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Effect of a flavoring component on water consumption and performance of piglets during nursery

Efeito de um flavorizante sobre o consumo de água e desempenho de leitões pós-desmame

Efecto de un aromatizante sobre la ingesta de agua y el rendimiento de lechones posdestete

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Abstract
The study assessed the addition of a commercial flavoring agent in the water used for piglets on water consumption and performance during the post-weaning period. The study used 60 piglets distributed in a randomized block

experimental design, which included two treatments: with and without the inclusion of a commercial flavoring agent: 100 g/1000L with ten replications per treatment, each replication using three animals. The calculated parameters were: mean water consumption per animal, total daily water consumption, mean daily feed consumption, total feed consumption, mean feed consumption, daily weight gain, mean daily weight gain, total weight gain, feed conversion, feed efficiency, and diarrhea occurrence. The flavoring agent inclusion increased the mean water consumption per animal and the total daily water consumption in phase one and two of the experiment. However, the inclusion did not significantly influence the mean feed daily consumption, total feed consumption, and daily weight gain. There was a positive correlation between water and feed consumption for both treatments in the first phase, with a higher mean for the flavoring agent treatment group's initial feed/water consumption rate. The analysis of the entire cycle did not display statistical differences between the groups for the studied variables. In addition, the diarrhea occurrence did not differ between treatments. The results of this experiment indicate that manipulating the hedonic characteristics of drinking water by adding the flavoring agent is beneficial with regard to increasing water consumption in the first two weeks after weaning.
Keywords: Water intake; Weaning; Diarrhea; Consumption stimulator; Swine.

Resumo
O estudo avaliou a adição de um flavorizante comercial na água de consumo de leitões, sobre ingestão de água e desempenho durante o período pós-desmame. Foram utilizados 60 leitões, distribuídos em um delineamento em blocos casualizados, compreendendo dois tratamentos: sem e com a adição de um flavorizante comercial - 100 g/ 1000L de inclusão, com 10 repetições por tratamento, cada repetição com três animais. Os parâmetros calculados foram: consumo médio de água por animal, consumo total diário de água, consumo médio diário de ração, consumo total de ração, consumo médio de ração, ganho de peso diário, ganho de peso médio diário, ganho de peso total, conversão alimentar, eficiência alimentar, e a ocorrência de diarreia. Considerando as fases 1 e 2, verificou-se que a adição do flavorizante na água proporcionou o aumento do consumo médio de água por animal e para o consumo total diário de água. Contudo, não promoveu influência significativa sobre o consumo médio diário de ração, consumo total de ração e para ganho de peso diário. Observou-se uma correlação positiva entre o consumo de água e ração para ambos os tratamentos durante a primeira fase, no entanto, o comportamento inicial na relação entre os consumos ração/água para o tratamento com flavorizante apresentaram médias maiores. Para o ciclo completo, não houve diferença estatística para as variáveis estudadas. As porcentagens da incidência de diarreia não demonstraram diferenças estatísticas. Logo, a manipulação das características hedônicas da água de consumo por meio da adição do flavorizante é benéfica, proporcionando aumento no consumo de água nas duas primeiras semanas do pós-desmame.
Palavras-chave: Ingestão de água; Desmame; Diarreia; Estimulador de consumo; Suínos.

Resumen
El estudio evaluó la adición de un saborizante comercial en el agua de bebida de lechones, sobre el consumo de agua y el rendimiento durante el período post-destete. Se utilizaron 60 lechones, distribuidos en un diseño de bloques al azar, comprendiendo dos tratamientos: sin y con adición de un aromatizante comercial - 100 g/1000L de inclusión, con 10 repeticiones por tratamiento, cada repetición con tres animales. Los parámetros calculados fueron: consumo de agua promedio por animal, consumo de agua total diario, consumo de alimento promedio diario, consumo de alimento total, consumo de alimento promedio, ganancia de peso diaria, ganancia de peso promedio diaria, ganancia de peso total, conversión alimenticia, eficiencia alimenticia y el aparición de diarrea. Considerando las fases 1 y 2, se verificó que la adición de saborizante en el agua proporcionó un aumento en el consumo promedio de agua por animal y para el consumo total de agua diario. Sin embargo, no promovió una influencia significativa en el consumo diario promedio de alimento, el consumo total de alimento y la ganancia de peso diaria. Hubo una correlación positiva entre el consumo de agua y alimento para ambos tratamientos durante la primera fase, sin embargo, el comportamiento inicial en la relación consumo de alimento/agua para el tratamiento de aromatización mostró promedios superiores. Para el ciclo completo, no hubo diferencia estadística para las variables estudiadas. Los porcentajes de incidencia de diarrea no mostraron diferencias estadísticas. Por lo tanto, la manipulación de las características hedónicas del agua de bebida mediante la adición de saborizantes es beneficiosa, proporcionando un aumento en el consumo de agua en las dos primeras semanas después del destete.
Palabras clave: Consumo de agua; Destete; Diarrea; Estimulador del consumo; Cerdos.

1. Introduction

In swine farming, the transition phase from farrowing to the nursery is a critical period for piglets, due to the adverse effects from environmental, nutritional, social, and behavioral changes, directly reflecting on performance. In order to reverse the impacts of this phase, strategies such as manipulating the attractive characteristics of feeds to stimulate feed consumption after weaning can help to mitigate the effects caused by the complex changes faced, thus allowing a better adaptation at weaning. Studies carried out over decades have investigated the pigs' preferences for food flavors to create new strategies to improve productivity. Initial research focused on the use of sucrose in addition to artificial sweeteners such as saccharin (Roura and Fu, 2017). The preference of saccharin-containing solutions by pigs has shown that this substance increases drinking water consumption during the post-weaning period (Kennedy and Baldwin, 1972). Water is a primary nutrient for survival, acting as a medium for nutrient translocation, chemical reactions, ion exchange, and conduction of substances throughout the body (Silva et al., 2020). In addition, the inclusion of substances with a favorable, attractive taste in drinking water can increase water and feed intake, providing piglets with better conditions to face the new weaning challenges (Frederick and Van Hegten, 2006). However, there has been little work to investigate the strategic use of products based on high-intensity sweeteners in drinking water. Thus, the research aimed to evaluate the effect on water intake and performance of adding a commercial flavoring to the drinking water of piglets during the post-weaning period.

2. Methodology

2.1 Experimental location

All animal handling methods were carried out following the regulations approved by the Institutional Committee for Animal Welfare and Ethics/Protection of the Federal University of Minas Gerais (UFMG - CEUA) under protocol number 187/2019. The experiment was performed between October and November 2019 in the Pig farming sector of the Agriculture Science Institute (Instituto de Ciências Agrárias) of the Federal University of Minas Gerais - UFMG, located in a climatically characterized region with a tropical climate and dry winter (Aw class) according to Köppen (1948).

2.2 Experimental animals handling

The research used 60 piglets (30 castrated males and 30 females) of a commercial genetic line (TN70 x Talent). Conventional maternity management was performed according to the standard management determined by the farm, in which the animals were submitted to tail docking, teeth clipping, and iron administration after three days of birth, and the males were castrated at ten days of age. At entering the nursery, the piglets were vaccinated with pro-vac and serkel pneumo (Vencofarm, Londrina, Paraná, Brazil). During the post-weaning period, the management of curtains and heating lamps were monitored so that the thermal environment was standardized. The facilities' sanitary management was carried out daily in the morning (9:00 am) and the afternoon (2:00 pm) by cleaning the stalls with a spatula, scraping the feces, and after this procedure, washing with water to remove the feces from the floor of the nursery rooms. Hydrated lime was used in the circulation aisles. The lime was changed in the footbaths when necessary.

2.3 Experimental design

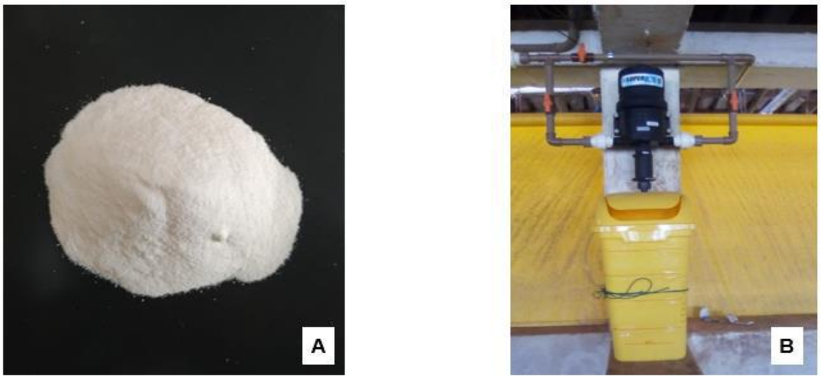
The animals were housed in groups of three piglets per pen according to body weight, litter origin, and sex. They started the experiment at approximately 9.24 kg body weight and an average age of 28 days and remained in the trial until approximately 27.5 kg BW (average 70 days of age). The animals were distributed in a randomized block design in two rooms, with each considered a block comprising two treatments: without and with the addition of a commercial flavoring agent (100 g/1000L of inclusion, with ten replications per treatment, in which each repetition was composed of three animals).

2.4 The use of the flavoring agent and the drinking water

The flavoring agent (Figure 1A) is a proprietary combination of sodium saccharin with thaumatin and was added to the animals' drinking water through the hydraulic system that supplied 100 g of flavoring per 1000L of water through a pipeline independent of the control treatment. The product was diluted in water and stored in a 20 L reservoir, in which the dispenser (Figure 1B) Superdoser 15 TF (A Hydro Systems, USA) removed the solution and distributed it to the respective stalls that received the treatment with the product.

Water distribution was carried out through a single network divided into two routes. One passed through the dispenser, and the other did not. Both water distribution routes were divided into two lines, one for each nursery hall (rooms 1 and 2), and each water line supplied a row composed of five stalls. At the beginning of each water line, a hydrometer quantified water consumption.

Figure 1 - Flavoring agent Power sweet® (A); Superdoser dispenser and water-based flavoring solution storage container (B).



Source: Personal archive (2019).

2.5 Experimental diets

Table 1 displays the diets prepared to satisfy or exceed the nutritional requirements for piglets according to the recommendations of Rostagno (2017). Diets were prepared according to the animals' growth phase: Pre-1 diet, from 28 to 36 days (Phase 1); Pre-2 Diet, from 37 to 49 days (Phase 2); Initial diet 1, from 50 to 57 days (Phase 3); and initial diet 2, from 58 to 70 days (Phase 4). 0.03% of Power Sweet ® flavoring agent was included into each experimental diet.

Table 1 - Ingredients and nutritional specifications of the diets used in the experiment.

Ingredients	Pre-1	Pre-2	Initial-1	Initial-2
Corn	18.401	30.845	42.740	56.905
Soybean meal 46%	16.000	19.000	25.000	28.000
Soybean protein concentrate	8.000	5.000	3.000	0.000
Pre-cooked corn	10.000	10.000	7.000	0.000
Swine plasma	5.000	3.000	0.000	0.000
Biscuit meal	10.000	5.000	5.000	5.000
Corn oil	3.400	3.350	3.350	4.300
Sugar	3.500	3.500	2.000	0.000
Milk whey	21.000	15.000	6.000	0.000
Dicalcium phosphate	1.694	1.980	1.946	2.025
Calcium carbonate	0.00	0.00	0.080	0.265
Sodium chloride	0.400	0.400	0.400	0.400
Power sweet®[5]	0.030	0.030	0.030	0.030
Ultracid® (organic acids blend)[3]	0.200	0.150	0.100	0.100
L-Lysine HCl	0.404	0.551	0.600	0.549
D-Methionine	0.220	0.247	0.245	0.186

L-Threonine	0.192	0.272	0.300	0.268
L-Tryptophan	0.065	0.080	0.090	0.067
L-Valine	0.110	0.175	0.176	0.130
Mineral Premic Oligo SUI[1]	0.200	0.200	0.200	0.200
Premix Vitamin IReprod OVN[2]	0.050	0.050	0.050	0.050
Toxic-nil® (Mycotoxin binder)[4]	0.100	0.100	0.100	0.100
80% Zinc oxide	0.280	0.240	0.200	0.100
Nutritional specifications				
ME kcal/kg	3450	3400	3370	3366
Crude protein %	22.10	20.20	19.10	18.23
Total Ca %	0.680	0.710	0.715	0.720
Digestible P %	0.439	0.430	0.400	0.360
SID AAS. %				
Lysine	1.50	1.45	1.35	1.25
Methionine + Cysteine	0.84	0.81	0.77	0.71
Threonine	1.00	0.97	0.91	0.84
Valine	1.06	1.02	0.94	0.87
Tryptophan	0.31	0.29	0.27	0.24

[1]Carbo-amino-phospho cobalt chelate (cobalt: 20.4 mg/kg feed), Carbo-amino-phospho copper chelate (copper 15 mg/kg feed), Carbo-amino-phospho chromium chelate (chromium 20 mg / kg of feed), Carboamino-phosphate iron chelate (iron 10.4 g / kg of feed), Carbo-amino-phosphorus manganese chelate (manganese 4.6 g / kg of feed), Selenium Carbo-Amino Phosphate chelate (36.8 mg/kg feed Selenium), Zinc Carbo-Amino Phospho Chelate (11.5 g/kg Feed Zinc), Butylated Toluene Hydroxide (BHT), Calcium iodine (iodine 133 mg / kg of feed). [2]Vitamin A (1125,000 IU / kg of feed), Vitamin D3 (190,000 IU / kg of feed), Vitamin E (10,000 IU / kg of feed), Vitamin K (500 mg / kg of feed), Biotin (50 mg / kg of feed) of feed), Folic acid (450 mg/kg of feed), Niacin (6,000 mg/kg of feed), pantothenic acid (3,000 mg/kg of feed), Vitamin B2 (1,000 mg/kg of feed), Vitamin B1 (400 mg/kg of feed), vitamin B6 (600 mg/kg of feed), and vitamin B12 (5,000 mcg/kg of feed). [3]Organic acids mixture: formic acid / acetic acid / propionic acid / lactic acid / citric acid / carrier and anticaking agent. [4]Mycotoxin binder [5]Food sweetener. Source: Personal archive (2019).

2.6 Assessed parameters

2.6.1 Environmental variables

The environmental temperature and relative humidity inside the facility followed outside conditions and were continuously recorded at 08:00, 14:00, and 18:00 in the test rooms. The maximum and minimum values were collected in the late afternoon using two thermohygrometers (Valley Great Tools, TH01) located at a one-meter height from the floor and in the center of each experimental room.

2.6.2 Water consumption

Water consumption data were collected daily at 06:00 from the data provided by the hydrometers installed in each water line distributing the water to each treatment within the experimental test.

2.6.3 Animals' feed consumption and performance

Every morning, leftovers from the collection trays were scraped, collected, and weighed, when available, to quantify consumption. Soon after, the fresh feed was distributed once a day between 07:00 and 07:30 am. The piglets were identified with a number on their back, allowing individual weighing at the beginning and end of each experimental phase, giving five weighings per pig in total. For each phase of the nursery, according to Silva et al. (2020), the following parameters: the mean daily feed consumption (MDFC), total feed consumption (TFC), and daily weight gain (DWG). Considering the entire weaning period were calculated the mean feed consumption (MFC), daily mean weight gain (DMWG), total weight gain (TWG), feed conversion (FC), and feed efficiency (FE).

2.6.4 Diarrhea incidence

The frequency of occurrence of diarrhea was performed through visual observation, adapted from the method recommended by Guedes et al. (2018), during the nursery period. And at the end of the cycle, the relative frequencies of occurrences for each phase were obtained.

2.7 Calculations and statistical analysis

Water consumption data was derived from the difference between the final and initial consumption. The total daily consumption (TDWC) was calculated by the sum of the daily consumption of the 30 animals belonging to the treatment. The mean water consumption per animal (MWCA) was obtained by the formula: MWCA= (TDWC/N), where TDWC is the mean daily consumption, and N is the number of animals per treatment. Total feed consumption (TC) for each phase was calculated using the formula: (TC= PF-FL), where PF is the provided feed, and FL is the feed leftover; The mean daily feed consumption (MDFC) obtained by MDFC = (PF-FL)/D, where PF is the provided feed, FL is the feed leftover and D are the days during which the animals remained in the experiment.

Growth was calculated as the daily weight gain (DWG), using the formula: DWG= FW-IW/D*1000, where FW is the final weight, IW is the initial weight, and Ds are the days during which the animals remained in the experiment. The daily mean weight gain (DMWG) was obtained by the formula: DMWG = FW-IW/D*1000, where FW is the final weight, IW is the initial weight, and Ds are the days during which the animals remained in the experiment. The total weight gain (TWG) was acquired by the formula: TWG= (FW-IW) where FW is the final weight at the end of the experimental period, and IW is the initial weight. The feed conversion (FC) was quantified by FC= (TWC/TFC), where TFC is the total feed consumption, and TWG is the total weight gain during the experimental period. The feed efficiency (FC) was obtained by FE= (TWG/TFC), where TWG is the total weight gain, and TFC is the total feed consumption during the experimental period.

Regarding the effects of the treatments used (with and without flavoring in the water), blocks and initial weight were tested according to a general linear procedure analysis of variance (SAS GLM procedure). The piglets' IW was considered as a model's covariant. The least squares procedure (PDIFF option) compared the means, as a significant F value was obtained. The means comparison was performed according to the PDIFF option of the SAS procedure using Tukey's test at $p<0.05$. The diarrhea incidence data were submitted to Friedman's test and then displayed on a Boxplot graph using the statistical program R.

3. Results

The environmental data collected during the experimental period inside the nursery displayed, maximum and minimum temperatures of 35.32 and 24.9 ºC, and the maximum and minimum relative humidity were 73% and 37%, respectively. Table 2 shows the means and the standard error of the mean obtained from analysis of the feed and water consumption, and performance data, comprising the parameters: mean daily feed consumption (MDFC), total feed consumption (TFC), mean water consumption per animal (MWCA), total daily water consumption (TDWC) and daily weight gain (DWG) by phase.

Considering phase one, the flavoring agent inclusion increased by 194.4% the mean water consumption per animal (MWCA; p= 0.0017) and 193.33 % the total daily water consumption (TDWC; p=0.0017) as compared to the controls. However, the inclusion did not significantly influence the mean daily feed consumption (MDFC), total feed consumption (TFC), and daily weight gain (DWG). During phase 2, the treatment that received flavoring also affected the average water consumption per animal (MWCA; p=0.0005) and the total daily water consumption (TDWC; p=0.0005), increasing them by

52.58% as compared to controls. However, there were no significant effects on MDFC, TFC, and DWG for piglets that received flavor compared to the control.

Table 2 - Means and mean standard error (MSE) of feed consumption data, performance, and water consumption of piglets treated or not with flavoring agent in the water during the weaning period.

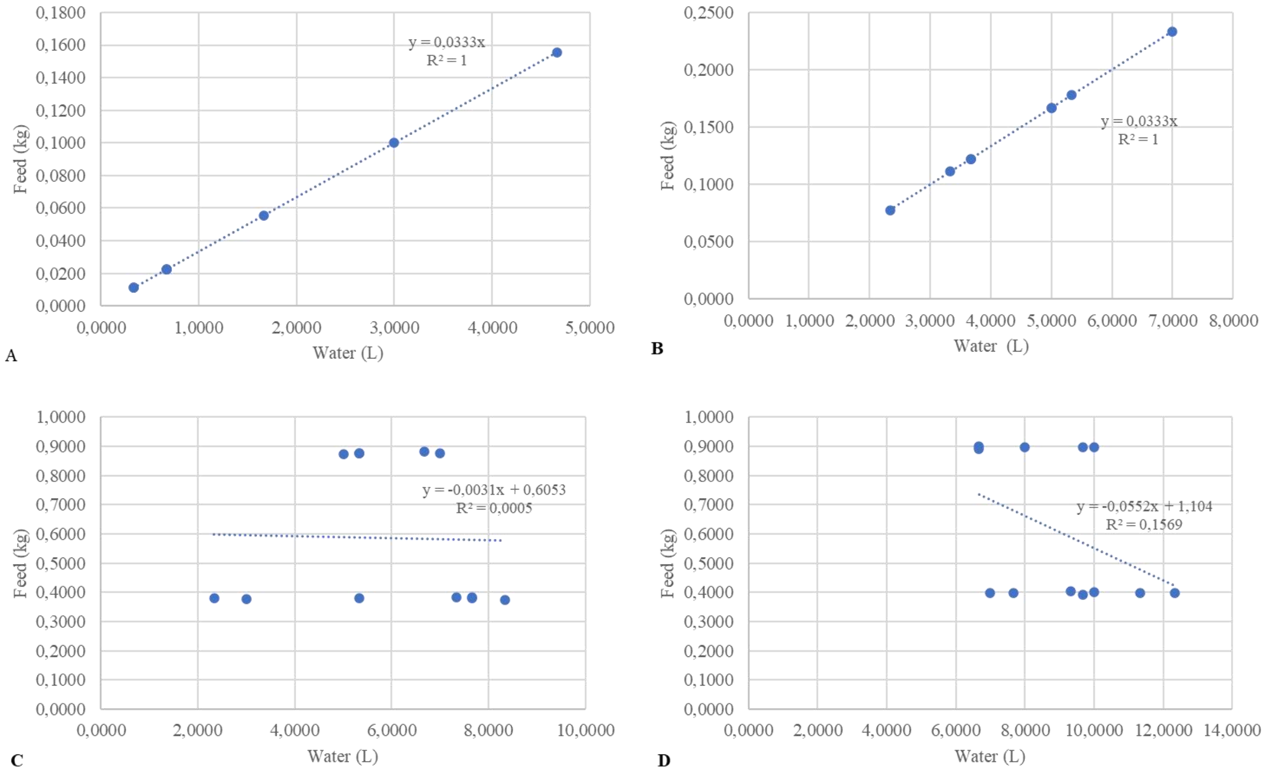
Phase	Parameters	Treatments		SE	P-value
		C	F		
1	MDFC (g)	354.7	365.3	11.3415	0.6338
	TC (kg)	8.5153	8.7679	0.2718	0.6358
	MWCA (L)	1.500 [b]	4.416 [a]	0.5242	0.0017
	TDWC (L)	45.000 [b]	132.000[a]	15.7288	0.0017
	DWG (kg)	0.2641	0.2818	0.0124	0.4743
2	MDFC (g)	586.8	596.4	11.9656	0.6491
	TC (kg)	21.1209	21.4681	0.4314	0.6483
	MWCA (L)	5.916 [b]	9.027 [a]	0.4930	0.0005
	TDWC (L)	177.500 [b]	270.833 [a]	14.7922	0.0005
	DWG (kg)	0.4088	0.4022	0.0110	0.7585
3	MDFC (g)	951.8	951.4	11.0063	0.9826
	TC (kg)	19.9847	19.9784	0.2314	0.9869
	MWCA (L)	12.904	11.380	0.5727	0.1942
	TDWC (L)	387.142	341.428	17.1840	0.1943
	DWG (kg)	0.6846	0.6659	0.0103	0.3545
4	MDFC (g)	1101.30	1114.50	25.9545	0.8032
	TC (kg)	39.6500	40.1203	0.9336	0.8050
	MWCA (L)	13.00 [a]	6.416 [b]	0.8698	<0.0001
	TDWC (L)	390.000 [a]	192.500 [b]	26.0942	<0.0001
	DWG (kg)	0.5797	0.5714	0.0162	0.7838

MDFC- Mean daily feed consumption, TFC - total feed consumption, MWCA - Mean water consumption per animal, TDWC- Total daily water consumption, DWG- Daily weight gain C- control - F - Flavoring agent, MSE - MSE - Mean Standard Error. Means with different letters superscript on the line displayed a significant difference ($p < 0.05$). Tukey's test ($p<0.05$). Source: Personal archive (2019).

In phase 3, the MWCA, TDWC, TC, and DWG parameters did not display significant differences between the treatments' mean values. During phase 4, the mean MWCA, TDWC values displayed significant differences from the control treatment, with higher values recorded for the flavoring agent group. The MDFC, TC, and DWG parameters did not differ between the treatments.

The scatter plots in Figures 2 and 3 display the correlation between water and feed consumption to identify better the effect on the behavior of the averages between the parameters. Figures 2A and 2B highlight a positive correlation between water and feed consumption for both treatments in the first phase. On the other side, the flavoring agent treatment group's initial feed/water consumption rates were different, displaying higher means.

Figure 2 - Correlation between the mean water and feed consumptions during phase 1 (A: control and B: flavoring agent) and phase 2 (C: control and D: flavoring agent).

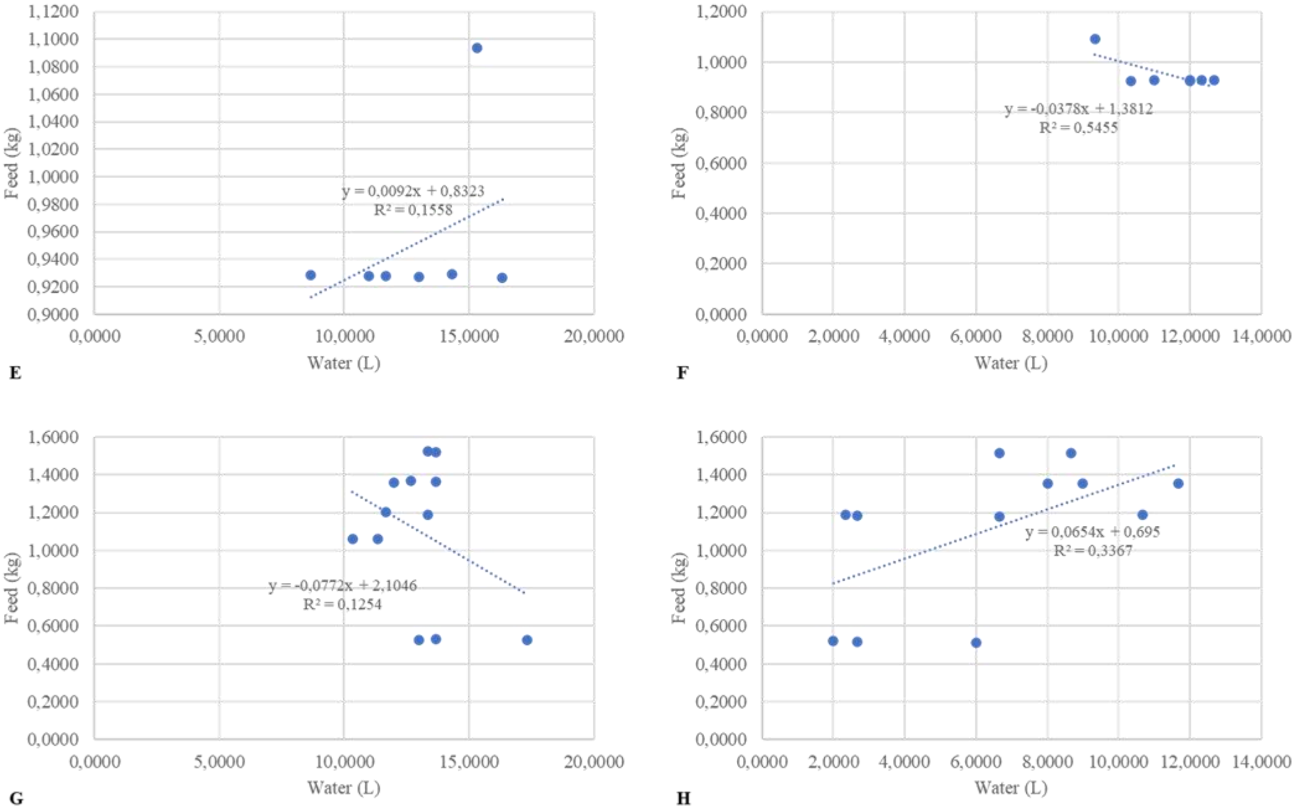


Source: Personal archive (2019).

The means obtained during the second experimental period shown in Figure 2C illustrate a change in the feed: water relationship as the graph does not display a correlation between the variables. While in Figure 2D, we can see a moderate negative correlation.

Analyzing the graphs referring to the third phase of the experimental period, in Figure 3E, there is a change in the behavior between the variables, reestablishing a moderate positive correlation. In Figure 3F, the variables displayed a moderate positive correlation.

Figure 3 - Correlation between average water consumption and average feed consumption during Phase 3 (E: Control and F: Flavoring agent) and Phase 4 (G: Control and H: Flavoring agent).



Source: Personal archive (2019).

Figure 3G displays a moderate negative correlation. Figure 3H displays a weak positive correlation between the variables.

Table 3 displays the data for the mean feed consumption (MFC), initial weight (IW), final weight (FW), average daily weight gain (ADG), Total weight gain (TWG), feed conversion (FC), and feed efficiency (FE). Considering the entire cycle, there was no significant difference for the variables MFC, IW, FW, DMWG, TWG, FC, and FE.

Table 3 - Means and standard error (SE) of the data on post-weaning piglets feed consumption and performance, as they are treated or not with flavoring agent in the water during the entire cycle (28-70 days).

Parameters	**Treatments**		**SE**	**P-value**
	C	**F**		
MFC (g)	748.5	756.8	11.4923	0.6834
IW (kg)	9.2394	9.2401	0.3638	0.9993
FW (kg)	27.0028	27.8412	0.7492	0.4800
DMWG (kg)	0.4843	0.4803	0.0080	0.7566
TWG (kg)	17.7637	18.6010	0.5735	0.4802
FC (kg)	1.5473	1.5783	0.0163	0.3587
FE (%)	64.767	63.477	0.6777	0.3550

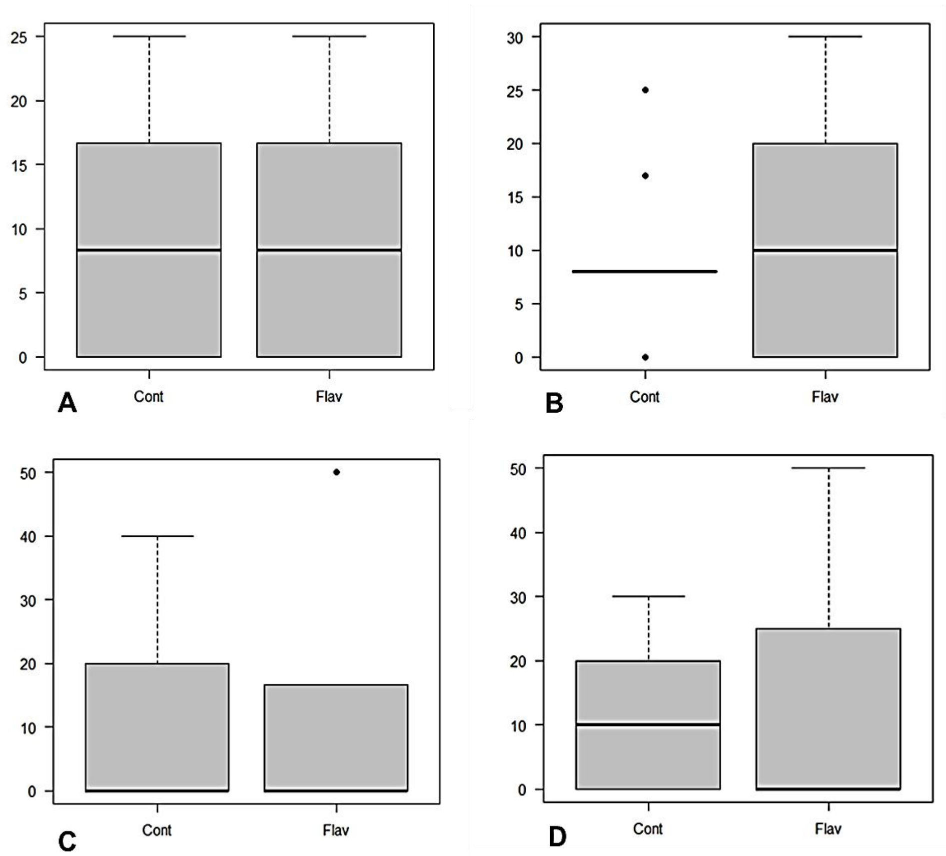
MFC – Mean Feed Consumption, IW – Initial Weight, FW – Final Weight, DMWG – Daily Mean Weight Gain, TWG – Total Weight Gain, FC – Feed Conversion, FE – Feed Efficiency. SE, Standard Error of the Average Means with different letters superscript on the line displayed a significant difference ($p < 0.05$). Tukey's test ($p<0.05$). Source: Personal archive (2019).

Diarrhea frequency percentages during the experimental period were submitted to Friedman's test; however, the analysis did not display any significant difference for any experimental phase. Therefore, the data are presented in boxplot graphics to visualize better the behavior of the means obtained for each treatment (Figure 4).

The data displayed in Figure 4A show that for the control (Cont), the values obtained were minimum (-18.16%), quartile 1 (0%), quartile 2 or median (8.30%), quartile 3 (18.78%) and the maximum (25%). A similar case occurred for the flavoring agent treatment (Flav), showing that the incidence of diarrhea for both treatments was the same.

Figure 4B shows the values of minimum (6.43%), quartile 1 (8%), quartile 2 or median (8%), quartile 3 (10%), and maximum (13.18%) in the control group (Con). It is worth mentioning that in the control treatment during the second phase, three points stand out as outliers (0%, 17%, and 25%). For the treatment with flavoring, there is a minimum (-20%), quartile 1 (0 %), quartile 2 or median (10%), quartile 3 (20%), and maximum (30%). The control treatment showed a different distribution between the means in the second experimental period, while the flavoring treatment maintained a pattern similar to that shown in the first phase (Figure 4A).

Figure 4 – Boxplot plots of diarrhea incidence between the treatments control and flavored during phases 1 (A), 2 (B), 3 (C), and 4 (D).



Source: Personal archive (2019).

For Figure 4C, the minimum (-20%), quartile 1 (0%), quartile 2 or median (0%), quartile 3 (20%) and maximum (40%) were found for the control (Con). %), and for the treatment with flavoring, we have minimum (-15.04%), quartile 1 (0%), quartile 2 or median (0%), quartile 3 (16.70%) and maximum (35.6 %), there is still the presence of an outlier point (50%).

In Figure 4D, the minimum (-19%), quartile 1 (0%), quartile 2 or median (10%), quartile 3 (20%) and maximum (30%), and for the treatment with flavoring we have minimum (-27.50%), quartile 1 (0%), quartile 2 or median (0%), quartile 3 (25%) and maximum (50%).

4. Discussion

Using the flavoring agent in the piglets' drinking water increased the total daily water consumption and the average water consumption per animal by 193.33% and 194.4%, respectively, for the first phase and 52.8 % for both water consumptions in the second phase. During the nursery's first phases, the stress caused by the transition harms the piglets' development and performance. Thus, higher daily water consumption is essential during this phase, as younger piglets need more water per kilogram of live weight compared to older animals (Silva et al., 2000). Such results show that using a sensory additive is a formidable method for mitigating the effects of weaning stress (Messias et al., 2022). Using the same product under similar conditions, Silva et al. (2020) found an average water intake of 10.9L/pig in the first post-weaning week, using bowl-type drinkers, for piglets weaned at 21 days. In our study an average intake of 4.416L/piglet in the first phase was observed in animals weaned at 28 days using a nipple-type drinker. The animal's age and the type of drinker available can affect the water-drinking behavior (Lima & Pioczcovski, 2010).

Studies performed by Bigelow e Houpt (1988) suggest that the initial knowledge of the eating and drinking habits? of the animal is crucial to better understanding the ingestive behavior. It is characteristic for young pigs to have the habit of ingesting water while consuming food, and this relationship is considered positive for weaned piglets (Dybkjaer et al., 2006). Corroborating this assertion, we observed a positive correlation between feed and water consumption in the experiment's first phase for both treatments. However, the animals that received the flavoring agent via water changed the initial behavior of the relationship between feed and water consumption. McLaughlin (1983) claimed that olfactory suggestions could provide sensory elements before food consumption, influencing whether ingestion takes place or not.

In addition, water flavoring was present in the treatment and control groups' feeds. Thus, the initial behavior change in feed and water consumption during the experiment may be due to a sensory impression. For Balch and Campling (1962), the chemical senses of smell and taste greatly influence the behavior of feed selection and consumption. Besides, it is crucial to consider that the pigs' olfactory system can identify non-volatile compounds, showing a preference for sweet flavors (Messias et al., 2022). Thus, from the moment the animals came into contact with the water, they perceived the presence of the flavoring agent flavor and aroma. When consuming the feed, they found something similar in its composition, creating a link and promoting a positive memory in relation to consumption.

Pigs have approximately 20,000 taste buds in the oral cavity (Roura et al., 2008), and the identification of sweet taste is mediated by the T1R2-T1R3 receptor present in the taste cells of the lingual epithelium and enteroendocrine cells of the intestinal epithelium (Daly et al., 2021). According to Glaser et al. (2000), pigs perceive the saccharin sweet taste less than humans. Studying the effect of saccharin via water in humans, Galindo – Cuspineira et al. (2006) suggested that saccharin can act as a sweet agonist when used in small concentrations and as an antagonist in high concentrations, generating a decrease in the perception of sweet taste and a bitter taste. Perhaps prolonged exposure to flavoring during the nursery stage may have generated an overload in the saccharin receptors in the taste cells of the lingual epithelium, thus reducing the influence of treatment on water intake from the third nursery phase.

The association of thaumatin with saccharin allowed for better combination regarding the product's effect on water consumption. Unlike the results obtained in this study, other studies using only sodium saccharin, both in water (200g / 1000L) and in the diet (200g /t of feed), did not observe an increase in daily water consumption (Silva et al., 2001). In the same form, Maenz et al. (1993) observed no increase in water intake using 2 g/L of sodium saccharin. These results may have resulted from the metallic aftertaste caused by high saccharin concentrations, which motivates its combination with other sweeteners that mask this flavor (Duengelhoef, 2010), such as thaumatin (Nelson, 1992, p.447, cited in Dong and Pluske, 2007).

Despite finding a correlation between water and feed consumption, it was impossible to observe differences in the increase in feed consumption between treatments, which promoted similar gains. Silva et al. (2020) highlighted that it is possible that the increase in feed consumption is related to greater water consumption in the first phase of the nursery and that this relationship can improve growth rates. A higher water supply to piglets can stimulate nutrient absorption, positively impacting weight gain and post-weaning feed intake adaptation, reducing the problems caused by the phase transition (Ogumbameru et al., 1991). However, it is worth mentioning that as the animals develop, variations occur in the total daily consumption of water, in the water/feed ratio, and in the fragmentation of daily water consumption in pre-prandial, intra-prandial, post-prandial intake, and non-prandial (Bigelow and Houpt, 1988). Feed consumption, especially at the beginning of post-weaning, can be influenced by nutritional, immune, digestive, and metabolic changes (Lovatto et al., 2004). Besides, diarrhea can reduce weight gain and, in some cases, damage the gastrointestinal villi, thus hindering development during post-weaning (Silva et al., 2020). Shaw et al. (2006) emphasize that studies on water use are complicated due to the behavioral, nutritional, and physiological effects of its consumption and the difficulty in isolating the need for its ingestion.

The present study did not display differences in diarrhea incidence between the treatments, even if the group that received the flavoring agent consumed more water. Post-weaning diarrhea is quite common, as the piglets' digestive tract is still under development (Quadros et al., 2002). Piglets were housed in suspended nursery systems. cleaning was performed twice a day, reducing the presence and contact with feces and, thus, exposure to possible diarrhea-causing pathogens. The diets were the same for both treatments, nullifying the diet's effects on diarrhea occurrence. The presence of zinc oxide in the diets may have contributed to uniformity between the treatments, as zinc ions interact with Escherichia coli (the leading agent causing diarrhea), inhibiting or decreasing its activity in the gastrointestinal tract, contributing to alleviating diarrhea (Arantes et al., 2007; Silva et al., 2008). Another factor would be that the animals received medicated rations during the first and second phases.

5. Conclusion

The manipulation of the hedonic characteristics of drinking water by the additions of a flavoring agent is beneficial with regard to increasing water consumption in the first two weeks after weaning. Therefore, it is suggested that, for future research, the neurosensory mechanisms linked to the consumption of water and food and their reflection on the behavior and the reduction of stress for post-weaning piglets be evaluated.

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