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Productive behavior of piglets (*Sus scrofa domesticus*) fed concentrates with an inclusion of six natural flavorings and one commercial synthetic flavoring

Comportamiento productivo de lechones (*Sus scrofa domesticus*) alimentados con concentrados con una inclusión de seis saborizantes naturales y un saborizante sintético comercial

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ABSTRACT

Natural additives can provide positive characteristics that help make animal feed more palatable, thereby increasing feed intake and improving productivity. In this study, 260 piglets from 14 to 56 days of age were monitored, with an initial weight of 4.34 ± 0.75 kilograms. There were 6 treatments with natural flavorings with pro-nutrients, plus 1 treatment with a commercial product, and 1 control without flavorings. The average daily feed consumption per piglet was between 408 and 525 g, the average final weights between 19.90 and 26.30 kg, the average daily weight gains between 0.367 and 0.517, and the average feed conversions were between 0.988 and 1.195. Feeding costs averaged between 0.78 and 0.94 dollars. It was observed that the best values for live weight gain and feed conversion index, and decreasing production costs, were for treatments that included natural flavorings. It is recommended to study the use of these aromas in the growth and fattening stages.

Keywords: Flavoring; Non-nutritional additive; Piglet; Productive behavior.

RESUMEN

Los aditivos naturales pueden proporcionar características positivas que ayudan a que el alimento animal sea más agradable y, así, aumentar el consumo de alimento y mejorar la productividad. En este estudio, se controlaron 260 lechones de 14 a 56 días de edad, con un peso inicial de 4,34 ± 0,75 kilogramos. Se formaron 6 tratamientos con los saborizantes naturales con pro-nutrientes, más 1 tratamiento con un producto comercial, y 1 control sin saborizantes. El consumo medio diario de pienso por lechón estuvo entre 408 y 525 g, los pesos finales medios entre 19,90 a 26,30 kg, las ganancias medias diarias de peso entre 0,367 y 0,517, y las conversiones alimentarias medias estuvieron entre 0,988 y 1,195. Los costos de alimentación resultaron en promedio entre 0,78 y 0,94 dólares. Se observó que los mejores valores de ganancia de peso vivo y el índice de conversión alimenticia, y disminuyendo los costos de producción fue para los tratamientos que incluían saborizantes naturales. Se recomienda estudiar el uso de estos aromas en las etapas de crecimiento y engorde.

Palabras clave: Saborizante; Aditivo no nutricional; Lechón; Comportamiento productivo.

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1. Introduction

The growth of farms at national level was achieved by Peruvian producers, which has generated an increase in production efficiency and price stabilization. In Peru, on average, between 8.8 and 8.9 Kg of pork are consumed per person per year (Chávez, 2020). In pig breeding, a crucial factor is genetic selection, which is the criteria for the selection of an adequate breeding combination of the results of hybrid population tests; in the case of Peru, breeds such as Landrace, Yorkshire, Hampshire, Duroc, and Pietrain are frequently used (Pedersen et al., 2019; UNALM, 2006). To ensure profitable production, optimal management of sows and piglets is essential, considering that, according to many authors, the best reproductive and piglet growth parameters are obtained when sows are between their third and fifth parturition (Arango et al., 2005; Hoving et al., 2011; Knecht et al., 2015; Nevrkla et al., 2021). Piglets are pigs from 0 to 60 days old that are weaned from 21 to 28 days (Paramio et al., 2021) being piglet management crucial for their growth and subsequent fattening, so another factor of utmost importance is feeding, since adequate feed intake is decisive for good results, especially in the earliest stages and periods with higher nutritional needs (Ballina, 2010; Pié, 2020). Likewise, at this stage, the palatability of the feed acts as an aid for a better-tasting feed that will be more attractive to the animal so that its consumption increases, even the opposite of being an unpalatable feed (Mesas, 2015).

Organoleptic additives are a type of feed additive defined as "Any substance which, when added to feed, improves or modifies the organoleptic properties of the feed" (European Union, 2009), such as feed flavorings that improve the voluntary feed intake of pigs as chewing and swallowing, favoring the release of flavorings via Retronasal route (Bojanowski & Hummel, 2012; Figueroa et al., 2020), improving their productive parameters (Renaudeau et al., 2008). Flavorings provide positive characteristics that help make the feed more palatable, increase feed intake, improve productivity, and achieve goals rapidly in the short term. Likewise, feed additives based on essential oils, aromatic herbs, or spices serve the purpose of improving feed palatability and zootechnical performance, especially during sensitive periods (Franz et al., 2010; Jacela et al., 2010; Pié, 2020; Windisch et al., 2008). Natural additives are obtained by physical methods such as extraction, distillation, and concentration; in this way, oleoresins, balsams, extracts, and essential oils are obtained and used to flavor various products. Aromatic substances isolated by physical, microbiological, and enzymatic methods can also be obtained from raw materials of natural origin.

While artificial additives are chemical compounds obtained by synthesis that are used for their aromatic properties in their primary state or prepared for human consumption (Estrada, 2006). Feed aromas could also be used to change feed intake patterns and the kinetics of daily intake (Silva et al., 2021). For piglets, flavorings in pre-weaning or post-weaning diets are used as palatability enhancers to stimulate voluntary intake (Vilchez, 2013). Several studies have investigated the beneficial effects of feed supplementation with sensory additives on the palatability of feed and water, the use of different flavorings, and the masking of bitter substances in the ration (Ambi, 2011; Cieza, 2017; García, 2003; Guato, 2015; Orozco-Hernández et al., 2014; Sabala, 2018; Santillán, 2017).

The objective of this study is to evaluate the inclusion of natural and artificial additives in piglet diets and how they affect their productive parameters.

2. Materials and methods

The study was conducted on a commercial farm in Majes (Arequipa, Peru). Rearing conditions for the piglets, together with animal welfare, were under Peruvian Ministry of Agriculture guidelines, also following ARRIVE guidelines and conducted following the UK Animals (Scientific Procedures) Act 1986 and associated guidelines, Directive 2010/63/EU for animal experiments.

Swine farm

The research was conducted at the pig farm "Fundo La Ladera" located in the Annex of La Real, District of Aplao, province of Castilla, Majes Valley.

Piglets

The animals used in this experiment were healthy piglets (*Sus scrofa domesticus*) products of crossbreeding commercial breeds (Largewhite, Landrace, York, Duroc, and Pietrain) of 14 days of age.

Treatments

For this work, six flavorings designed with natural flavor molecules and pro-nutrients, and one synthetic flavoring used commercially in the area were used. Table 1 shows the distribution of flavorings among 260 piglets born in 8 farrowing

groups, with a range of 20 to 50 piglets per group, available during the four experimental months from 14 to 56 days of age.

Table 1
Distribution of treatments

	Treatments	Total
T0	Control (T)	47
T1	Flavoring P (Commercial)	44
T2	Flavoring G	35
T3	Flavoring H	23
T4	Flavoring I	34
T5	Flavoring J	18
T6	Flavoring K	21
T7	Flavoring L	40
TOTAL		260

Experimental rations and their nutritional composition

The experimental rations were administered in two feeding phases, from 14 to 42 days (Pre-start) and from 43 to 56 days of age (Start). The 2 phases had equal formulas for all treatments with different flavorings, forming the treatments TP, TG, TH, TI, TJ, TK, and TL, in which 1 kg per ton of the flavorings P, G, H, I, J, K, and L, respectively, were added. Table 2 shows the basic composition of the experimental rations.

Piglet feeding and weight control

Piglets were fed two feeds, Pre-starter, and starter, until weaning. Their intakes were evaluated by groups formed by the litters of each treatment. Weekly consumption was verified by adding the week's supply and subtracting the remainder at the end of the week. Piglets were weighed at 14 days, at weaning (28 days), at 42 and 56 days of age.

Variables evaluated

Feed consumption (per week and phase); live weight (at the beginning of the experiment, each week, and at the end of each phase); live weight gain (weekly and by phase); feed conversion (per week and phase); and economic merit were evaluated.

Experimental design

In the present study, an ANOVA was applied for a completely randomized design; the Duncan test was utilized with a significance level of 5%, and SPSS statistical software was used for data processing.

Table 2
Composition of the experimental rations administered in the Pre-starter and Starter phases (%)

Components	Pre-starter 14–42 days	Starter 42–56 days
Vegetable oil	2.3	0
Acidifier	0.2	0.2
Wheat bran	1	0.6
Mycotoxin binder	0.2	0.15
Alquernat nebsui	0.05	0
Sodium butyrate	0.2	0.15
Bio choline	0.03	0.03
Fine calcium carbonate	1.26	1.43
Strawberry red color	0.04	0.03
Soy protein concentrate 60%	3.78	0
Antioxidant	0.03	0.02
Compacting agent	0.15	0.15
Growth promoter	0.05	0
Monocalcium phosphate 22%	0.61	1.27
Prime fish meal	5	0
Whole soybean flour	8	8.1
Mananase	0.032	0.032
Xylanase	0.01	0.01
Lysine	0.345	0.38
Ground corn	43	55.33
Molasses	1.11	0.7
Methionine 99%	0.195	0.138
Antifungal	0.1	0.05
Yeast wall	0.5	0.15
Phytase	0.025	0.013
Zinc Oxide	0.3	0.1
Artificial Flavoring	0.1	0.1
Swine plasma	4	0
Vitamin-mineral premix	0.15	0.12
Salt	0.3	0.35
Sweet whey	20.7	2.1
Copper sulfate	0.05	0.1
Soybean cake 47%	8	28
Threonine	0.18	00.125
Tryptophan	0.065	0.075
Valine 98%	0.05	0
Total	100	100

3. Results and discussion

Feed consumption

The average feed consumption can be seen in Table 3. The use of the J and L flavorings increased feed intake compared to the control treatment (TT) and even surpassed the commercial treatment (TP). These values indicate that the use of some flavorings increases feed consumption.

Table 3
Average daily feed consumption per phase in different experimental treatments

Treatments	Daily feed consumption/piglet/phase (kg)			
	14–28	28–42	42–56	14–56
TP	0.015	0.414	0.837	0.422
TT	0.019	0.467	0.875	0.454
TG	0.015	0.456	0.754	0.408
TH	0.020	0.418	0.873	0.437
TI	0.015	0.409	0.818	0.414
TJ	0.027	0.489	1.059	0.525
TK	0.025	0.469	0.842	0.446
TL	0.019	0.471	0.877	0.456

Feed consumption in this research increased with the use of J and L flavorings (natural flavorings), and highly significant differences were found between them and the control treatment. Guato (2015) investigated where he evaluated 3 flavorings in piglet diets and compared them to a control diet; the treatments he considered were E3 (Concentrate + S. flavit banana), E2 (Concentrate + S. flavit cinnamon), E1 (Concentrate + S. flavit Sweet) and Tt (Control), the results in terms of feed consumption had highly significant differences ($p > 0.05$) concluding that the use of flavorings improved feed consumption in comparison to the control treatment, as well as Ambi (2011) who conducted an investigation using flavorings in diets of growing and finishing pigs, obtaining positive results in terms of consumption since he observed an increase thanks to the use of these additives, while Santillán (2017) determined the dietary addition of flavorings (cinnamon and banana) in the feed of "Landrace-York" piglets just weaned and did not obtain considerable statistical variations in terms of feed consumption among the treatments studied $p > 0.05$). The use of some flavorings helped to make the feed more palatable, and therefore influenced a higher feed intake, allowing better final weights. In the present investigation, the highest average final weight achieved by the piglets was 26.30 kg (TJ), significantly higher than the rest of the treatments, similar to Ambi (2011), which obtained significant differences with the use of additives, showing an increased live weight when evaluating diets of growing and finishing pigs. Santillán (2017) determined the dietary addition of flavorings (cinnamon and banana) in the feed of just-weaned "Landrace-York" piglets and concluded that there were no considerable statistical variations in terms of final piglet weight ($p > 0.05$) like Guato (2015), who obtained no significant differences between the results of piglets from different treatments ($p > 0.05$).

Live weight

Table 4 shows the average final weights of the piglets of each treatment (TG, TH, TI, TJ, TK, TL) including the control (TT) and the commercial flavoring (TP), where there are significant differences. The average final weight achieved by the piglets that received the TJ treatment (26.30 kg) was significantly higher than that of the control treatment (TT) and commercial treatment (TP).

Table 4
Final weight of the piglets

Treatments	Weight at 56 days (kg)
TP	20.16
TT	21.47
TG	19.90
TH	19.93
TI	22.30
TJ	26.30
TK	20.82
TL	21.50

Daily weight gain

Average daily weight gains per period for the different treatments are specified in Table 5. The average daily gain that was obtained by the piglets that received treatment J (517 g) was significantly higher than the control treatment TT and the commercial treatment (TP).

Table 5
Average daily live weight gains per phase

Treatment	Daily weight gain/piglet/phase (kg)			
	14–28	28-42	42–56	14-56
TP	0.191^{a}	0.379^{abc}	0.560^{a}	0.377^{ab}
TT	0.254^{c}	0.442^{d}	0.527^{a}	0.408^{bcd}
TG	0.177^{a}	0.339^{a}	0.587^{a}	0.367^{a}
TH	0.209^{b}	0.357^{ab}	0.563^{a}	0.376^{ab}
TI	0.174^{a}	0.421^{cd}	0.703^{a}	0.433^{d}
TJ	0.259^{c}	0.386^{bc}	0.905^{a}	0.517^{e}
TK	0.226^{b}	0.354^{ab}	0.589^{b}	0.389^{abc}
TL	0.266^{c}	0.462^{d}	0.514^{c}	0.414^{cd}

†Similar uppercase letters in the same column indicate no significant difference $p < 0.05$.

In the case of daily gains, in this research, there were significant statistical differences (with the TJ treatment standing out), as in the research conducted by Ambi (2011), where each of the treatments stood out in different periods. In contrast, Santillán (2017) and Guato (2015) found no differences in their research. The use of some flavorings increases daily weight gain in piglets.

Feed Conversion

Table 6 shows that TI piglets (0.988) obtained the best results over the other treatments. The treatments with natural flavorings had good feed conversions compared to the control ration, and even to the commercial treatment ration, making these results significantly different. Regarding feed conversion, Santillán (2017) and Guato (2015) did not find significant differences in their research.

Table 6
Average Feed Conversions of different treatments by phases

Treat-ment	Daily feed conversions/piglet/phase			
	14–28	28-42	42–56	14-56
TP	0.082 ab	1.159 a	1.545 ab	1.148 c
TT	0.082 ab	1.100 a	1.856 bc	1.159 c
TG	0.113 c	1.465 c	1.485 ab	1.159 c
TH	0.056 abc	1.224 ab	1.599 ab	1.195 c
TI	0.106 bc	1.035 a	1.286 ab	0.988 a
TJ	0.109 bc	1.415 bc	1.208 a	1.042 ab
TK	0.122 c	1.444 c	1.467 ab	1.171 c
TL	0.077 a	1.068 a	2.266 c	1.129 bc

†Similar uppercase letters in the same column indicate no significant difference $p < 0.05$.

Economic merit

The economic merit (feed cost per kg of live weight gained) of TI ($ 0.78) was the lowest while that of TK, TH and TG ($ 0.94) was the highest. Regarding cost, Guato (2015) did find significant differences since in the same groups (E3 and E1), the cost was higher, but the benefit was also higher, in contrast to the other groups (E2 and T). As in the present investigation.

Table 7
Economic merit of the different treatments

Treatments	Total cost	Total gain	Cost/kg of gain ($)
TP	52.041	15.821	0.91 b
TT	55.940	17.122	0.92 b
TG	51.435	15.434	0.94 b
TH	53.605	15.800	0.94 b
TI	50.952	18.174	0.78 a
TJ	64.257	21.714	0.82 a
TK	55.866	16.353	0.94 b
TL	56.701	17.384	0.90 b

†Similar uppercase letters in the same column indicate no significant difference $p < 0.05$.

4. Conclusions

According to this research, the inclusion of natural additives offers satisfactory results, increasing consumption and daily weight gain, achieving pigs ready for sale in less time. Therefore, it is significant to promote the use of these additives among pig farmers. In the future, it would be advisable to conduct studies on the use of these flavorings in other production stages, such as growth and fattening, to see if they increase consumption, daily weight gain, feed conversion, and final weight.

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