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Assessment of the drinker type on water intake and toy type on behaviour of nursery piglets

Avaliação do tipo de bebedouro sobre o consumo hídrico e o tipo de brinquedo sobre o comportamento de leitões de creche

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Highlights

There was an increase in water intake in starter piglets according to the type of drinker.
The metal chain toy promoted improvements in feeding behaviour and water intake.
Piglets increased as behavioural observations in the afternoon period.

Abstract

This study was conducted to assess the effect of two types of drinkers on water intake (WI) and two types of toys on behavioural observations of piglets in the nursery phase. A total of 72 crossbred entire male piglets (Landrace × Large White, Agroceres♂ and DanBred♀), weaned at 21 days of age, with an average initial body weight (AIBW) of 6.75 ± 0.19 kg were used. Two statistical models were fitted for WI. In model I, animals were distributed in a completely randomized design (CRD) with a split-plot in time, composed of six treatments (2 types of drinkers × 3 experimental phases), eight replications (days of sampling), and 36 animals/experimental unit (EU), without using AIBW as a covariate. In model II, animals were distributed in a CRD with two treatments (fixed or pendular nipple drinkers), eight replications (days of sampling) and 36 animals/EU, with use of AIBW

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as a covariate. For assessment of behavioural observations, the model was adjusted in a randomized block design, consisting of four treatments [two types of toys (metal chain and plastic bottle) × two daytime periods (morning and afternoon)], nine replications and three blocks constituted in time (days), totalling four pigs/EU. The results indicated an effect on animal daily WI in the starter phase in model I ($p < 0.000$) and II ($p = 0.006$). There was an effect ($p \leq 0.05$) of toy type for behavioural observations, in which pigs showed a greater proportion of fighting and belly nosing when they had the bottle toy. However, animals spent more time ($p \leq 0.05$) eating, drinking water, overlapping, and playing with the toy when they had access to the chain toy. There was an increase ($p \leq 0.05$) in sleeping behaviour in the morning period, as well as greater ($p \leq 0.05$) behavioural activity in the afternoon period. In conclusion, WI of nursery piglets was positively influenced by growth phase, and the fixed drinker stimulated greater WI in piglets in the starter phase. In addition, the metal chain, as an environmental enrichment, promoted improvements in feeding behaviour and WI, reducing fighting events, and the afternoon period had increased behavioural observations overall.
Key words: Animal welfare. Behaviour. Drinker type. Environmental enrichment. Water intake. Weaned piglet.

Resumo

Um estudo foi conduzido com o objetivo de avaliar dois tipos de bebedouros e seus efeitos sobre o consumo hídrico (CH) e dois tipos de brinquedos sobre os eventos comportamentais de leitões na fase de creche. Um total de 72 leitões machos inteiros mestiços (Landrace × Large White, Agroceres♂ e DanBred♀), desmamados aos 21 dias de idade e peso corporal inicial médio (PCIM) de 6,75 ± 0,19 kg. Para o CH foram ajustados dois modelos estatísticos. No modelo I, os animais foram distribuídos em um delineamento inteiramente casualizado (DIC) e esquema de parcelas subdivididas no tempo, composto de seis tratamentos (2 tipos de bebedouros × 3 fases experimentais), oito repetições (dias de amostragem) e 36 animais/unidade experimental (UE) e sem utilização de PCIM como covariável. No modelo II, os animais foram distribuídos em um DIC aninhado com dois tratamentos (bebedouro tipo chupeta fixo ou pendular), oito repetições (dias de amostragem) e 36 animais/UE, com utilização de PCIM como covariável. Para a avaliação dos eventos comportamentais, foi ajustado um modelo em delineamento de blocos casualizados, constituído de quatro tratamentos [dois tipos de brinquedos (corrente de metal e garrafa plástica) × dois períodos do dia (matutino e vespertino)], nove repetições e três blocos constituídos no tempo (dias), totalizando quatro suínos/UE. Os resultados indicaram efeito no CH diário animal na fase inicial no modelo I ($p < 0{,}000$) e II ($p = 0{,}006$). Houve efeito ($p \leq 0{,}05$) de tipo de brinquedo para as observações comportamentais, em que os suínos apresentaram maior proporção de brigas e empurrando a barriga quando tiveram o brinquedo de garrafa. Entretanto, os animais passaram maior tempo ($p \leq 0{,}05$) comendo, bebendo água, montando outro animal e brincando com o brinquedo quando tiveram acesso ao brinquedo de corrente. Houve um aumento ($p \leq 0{,}05$) no comportamento de dormir no período matutino, bem como os suínos apresentaram maior ($p \leq 0{,}05$) atividade comportamental no período vespertino. Em conclusão, o consumo hídrico de leitões em fase de creche é influenciado positivamente pela fase de crescimento e o bebedouro fixo estimulou um maior consumo de água em leitões na fase inicial. Em adição, o tipo de enriquecimento ambiental corrente promoveu melhorias no comportamento alimentar e de ingestão de água, reduzindo eventos de brigas, bem como o período vespertino aumentou os eventos comportamentais em geral.
Palavras-chave*:* Bem-estar animal. Comportamento. Tipo de bebedouro. Enriquecimento ambiental. Consumo de água. Leitão desmamado.

Introduction

Animal welfare is a topic that has been widely addressed in recent years (Dawkins, 2017). Consumers have sought products that aim at proper handling and well-being of farm animals. Consequently, several studies have looked for alternatives to associate improvements in husbandry conditions without affecting production cost. Among these alternatives, environmental enrichment with the use of toys is the most common (Machado et al., 2017; Foppa et al., 2014, 2018).

Innovations in swine production have been necessary in order to stimulate the species' natural behaviour, maximizing performance by reducing animal stress (Vasconcelos et al., 2015). Furthermore, issues regarding types of equipment in swine production, such as the type of drinker and how it may positively affect water intake, reduce water waste, and improve feeding behaviour (Torrey, Toth Tamminga, & Widowski, 2008) and the type of toy and how it impacts the well-being of the animals (Maia, Sarubbi, Medeiros, & Moura, 2013; Machado et al., 2017; Foppa et al., 2018), are promising alternatives in intensive pig production system.

Although several studies have been conducted to investigate different models of drinkers, water intake (Torrey et al., 2008; Bøe & Kjelvik, 2011) and the behaviour of piglets with different types of environmental enrichment (Van de Weerd, Docking, Day, Breuer, & Edwards, 2006; Maia et al., 2013), there is limited information on water intake with different types of drinkers, as well as on what type of toy improves behavioural activities of piglets.

The use of environmental enrichments keeps animals in better harmony with the environment, preventing undesirable aggressive behaviour (Bracke & Koene, 2019). Attempts to reduce stress in the nursery phase of piglets are important to improve animal performance as well as their welfare (Veloni et al., 2013; Dias, Silva, & Manteca, 2014). Moreover, the quality and quantity of water needed by animals must follow requirements and key factors, ensuring the good development of the animals (Andersen, Dybkjær, & Herskin, 2014). Each growing phase has a minimum water intake that must be met (Chimainski et al., 2019) to ensure repletion and proper functioning of all metabolic functions, which affects animal welfare and performance.

Water is a fundamental nutrient for all organisms, but as a research object, it has received little attention, especially in animal production (Patience, 2012). Therefore, this study was performed to evaluate the effect of two types of drinkers on water intake, as well as two types of toys on the behaviour of piglets in the nursery phase.

Material and Methods

This study was carried out at the swine facility of the Universidade Estadual do Oeste do Paraná (UNIOESTE) – located in Marechal Cândido Rondon, Brazil. Piglets were handled carefully to avoid any unnecessary discomfort and all experimental procedures were approved by the UNIOESTE Research Ethics Committee (CEUA-UNIOESTE).

Animals, experimental design, housing, and treatments

A total of 72 crossbred male piglets (Landrace × Large White, Agroceres♂, and DanBred♀), weaned at 21 days of age and initially weighing 6.75 ± 0.19 kg of body weight were allotted to different experimental designs. At the beginning of the experimental period, animals were weighed and identified with numbered earrings and housed in a nursery facility built with masonry walls and floor, and a ceramic roof. The nursery facility had a central aisle with pens on both sides. Pens (5.91 m2) were equipped with frontal gutter-type feeders and nipple drinkers (fixed or pendular) at the rear.

The room temperature and relative humidity were recorded by a datalogger with a digital display (Vketech, model temperature instruments), which was installed in the middle of the nursery facility. The daily average temperature was 25.3 °C, 23.8 °C and 24.8 °C for pre-starter I, pre-starter II, and starter phases, respectively. The nursery facility ventilation was provided with the aid of lateral curtains. The heating of the experimental pens was controlled using individual infrared heat lamps. Wooden squares (0.54 m^2) were used to accommodate piglets under the infrared heat lamps. A tarpaulin was attached to the top of the pens to reduce room temperature fluctuations.

Animals were fed a commercial feed (Table 1) with *ad libitum* intake. Feed was formulated to meet the requirements of piglets according to the Brazilian Tables for Poultry and Swine: food composition and nutritional requirements (Rostagno et al., 2011). Feed ingredients were analysed for physicochemical composition using near-infrared reflectance spectroscopy (NIRS™ DS2500 F analyser). The results were similar to those previously reported by Rostagno et al. (2011).

The animals had free access to water throughout the experiment. The water supply of the nursery facility was provided by two lines (right and left) equipped with an individual hydrometer to quantify separately the water intake (WI) on both sides. Only one type of drinker was activated on each water line. WI was recorded daily at 15h00 for eight days of each phase.

To assess environmental enrichment, toys were made with plastic bottles (32 cm long and 10 cm wide) and galvanized metal chains (32 cm long, with 5.5 mm links). Toys were hung using nylon ropes at the eye level of the piglets in the middle of pens to avoid contact with animals from different pens.

Behavioural observations

To evaluate behavioural activities, piglets from the same experimental unit (pen) were identified using coloured markers as follows: red, blue, purple, and white (unmarked animal). Marks were made on the day before the beginning of the observations in order to avoid stress on the animals before and during the evaluation period. Behaviour evaluations were performed over three days for eight hours (from 09h00 to 16h50) with ten-minute intervals. A total of 48 daily observations per animal was made. Evaluations were performed by three qualified people (located at strategic spots in the nursery facility) using an ethogram (Massari, Curi, Moura, Medeiros, & Salgado, 2015).

Table 1
Centesimal and calculated composition of piglet diets in the pre-starter (I and II) and starter phases (as fed basis)

Item	Experimental phases[1] (6.75 to 26.90 kg)		
	PI	PII	S
Corn	49.15	55.20	59.80
Soybean meal	18.00	25.00	30.00
Soybean oil	3.35	2.80	2.70
Fish meal	3.50	3.00	1.50
Nucleus[3]	26.00	14.00	6.00
Total (%)	100.0	100.0	100.0
	Calculated composition		
Crude protein (%)	18.50	19.00	20.00
Lactose (%)	7.10	2.60	-
Metabolizable energy (kcal kg^{-1})	3,55	3,42	3,40
Digestible lysine (%)	1.37	1.34	1.32
Digestible methionine (%)	0.52	0.52	0.48
Total calcium (%)	0.55	0.70	0.72
Available phosphorus (%)	0.39	0.35	0.34
Total sodium (%)	0.28	0.23	0.24

1) PI and PII: pre-starter I and II; S: starter.
2) Composition per phase (levels of warranty): PI, PII and S (g kg^{-1}), respectively: Humidity maximum (100.0; 100.0; 120.0), Crude protein minimum (190.0; 200.0; 200.0), Ether extract minimum (70.0; 60.0; 50.0), Mineral matter maximum (55.0; 55.0; 60.0), Average chain fatty acid minimum (3.8; 3.8; -)*, Lysine minimum (14.5; 13.0; 13.5), Methionine minimum (5.0; 4.0; 4.85), Crude fibre maximum (30.0; 50.0; 35.0), Calcium (6.0 to 7.0; 5.5 to 7.0; 8.0 to 9.0), Phosphorus (5.0; 5.0; 6.0), Sodium (3.3; 2.7; 2.7). *Trace (-): Value not reported on the label of the feed or absence.
3) Minimum level of microminerals and vitamins (mg kg^{-1}): Folic acid (0.65), Pantothenic acid (13.72), Cobalt (0.140), Copper (9,500), Iron (120), Iodine (1.20), Niacin (33.0), Selenium (0.30), Manganese (30.0), Vitamin B_1 (1.29), Vitamin B_2 (8.32), Vitamin B_6 (3.90), Vitamin K_3 (1.65), Zinc (2,137).

Statistical analysis

Two statistical models were fitted to the WI data of the piglets. In model I, 72 piglets were distributed in a completely randomized design (CRD) with a split-plot in time, with six treatments [two types of drinkers (fixed or pendular nipple) × three growth phases (pre-starter I, II, and starter)], eight replications (days of sampling), and 36 animals per experimental unit (a set of nine pens on each side of the facility), where the daily average water intake per animal (DWIA) was evaluated. The statistical model used was $Y_{ijk} = \mu + B_i + \varepsilon_{ik} + F_j + B_{Fij} + \varepsilon_{ijk}$, where: Y_{ijk} = the observation of water intake in each plot, measured in the i-th class of type of drinker, in the j-th class of growth phase and in the k-th replication; μ = overall average, B_i = effect of the drinker (i = 1 and 2), ε_{ik} = random error of the plot, F_j = effect of the growth phase (j = 1, 2 and 3), BF_{ij} = interaction between type of drinker and growth phase, and ε_{ijk} = random error of the subplot. The effects of drinker type and the growth phase on the DWIA were verified via analysis of variance (ANOVA). DWIA means between drinker types were compared using the ANOVA F test. Means among growth phases were determined using the Student-Newman-Keuls test.

In model II, 72 piglets were distributed in a CRD, with two treatments (fixed or pendular nipple drinker), eight replications (days of sampling), and 36 animals per experimental unit (a set of nine pens on each side of the facility). The statistical model used was $Y_{ij} = \mu + T_i + \beta_1(X1_{ij} - X\ldots) + \varepsilon_{ij}$, where: Y_{ij} = the observation of water intake in each experimental unit, measured in the i-th treatment (drinker type) and in the j-th replication; μ = overall average; T_i = effect of treatment (i = 1 and 2); β_1 = regression coefficient of Y over X1; $X1_{ij}$ = average initial body weight (covariate) of animals in each experimental unit, measured in the i-th treatment class and in the j-th replication); X… = overall average for the covariate X1; and ε_{ij} = random error of the experimental unit associated with each observation Y_{ij}.

Using model II, data on daily water intake per animal in pre-starter phase I (DWIA-I), daily water intake per animal in pre-starter phase II (DWIA-II), daily water intake per animal in starter phase ($DWIA_{SP}$), daily water intake accumulated per animal in pre-starter I and pre-starter II phases ($DWIAA_1$) and daily water intake accumulated per animal in the total period ($DWIAA_{TP}$) were analysed. The effect of drinker type was verified by analysis of covariance (ANCOVA). Averages of WI between drinker types were compared using the ANCOVA F test.

Behavioural observations were performed simultaneously with the Expt. I. Seventy-two piglets were distributed in a randomized complete block design. A total of 108 records of behavioural variables of nursery piglets were obtained from the combination of two types of toys (metal chain and plastic bottle) × two times periods (morning and afternoon), which were repeated nine times in three blocks (days), with four pigs/EU (pen). Behaviour observations (standing up, lying down, sleeping, defecating, urinating, eating, dispute in the feeder, drinking, playing in the drinker, fighting and others, smelling another animal, running, exploring, belly nosing, sucking or biting another piglet, overlapping, playing with toy, and fighting with the piglet in the adjacent pen) were taken from 09h00 to 12h50 (morning) and from 13h00 to 16h50 (afternoon), according to Massari et al. (2015). Statistical analysis was performed by adjusting generalized linear models (GLM). Data were expressed as percentages obtained by the ratio between the sum of the count of successes obtained for the treatment and the total number of records per treatment, which was 96 (six records per hour × four hours × four animals). The binary data of the behavioural variables were modelled by the binomial distribution, with a logit link function, represented by $g(\mu) = \ln(\pi/1- \pi)$, where π is the probability of a pig presenting a certain behaviour.

The maximum likelihood method was used to estimate the parameters of the models. GLM was represented by the systematic portion $\eta = \mu + B_k + T_i + P_j + TP_{ij}$, where μ = overall average, B_{lk} = effect of blocks, T_i = effect of toy types (i = 1 and 2), P_j is the effect of the period (j = 1 and 2), TP_{ij} = effect of interaction between the i-th toy and the j-th period.

The significance of the effects associated with T, P, and the interaction (T ×

P) was verified in the type III analysis, using the Wald test. The goodness-of-fit of the model was verified via the highest value of the logarithm of the maximum likelihood function and by comparing the value of the ratio between residual deviance (scaled deviance) and residual degrees of freedom with the percentiles of the distribution (McCullagh & Nelder, 2019).

The observed averages (proportions) of least squares (lsmeans) of the behavioural variables related to the isolated effects of toy type and period, and of interaction (T × P), expressed by the hierarchical effects of T given P and P given T were compared by testing the difference between lsmeans, using the chi-square test. Significant differences were set at $p \leq 5\%$. Statistical analyses were performed using the SAS University Edition software (SAS Inst. Inc., Cary, NC, USA).

Results and Discussion

Effect of drinker type on water intake

There was no interaction ($p = 0.166$) between drinker type and growth phases and no effect of drinker type ($p = 0.202$) on DWIA. There was an effect ($p < 0.000$) of growth phase on the DWIA (Table 2). A higher DWIA was observed for piglets in the starter phase compared to those in pre-starter phases I and II.

Table 2
Daily water intake per animal (DWIA) in litters and standard deviations (in parentheses) during the experimental phases

Item	Experimental phases		
	Pre-starter I	Pre-starter II	Starter
DWIA	1.90 (0.23)[c]	2.60 (0.51)[b]	3.95 (0.39)[a]
SEM[1]		0.056	
p-value[2]		<0.000	

[a,b,c]Averages followed by different letters in the row differ from each other by the Student-Newman-Keuls test at 5% probability level.
[1)] SEM = Standard error of mean.
[2)] p-value = Probability.

There are few current reports on different types of drinkers and their effect on water intake in nursery piglets. The reason why piglets show differences in water intake by phase is attributed to the increase of body weight according to the growth phase and also the influence of physiological needs (Patience, 2012). Other factors, such as the flow of drinkers, can also influence the difference in water intake and eating behaviour (Torrey et al., 2008). In this case, despite the flow of the drinkers being above the recommended (1.47 and 2.05 L min^{-1}) (Li, Chénard, Lemay, & Gonyou, 2005), no effects on WI and body development of the animals in the present study were observed. Factors such as room temperature and diet (Patience, 2012), and position or angle of placement of the drinker (Arulmozhi et al., 2020) have previously been reported to affect WI. However, in the present study, the piglets were kept under similar dietary and room temperature conditions, as well as constant adjustments of the drinkers according to the growth of the animals.

No difference was found for DWIA (p = 0.202), expressed in litters, for piglets that drank from a fixed (2.89 ± 1.07 L) or pendular drinker (2.75 ± 0.81 L). Guerini et al. (2015) reported DWIA of 2.32 ± 1.02 L day^{-1} for piglets in the nursery phase during 34 days of housing. Water intake of growing pigs in thermoneutral environments fed for *ad libitum* intake ranges from 2.1 to 2.7 L kg^{-1} of feed intake (Li et al., 2005). No preference for a particular model of a drinker was observed, possibly because both drinkers were nipple types. However, Bøe and Kjelvik (2011) reported higher water intake in piglets with nipple drinkers than with bowl drinkers.

There was a difference (p = 0.006) between $DWIA_{SP}$ for piglets that had access to a fixed nipple drinker (4.17 L $animal^{-1}$ day^{-1}) when compared to those that used a pendular nipple drinker (3.73 L $animal^{-1}$ day^{-1}) (Table 3). As the body weight increases, water intake also increases due to a higher need for this nutrient and dry matter intake (Chimainski et al., 2019). Therefore, the average water intake increased as the growth phase progressed. However, the difference obtained for the average water intake in the starter phase between drinker type was mainly due to the easier access of the fixed drinker. This could have allowed greater manipulation by the animals compared to the pendular drinker, preventing the development of behavioural issues (Torrey et al., 2008).

Table 3
Comparison between average water intake, adjusted for average initial body weight of piglets and standard deviations (in parentheses) according to type of drinker

Item[1]	Type of drinker		p-value[2]
	Fixed	Pendular	
$DWIAA_{TP}$	2.88 (0.07)	2.76 (0.07)	0.188
$DWIAA_1$	2.23 (0.06)	2.27 (0.06)	0.607
DWIA-I	1.86 (0.07)	1.94 (0.07)	0.437
DWIA-II	2.60 (0.10)	2.61 (0.10)	0.917
$DWIA_{SP}$	4.17 (0.10)[a]	3.73 (0.10)[b]	0.006

[a,b]Averages followed by different letters in the row differ from each other by the F-test of the analysis of covariance, with average initial body weight as a covariate, at the 5% probability level.
[1)] $DWIAA_{TP}$: daily water intake accumulated per animal in the total period; $DWIAA_1$: daily water intake accumulated per animal in the pre-starter I phase; DWIA-I: daily water intake per animal in pre-starter I phase; DWIA-II: daily water intake per animal in pre-starter II phase; $DWIA_{SP}$: daily water intake per animal in starter phase.
[2)] p-value = Probability.

The accumulated average water intake in pre-starter phases I and II, as well as in the total period of nursery, did not differ due to the type of drinker. This suggests that animals had no loss in their development due to lack of water, as this could restrict feed intake (Bøe & Kjelvik, 2011). The results of the present study agree with the values recommended by others (Li et al., 2005; Guerini et al., 2015). However, more studies are needed to describe the individual water intake behaviour of piglets and the effects of external factors (Andersen et al., 2014).

Effect of toys type on behavioural observations

There was an effect of toy type on the behavioural variables of eating (χ^2 = 4.73; p = 0.029), drinking (χ^2 = 4.23; p = 0.039), fights, threats, chases and avoidances, head thrusts (χ^2= 5.88; p = 0.015); belly nosing (χ^2 = 5.13; p = 0.023), overlapping (χ^2 = 4.40; p = 0.036), and playing with toys (χ^2 = 12.31; p = 0.000) (Table 4).

Table 4
Behavioural observations (%) and standard deviations (in parentheses) according to type of toy

Item	Type of toy		p-value²
	Metal chain	Plastic bottle	
Standing up	8.80 (6.46)	9.51 (8.60)	0.975
Lying down	38.95 (10.20)	37.49 (11.50)	0.527
Sleeping	25.98 (13.20)	27.87 (15.33)	0.525
Defecating	0.12 (0.35)	0.18 (0.53)	0.682
Urinating	0.54 (0.74)	0.52 (0.90)	0.890
Eating	11.81 (4.68)[a]	10.21 (3.51)[b]	0.029
Dispute in the feeder	0.41 (1.03)	0.72 (1.60)	0.297
Drinking	2.57 (2.43)[a]	1.71 (1.61)[b]	0.039
Playing in the drinker	0.59 (1.16)	0.41 (0.68)	0.436
Fighting and others	1.22 (1.91)[b]	2.00 (2.71)[a]	0.015
Smelling another animal	0.23 (0.59)	0.48 (1.54)	0.280
Running	0.37 (1.07)	0.45 (1.13)	0.617
Exploring	3.99 (3.65)	4.96 (4.92)	0.264
Belly nosing	0.22 (0.69)[b]	0.62 (1.30)[a]	0.023
Sucking or biting another piglet	1.11 (1.49)	1.35 (1.91)	0.514
Overlapping	0.80 (1.44)[a]	0.32 (0.70)[b]	0.036
Playing with toy	2.00 (2.70)[a]	0.80 (1.10)[b]	0.000
Fighting with the piglet in the adjacent pen	0.31 (1.14)	0.40 (0.97)	0.893

[a,b]Averages followed by different lower case letters in the row differ from each other by the chi-square test of the generalized linear model analysis of type III at the 5% probability level.
[1)] p-value = Probability.

There was a higher proportion (p = 0.028) of piglets feeding in pens containing the metal chain toy (11.81%) than piglets housed in pens containing the plastic bottle toy (10.21%). Similarly, there was a higher frequency (p ≤ 0.05) of piglets drinking water (2.57%) and playing with toys (2.00%), when piglets were housed in pens with the metal chain toy instead of pens with the plastic bottle toy with frequencies of 1.71% and 0.80%, respectively. Piglets housed in pens with the metal chain toy had a lower frequency of fighting (1.22%) than piglets housed in pens with the plastic bottle toy (2.00%). For the other variables, there was no effect ($p > 0.05$) of toy type.

Toys can be hung or put on the floor of pens and can influence the behaviour of piglets. This agrees with Guy, Meads, Shiel and Edwards (2013), who reported a greater preference for hung materials compared to those put on the floor. This can be explained by the fact that objects on the floor quickly become dirty and may become less attractive to animals (Guy et al., 2013; Maia et al., 2013). In a study conducted by Jensen, Studnitz, Halekoh, Pedersen and Jørgensen (2008), where three types of suspended toys (sisal rope, wooden beam, and bite-rite) were evaluated, they found that animals were not interested in any of these.

The choice of toy to be used for environmental enrichment must consider the age of the animals (Docking, Van de Weerd, Day, & Edwards, 2008). Generally, environmental enrichment is implemented after weaning and some studies have shown that the use of destructible, variable, complex, and malleable materials with edible parts, draw more attention from animals (Van De Weerd, Docking, Day, Avery, & Edwards, 2003; Maia et al., 2013). This may explain the greater interest of animals in the metal chain toy due to its easier manipulation and the possibility of chewing, while the hanging plastic bottle toy did not facilitate the same behaviours.

Undesirable behaviours such as fights, threats, chases and avoidances, head thrusts, and belly nosing were also more frequently expressed ($p < 0.05$) in pens with the plastic bottle toy. These behaviours could be attributed to the lack of ability to manipulate the plastic bottle by the piglets, reducing the possibility of biting and pulling, which frequently occurred in pens with the metal chain toy. Toy characteristics, such as flexibility, which allows chewing, are attractive to pigs (Foppa et al., 2018). Thus, the piglets quickly lost interest in the plastic bottle toy and, consequently, sought other alternatives on which to spend their energy, increasing undesirable behaviours.

Eating and drinking were observed in a higher proportion in pens with the metal chain toy. This could be explained by the activation of the digestive system or by the fact that pigs spent more time interacting with the toy during the experimental period. This occurs due to the chewing activity of the metal chain toy (Mkwanazi, Ncobela, Kanengoni, & Chimonyo, 2019), resulting in greater production and consumption of saliva, which may justify an increase in the need for feed and water. Similarly, greater playing with toy activity resulted in reduced undesirable behaviours, such as fights, chases, avoidances, head thrusts, and belly nosing. This contributes to improving the welfare of the animals (Table 4).

There was an effect of the period of the day on behavioural variables: standing ($\chi^2 = 49.20$; $p < 0.0001$), sleeping ($\chi^2 = 45.55$; $p < 0.000$), feeding ($\chi^2 = 7.72$; $p = 0.005$), competition in the feeder ($\chi^2 = 4.77$; $p = 0.029$), playing in the drinker ($\chi^2 = 4.50$; $p = 0.033$), fights, chases and avoidances, and head thrusts ($\chi^2 = 25.75$; $p < 0.000$), running ($\chi^2 = 5.15$; $p = 0.023$), exploring ($\chi^2 = 7.54$; $p = 0.006$), and playing with toys ($\chi^2 = 3.89$; $p = 0.048$) (Table 5).

An average frequency of sleep activity of 18.74% was observed in the afternoon, while in the morning this was approximately 35.00%. Pigs showed a "standing" frequency of 13.24% in the afternoon and 5.02% in the morning. A lesser sleeping behaviour is attributed to environmental enrichment that allows greater curious behaviour (Machado et al., 2017). It could also be due to variation in the weather throughout the day, which modifies the animal behaviour pattern (Cross, Brown-Brandl, Keel, Cassady, & Rohrer, 2020) and stress hormone concentrations (Mkwanazi et al., 2019).

In the afternoon, piglets were more active, which may be associated with a higher room temperature, promoting greater behavioural activities. Miranda, Borges, Menegale and Silva (2012), who evaluated the noise of piglets in the nursery phase and found low levels of activity (low movement) for the thermal comfort range (20 to 23 °C). Furthermore, these authors observed an increase in behaviours such as fights and restlessness in temperatures ranging from 23 to 30 °C. These results are similar to those of the present study.

Table 5
Behavioural observations (%) and standard deviations (in parentheses) according to the daytime period in both types of drinkers

Item	Daytime		p-value[1]
	Morning	Afternoon	
Standing up	5.02 (3.77)[b]	13.24 (8.09)[a]	<0.000
Lying down	36.64 (12.15)	39.89 (9.10)	0.114
Sleeping	35.00 (12.35)[a]	18.74 (10.96)[b]	<0.000
Defecating	0.16 (0.50)	0.14 (0.38)	0.805
Urinating	0.42 (0.83)	0.64 (0.79)	0.183
Eating	9.89 (4.31)[b]	12.23 (3.83)[a]	0.005
Dispute in the feeder	0.31 (0.98)[b]	0.80 (1.57)[a]	0.029
Drinking	1.99 (1.91)	2.34 (2.31)	0.495
Playing in the drinker	0.32 (0.69)[b]	0.68 (1.15)[a]	0.033
Fighting and others	1.10 (1.81)[b]	2.08 (2.70)[a]	0.006
Smelling another animal	0.24 (0.66)	0.46 (1.47)	0.353
Running	0.36 (1.10)	0.45 (1.10)	0.548
Exploring	4.94 (4.82)	3.96 (3.69)	0.218
Belly nosing	0.32 (0.82)	0.50 (1.20)	0.328
Sucking or biting another piglet	1.41 (1.99)	1.04 (1.34)	0.325
Overlapping	0.44 (0.89)	0.71 (1.39)	0.224
Playing with toy	1.22 (2.33)[b]	1.65 (2.02)[a]	0.048
Fighting with the piglet in the adjacent pen	0.24 (0.94)	0.46 (1.17)	0.317

[a,b]Averages followed by different lower case letters in the row differ from each other by the chi-square test of the generalized linear model analysis of type III at the 5% probability level.
[1)] p-value = Probability.

Aggressive behaviours, such as competition in the feeder, fights, chases, and avoidances, and head thrusts, were observed mainly in the afternoon. Similarly, an increase in playing around the drinker was observed in the afternoon (Table 5). Interaction between toy type and daytime was observed for behavioural variables of fight, threats, chases and avoidance, and head thrusts ($p = 0.030$) (Table 6). In the morning, piglets housed in pens containing metal chain toys showed lower percentage values (0.45%) of these behaviours than pigs housed in pens with plastic bottle toys (1.82%). This may be explained by the lower effectiveness of the toy in extending the interest of the animals, leading to a loss of stimulus (Machado et al., 2017).

Piglets housed in pens containing metal chain toys had a higher percentage of fights, threats, chases and avoidances, and head thrusts in the afternoon (1.98%) compared to the morning (0.45%) (Table 6). Room temperature affects the physiological parameters of animals, reflecting behavioural changes (Mkwanazi et al., 2019). The environmental changes promoted in this study by both types of toys affected the behavioural activities of the piglets. According to Machado et al. (2017), environmental enrichment techniques are being developed to improve animal welfare and make them economically viable. Furthermore, water intake and water waste can be standardized using an ideal drinker in a production system, without negative implications for social behaviour or growth rates (Torrey et al., 2008).

Table 6
Behavioural observations of fight, threats, chases and avoidance, and head thrusts (%) and standard deviations (in parentheses) according to type of toy and daytime period

Type of toy	Daytime period	
	Morning	Afternoon
Metal chain	0.45(0.89)^{bB}	1.98(2.33)^{A}
Plastic bottle	1.82(2.28)^{a}	2.18(3.12)

^{a,b,A,B}Averages followed by different lowercase letters in the column and different uppercase letters in the row differ from each other by the lsmeans difference test at 5% probability level ($p = 0.030$).

Conclusion

Based on the results of this study, water intake of nursery-stage piglets was positively influenced by growth phase. Piglets in starter phases consumed more water when subjected to a fixed drinker model. Moreover, the type of environmental enrichment and time of day may influence the behaviour of nursery piglets.

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