent a complementary way of microorganism control.

Another important factor regarding the supply of liquid diets for pigs is the possibility of producing better carcass quality, which is directly related to stress conditions; however, little research has been carried out regarding this association. It is believed that by providing liquid diets, carcass quality can be improved, because the water is associated with the thermoregulation mechanism and hence the heat sensation dicreases (SILVA et al, 2011; CANIBE & JENSEN, 2012).

Researchers are not yet certain about the viability of the use of liquid feeding. Studies on the proper use of nutrients and particle size of the ingredients of feed moistened by water can supply the researcher with information on the nutrient digestibility of liquid diet (PEDERSEN & STEIN, 2010). HAN et al. (2009) found that liquid diets offered to piglets at 30 days of age, for 10 days, were sufficient to increase the digestibility of dry matter, energy, crude protein and neutral detergent fiber content of the diets.

This study was conducted to evaluate the effects of adding water into mash feeds on nutrient and energy digestibility, performance, water intake, manure quality and carcass characteristics of pigs in the finishing phase.

MATERIAL AND METHODS

We conducted two experiments (digestibility and performance) with pigs in the finishing phase, at the Swine Department and Animal Nutrition Laboratory, Department of Animal Production, School of Veterinary and Animal Science, Federal University of Goias

We used 12 barrows for the metabolism trial. The animals were commercial hybrids with an initial weight of 64 ± 4.8 kg, and were distributed in randomized blocks, based on their weight of the animals, with three treatments (water levels added to the diet) and four replications, totaling 12 experimental units. For the performance trial, we used 18 barrows and 18 females, all commercial hybrids, with initial weight of 60 ± 4.6 kg, distributed in a completely randomized design, with the same treatments, but in six replications, totaling 18 experimental units.

The digestibility trial plots consisted of one animal per Pekas' (1968) metabolic cage, placed in a masonry shed with curtains and isothermal ceiling. The performance trial plots were formed by a female and a male animal housed in a cubicle with compact floor, equipped with masonry feeder and nipple drinker.

We formulated the ration to meet the animals' requirements, according to the category and the Brazilian tables of nutritional requirement and food composition for birds and pigs (ROSTAGNO et al., 2005). One of the treatments consisted of dry feed. The other two treatments consisted of the dry feed with the addition of an equal proportion of water (1:1 water:feed ratio), and of the double of water (2:1 water:feed ratio), being characterized as wet and liquid feed, respectively. We used the kilogram as the proportional unit. The proximate and nutritional composition and energy of the ration are displayed in Table 1.

Table 1 - Proximate composition and nutrient content of the ration

Ingredient	Proximal Composition (%)
Corn	79.98
Soybean meal	17.42
Vitamin and mineral supplement[1]	0.30
L-lysine HCl 78%	0.11
Limestone	0.39
Dicalcium phosphate	1.09
Salt	0.35
Vegetable oil	0.35
Total	100.00
Calculated nutritional content[2]	
Metabolizable energy (kcal / kg)	3.250
Crude protein	14.50
Lysine (%)	0.679
Digestible methionine (%)	0.211
Calcium (%)	0.484
Available phosphorus (%)	0.248
Sodium (%)	0.160

[1]Quantities per kg of product: Vitamin A - 840,000 UI; Vitamin D3 - 180,000 UI; Vitamin E - 3,300 mg; Vitamin K3 - 240.00 mg; Vitamin B1 - 135 mg; Vitamin B2 - 660 mg; Vitamin B6 - 135 mg; Vitamin B12 - 2,700 mcg; Niacin - 4,200 mg; Folic acid - 75 mg; Pantothenic acid - 2,100 mg; Manganese - 4,500 mg; Zinc - 24,000 mg; Iron - 16,250 mg; Copper - 2,394 mg; Iodine - 90 mg; Selenium - 90 mg; Antioxidant - 235.87 mg; Growth Promoter - 30,316 mg; Manganese monoxide - 27,000 mg; Zinc oxide - 144,000 mg; Copper sulfate - 14,400 mg; Iron sulfate - 99,000 mg; Calcium iodate - 540 mg; [2]dry matter basis.

We settled minimum and maximum thermo-hygrometers in the sheds where both tests were performed, at the height of the animals, for measuring the temperature and humidity inside the shed, once a day during all the experimental period.

The metabolic trial lasted 15 days, eight for the animals' adaptation to cages and experimental diets and seven for feces and urine collection. Throughout the experimental period, we fed the animals twice a day, at 7:00 a.m. and 5:00 p.m. We defined the feed supply during the sample collection on the first eight days of experiment, based on the individual metabolic weight of each animal ($kg^{0.75}$). We added water to the diet at every meal, always following the ratio proposed by the treatments (dry feed, 1:1 water:feed ratio and 2:1 water:feed ratio), with subsequent homogenization and supply to the animals. We provided fresh water *ad libitum* immediately after food intake; however, we established control to calculate water intake. Both amounts of feed and water supplied were systematically recorded on individual cards.

We carried out total feces collection daily, and weighed, bagged, recorded and stored the samples under freezing in labeled plastic bags. We collected the urine daily in plastic containers with 20 ml of HCl (1:1) to avoid nitrogen loss and bacterial proliferation. Then we weighed, recorded and homogenized the samples, and removed a 200 mL portion for storage under freezing.

After the collection period, feces were thawed and homogenized for the withdrawal a 20% portion for pre-drying at 55°C in a forced air oven for 72 hours. Urine was also thawed and homogenized, filtrated and packaged under refrigeration. We carried out laboratory analyses of calcium and phosphorus in the ration and feces, as well as of dry matter, nitrogen, protein and energy of feed, feces and urine, according to the methodology described by SILVA & QUEIROZ (2002).

We used the amount of food provided, feces and urine excreted, and the results of the laboratory analysis in the calculations of digestibility and metabolizability, as described by SAKOMURA & ROSTAGNO (2007), according to the following formulas: CAD = (NI - FN) / NI x 100, where: CDA is the coefficient of apparent digestibility, NI is the nutrient intake and FN is the fecal nutrient; and CAM = (NI - FN - UN) / DMI x 100, where: CAM is the coefficient of apparent metabolizable energy, NI is the gross energy intake, FN is the gross energy excreted in feces, UN is the gross energy excreted in urine, and DMI is the dry matter intake. The variables used to assess the quality of the manure were moisture, nitrogen and phosphorus in the feces.

In the performance trial, we fed the animals twice a day, at 7:00 a.m. and 5:00 p.m., always providing enough food to satisfy the animals, based on the leftovers in the feeders. We weighed the feed in plastic containers, adding water with further homogenization in the proportion established for treatments, before providing it to the animals. The cleaning of the stalls was performed every two days and the cleaning of the feeders, every week, with the aid of spatulas. The leftovers were submitted to water loss in a forced-circulation oven at 55°C for 72 hours to specify the amount of dry feed not consumed by the animals.

The variables evaluated were feed intake, weight gain and feed conversion. The end of the experiment occurred when the average weight of animals in each experimental unit reached the range of 100 kg of live weight. At this moment, the animals were slaughtered for carcass evaluation, following the methodology described by BRIDI & SILVA (2006).

The results of digestibility, water intake, manure quality and of performance were submitted to analysis of variance. For comparison of means, we used Student Newman Keuls test (SNK) at 5% probability. All statistical analyses were performed in SAS (SAS, 2000).

RESULTS AND DISCUSSION

The respective minimum and maximum values of temperature and humidity, during the digestibility trial were 22.3 ± 0.6°C and 31.1°C ± 1.1, and 59.9 ± 5.4% and 93.1 ± 2.9%, and during the performance trial they were, respectively, 22.1 ± 0.8°C and 30.6°C ± 0.7, and 58.0 ± 3.3% and 93.2 ± 3.1%.

During the analysis of the means of the coefficient of digestibility of nutrients and energy (Table 2), we verified that reports about the digestibility of liquid diets for finishing pigs are still scarce in the literature. Adding water to the feed for animals in the finishing phase did not affect the digestibility of nutrients and energy, which can be related to the fact the diet offered was unfermented. SILVA et al. (2011) used unfermented rations with the addition of water for piglets with an average weight of approximately 19.0 kg, and found an effect only for the coefficient of metabolization of crude protein, which was improved in wet (1:1 water:feed ration) and liquid feed (2:1 water:ration ratio) compared to dry feed.

CANIBE & JENSEN (2003) characterized fermented liquid feed as the mixture of dry feed with liquid ingredients, stored in a controlled environment for a determined period of time before being supplied to the animals, and unfermented liquid feed as the mixture of dry feed with liquid ingredients right before supplying it to the animals. According to LAWLOR et al. (2002), the effect of mild fermentation of the ration is beneficial to the animal because it promotes a balance between the pH of ration and the pH of the intestinal environment, due to the high levels of lactic bacteria, yeasts and lactic acid production. As in this trial we used unfermented experimental rations, they did not affect the action of pancreatic and intestinal enzymes, and did not diminish the population of enterobacteria, which would minimize the effects of competition for nutrients.

We verified that, when evaluating the mean values of nitrogen retained from the digestible energy and metabolizable energy of the treatments (Table 2), the absolute values of dry diet are lower when compared to the values of rations added of water, although there was no difference (P> 0.05) among the diets. According to the results, the addition of water to the ration for pigs may lead to the retention of more 3.8 g nitrogen per day in the animal's organism, representing a daily increase of 10.8%. This also occurs for the digestible and metabolizable energy, because there was an increase of up to 100 and 116 kcal/kg, respectively, in the liquid feed compared with dry feed. SILVA et al. (2011) found positive effects on digestibility of nitrogen for diets with addition of water at the ratio of 1:1 and 2:1 for piglets in the initial phase.

Table 2 - Coefficients of digestibility of dry matter, crude protein, ether extract, calcium, phosphorus, and gross energy, coefficient of metabolization of gross energy, and retained nitrogen, of rations for finishing pigs containing different levels of water

Variables[1]	Type of feed[2]			P	CV %
	Dry feed	Wet feed	Liquid feed		
Coefficients of digestibility of dry matter (%)	90.1	90.6	90.8	0.61	2.5
Coefficients of digestibility of crude protein (%)	87.2	89.5	89.5	0.56	4.0
Retained nitrogen (g/day)	31.2	35.0	33.1	0.34	10.0
Coefficients of digestibility of ether extract (%)	83.6	86.7	83.8	0.53	6.7
Coefficients of digestibility of calcium (%)	70.2	74.6	71.8	0.90	7.0
Coefficients of digestibility of phosphorus (%)	68.7	68.4	70.5	0.88	10.3
Coefficients of digestibility of gross energy (%)	88.5	90.6	88.9	0.38	2.6
Coefficient of metabolization of gross energy (%)	87.0	89.7	87.9	0.39	2.6

[1]on dry matter basis; [2]treatments: dry feed, wet feed = 1:1water:feed ratio, and liquid feed = 2:1 water:feed ratio

We did not observe any difference among treatments when evaluating the performance variables of pigs in the finishing phase fed rations with the addition of different water contents (Table 3). The results regarding liquid feed for pigs in the finishing phase contrasted the findings by NIVEN et al. (2006), who used water extracted from corn by maceration as diluent (around 2,293 g, 899 g and 2.55 for feed intake, weight gain and feed conversion, respectively). It is probable that the water extracted from corn by maceration contributed to the differences in relation to this trial because it presents nutrients in comparison with pure water.

We verified a reduction in the intake of fresh water up to 0.87 kg by animals receiving liquid diet compared with animals fed dry feed (Table 3). This 28% reduction is certainly related to the fact that part of the daily requirement of water was supplied by the water added to the diets, hence animals went less often to the drinker, which represents an advantage of the liquid feed system. YANG et al. (1981) observed reduction in water consumption when they provided dry pelleted diet or pelleted diet mixed with water at 2:1 water:feed ration. DYBKJÆR et al. (2006) emphasized that, for piglets, there is a close relationship between water and feed intake, and the diet composition and the ambient temperature affect the amount of water consumed.

For feces moist, phosphorus excretion and fecal nitrogen (Table 3), we verified no differences (P> 0.05) among the types of feed provided.

Table 3 - Performance, fresh water intake, feces humidity, fecal nitrogen, fecal calcium and fecal phosphorus in pigs in the finishing phase in function of diets containing different levels of water

Variables	Type of feed [1]			P	CV %
	Dry feed	Wet feed	Liquid feed		
Feed intake (g / dia)	3075	3052	3081	0.99	9.6
Weight gain (g / dia)	999	1067	1001	0.58	11.2
Feed conversion	3.07	2.89	3.09	0.49	9.2
Fresh water intake (kg/kg of consumed dry matter)	3.11[a]	3.31[a]	2.24[b]	0.05	14.5
Feces humidity (%)	64.9	62.2	63.8	0.39	2.7
Fecal phosphorus (g / dia)	4.78	5.10	5.16	0.69	13.1
Fecal nitrogen (g / dia)	6.00	5.50	4.75	0.48	25.6

[1]treatments: dry feed, wet feed = 1:1water:feed ratio, and liquid feed = 2:1 water:feed ratio

We found that, after feed supply, animals consumed almost all of what was offered in less than thirty minutes. This probably increased peristaltic movements, causing a high passage rate of food, which may have contributed to the better utilization of nutrients of humid diets. The completion of feeding immediately after mixing the water to the mash diet may have influenced the results.

In commercial farms, where the automated liquid feed system is used for pigs, the daily frequency of feeding, held in smaller portions, is up to eight times, allowing better utilization of nutrients by animals. BROOKS et al. (2003) reported problems regarding the use of liquid feeding system, such as the mechanization and automation of the system, the difficulty of harmonizing the technique of liquid feeding to the real nutritional needs of pigs and finding the optimal dilution, which depends on the ingredients used and the participation of each one in the diet, and the possible occurrence of fermentative processes.

We did not find significant differences (P <0.05) for carcass yield, carcass length and backfat thickness as a function of the addition of water to the diets (Table 4), so that the values for carcass yield agree with those reported by NIVEN et al. (2006).

Table 4 - Carcass yield, carcass length and backfat thickness of pigs in the finishing phase fed diets containing different levels of water

Variables	Type of feed [1]			P	CV %
	Dry feed	Wet feed	Liquid feed		
Carcass yield (%)	77.45	75.44	75.65	0.37	3.47
Carcass length (cm)	97.67	93.00	96.67	0.20	3.79
Backfat thickness P1 (cm)	4.25	4.21	3.78	0.26	12.88
Backfat thickness P2 (cm)	2.59	2.93	2.31	0.36	27.72
Backfat thickness P3 (cm)	2.58	2.50	2.20	0.68	32.35
Mean backfat thickness (cm)	3.14	3.21	2.76	0.38	18.88

[1]treatments: dry feed, wet feed = 1:1water:feed ratio, and liquid feed = 2:1 water:feed ratio

CONCLUSIONS

The addition of water to rations for pigs during the finishing phase does not influence the apparent digestibility of nutrients, the performance of the animals, or the carcass composition when animals are fed twice a day. Furthermore, it decreases fresh water intake, lessening waste when the animals go to the drinker, and reflecting positively on the volume and polluting power of manure.

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