Received 11.07.2025 Revised 13.10.2025 Accepted 27.11.2025

Vol. 21, No. 6
2025

Scientific Reports of the National University of Life and Environmental Sciences of Ukraine

Journal homepage: https://scireports.com.ua/en

UDC 636.4.083.37:591.5:502.174(477) DOI: 10.31548/dopovidi/6.2025.114

Assessment of the behavioural performance of growing pigs under different enrichment strategies in the context of implementing animal welfare regulations in Ukraine

Mykhailo Chentsov*
PhD Student
National University of Life and Environmental Sciences of Ukraine
03041, 15 Heroiv Oborony Str., Kyiv, Ukraine
https://orcid.org/0000-0003-1293-1657

Anna Lykhach
Doctor of Agricultural Sciences, Professor
National University of Life and Environmental Sciences of Ukraine
03041, 15 Heroiv Oborony Str., Kyiv, Ukraine
https://orcid.org/0000-0002-0472-6162

Abstract. The strengthening of animal welfare requirements in Ukraine necessitates the adaptation of pig housing technologies to European integration standards. The study aimed to assess the impact of different environmental enrichment strategies on the play behaviour of growing pigs under industrial conditions. The experiment was conducted on four groups of pigs, each consisting of 22 individuals, aged 28 days at the start, with identical feeding and housing conditions. Enrichment objects were introduced before the start of video monitoring to ensure animal adaptation. Behavioural observations were carried out in three periods: days 29-35, 50-56, and 70-76. Data analysis was performed using two-way analysis of variance with fixed factors "group" and "day," as well as their interaction "group × day." The results showed that the "group" factor accounted for 51.7% of the variation in the first period, and in periods 2 and 3, it reached 99% ($P < 0.001$). The duration of play behaviour in the control group ranged from 6.7 to 12.6 minutes, while in the group with a cotton rope, it was up to 42.7 minutes; in the group with bundles of packing paper, up to 65.2 minutes; and in the group with bottles partially filled with grain, up to 76.2 minutes. The results obtained for all periods of the study indicate that the "group" factor explained 78.0% of the total variation in play behaviour, while the "experiment period" explained only 5.0%, and unorganised factors accounted for 14.5%, indicating the clear dominance of enrichment type over time-

Suggested Citation:
Chentsov, M., & Lykhach, A. (2025). Assessment of the behavioural performance of growing pigs under different enrichment strategies in the context of implementing animal welfare regulations in Ukraine. *Scientific Reports of the National University of Life and Environmental Sciences of Ukraine*, 21(6), 114-127. doi: 10.31548/dopovidi/6.2025.114.

*Corresponding author

related changes. Hierarchical variance analysis confirmed that in all groups, both the period and the day of the experiment had a highly significant impact (all $P < 0.001$), but the proportion of variation due to unorganised factors was highest in the growing piglets of the control group, at 53.6%. These data suggest a significant stimulatory effect of environmental enrichment on pig activity. The advantage of the enriched groups demonstrates the potential for improving the behavioural and emotional components of animal welfare. It is emphasised that the implementation of accessible and effective enrichment strategies is of practical importance for modernising pig housing in Ukraine in line with welfare requirements

Keywords: ethical standards; European integration; behaviour; pigs; sustainable development; technology

Introduction

In modern animal husbandry, the issue of animal welfare is becoming increasingly important, both from an ethical perspective and in terms of economic and production considerations. This is particularly relevant in intensive pig farming, where limited space, standardised feeding and housing systems often prevent the expression of natural species-specific behavioural responses. Scientific studies by M. Delsart *et al.* (2020), L.A. Boyle *et al.* (2021), and K. Bucková *et al.* (2022) unanimously indicate that the implementation of environmental enrichment strategies promotes the increase of active behaviours such as exploratory behaviour, object manipulation, and play interaction, while simultaneously reducing stress, aggressive, or stereotypical behaviours in pigs.

According to Council Directive 2008/120/EC (European Union, 2008), pigs "must have constant access to a sufficient number of objects that can be provided for appropriate research and manipulation" to improve their welfare. Numerous studies by J. Li *et al.* (2020) have shown that in the absence of stimuli in pig housing, environmental enrichment with materials such as straw bedding or peat can reduce destructive behaviour and, conversely, enhance play interactions. A review by I.G. Colditz *et al.* (2024) highlights that, particularly during the juvenile phases of animal development, the environment plays a crucial role in shaping adaptive abilities and behavioural plasticity. The works of S. Pietrosemoli & C. Tang (2020), H.-S. Mun *et al.* (2023) emphasised that the presence of auditory effects, chewing objects, digging, or manipulation responds to the internal motivation of pigs to explore their environment and engage in social interactions.

In the context of animal husbandry legislation and practice, it is important to note that European Union countries have long implemented standards for pig housing conditions, taking animal welfare into account, including requirements for the presence of enrichment materials or objects (European Union, 2021). This holds particular significance for Ukraine: within the framework of its European integration obligations, and in preparation for the implementation of modern standards at the farm level, it has been announced that, starting from January 1, 2026, animal welfare regulations will be mandatory on all farms (Order of the Ministry for Development of Economy…, 2021). Thus, Ukrainian pig farming is on the threshold of significant transformations – both technological and behavioural. In the field of pig behaviour, environmental enrichment serves as both a technological tool and an indicator of welfare. Scientific studies by A. Lykhach *et al.* (2022) confirmed that the introduction of objects such as ropes, bottles filled with grain, hanging tree branches, or paper stimulation can contribute to an increase in the duration of play behaviour, a decrease in aggression, improved social interaction, and fewer injuries (such as those to the skin or tail). The study by L. Luo *et al.* (2020) showed that pigs in enriched environments had a lower frequency of aggressive contacts after regrouping.

The relevance of this approach for Ukraine is amplified by several factors: first, consumer interest in animal welfare, and second, Ukrainian producers, planning or already engaged in exports to EU countries, face the demand to comply with stricter standards. Therefore, research related to piglet behaviour in the context of environmental enrichment becomes of strategic importance: not only as a scientific contribution but also as a practical recommendation for the modernisation of the Ukrainian pig farming industry. Despite the availability of scientific data, there are several gaps that are relevant to Ukraine. Among them is the insufficient research on the play behaviour of piglets during the growing phase in the context of enrichment implementation, especially considering Ukrainian climatic, technological, and farm conditions. Thus, in the context of Ukrainian practice and science, the task is to develop a methodology that takes into account species-specific piglet behaviour, uses adapted enrichment objects, and evaluates their impact under industrial housing conditions. The next logical step is empirical research that will allow for a quantitative assessment of changes in piglet behaviour depending on the types of enrichment, as well as their impact on welfare and productivity.

In connection with the above, the aim of the study was to assess the impact of different environmental enrichment strategies on the duration and nature of play behaviour in growing piglets under industrial housing conditions, considering the future implementation of animal welfare regulations in Ukraine.

Materials and Methods

Animal handling in the experiment fully complied with international and national ethical standards: European legislation (European Union, 2008; 2010) and Ukrainian regulations (Order of the Ministry for Development of Economy..., 2021). The study protocol was approved by the Bioethics Commission of the National University of Life and Environmental Sciences of Ukraine (30 November 2023, protocol No. 008). Experimental research was conducted in 2023 at a farm in Ukraine – the private leased enterprise "Victoria" in the Bashtanka district of Mykolaiv region. Four groups of piglets participated in the study, with the maternal breed being Large White sows and the paternal breed being PIC 337 boars: Group I was the control group, and Groups II, III, and IV were the experimental groups, each consisting of 22 individuals. The age of the piglets at the start of the experiment was 28 days. Piglets in Group I (the control group) were kept without enrichment objects; Group II was provided with a twisted cotton rope with a diameter of 16 mm (Fig. 1), which was hung on the pen fence; Group III had 1-litre plastic bottles, filled 50% with grain (Fig. 2), with 4 bottles per pen, rotated weekly; Group IV had packaging paper with a density of 80 g/m² (Fig. 3), twisted into bundles, which was replaced twice daily.

Figure 1. *Twisted cotton rope, hung on the pen fence for the piglets in the experimental Group II*

Note: the enrichment object for the growing piglets is highlighted by a red oval

Source: authors' development

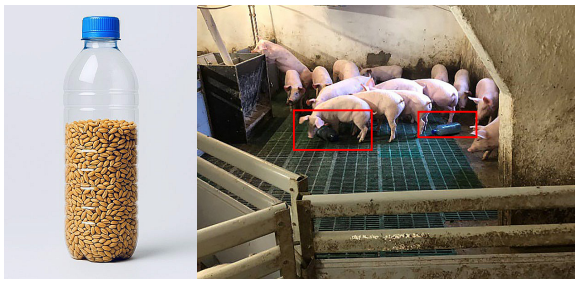

Figure 2. *Plastic bottles, filled 50% with grain, for the piglets in the experimental Group III*

Note: the enrichment objects for the growing piglets are highlighted by yellow circles

Source: authors' development

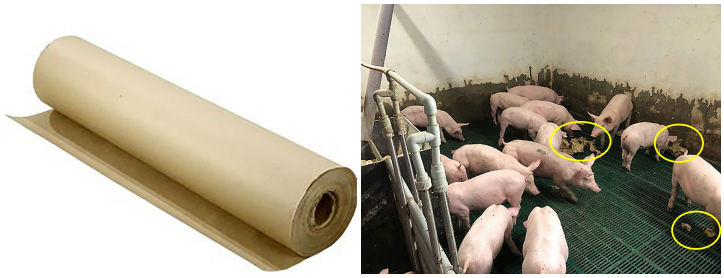

Figure 3. *Packaging paper, twisted into bundles, for the piglets in the experimental Group IV*

Note: the enrichment objects for the growing piglets are highlighted by yellow circles

Source: authors' development

Enrichment objects were provided to the experimental groups of piglets throughout the day before the start of video monitoring (Day 0) to allow the animals to adapt to the objects by the following morning. The objects (Figs 2 and 3) were placed on the floor in the cleanest part of the pen, at a sufficient distance from the walls to ensure full access. The hanging object (Fig. 1) was positioned on the pen fence in such a way that the piglets could manipulate it from all sides. The piglets were housed in pens with solid slatted polymer flooring, with an area of 0.4 m^2 per head. Feed was delivered to automatic feeders via rope-and-pulley conveyors. One automatic feeder was installed for every two adjacent pens, as well as two automatic drinking cups in each pen. Feeding in all experimental groups was the same and was carried out according to detailed feeding standards, taking into account the physiological characteristics of the animals; the feeding type was dry (Ibatulin, 2017).

Until the 42nd day of life, the piglets were fed ad libitum with a full-feed prestarter compound feed from "Cehavekorm" LTD Ukraine. From the 42nd to the 49th day, they were gradually switched to a starter compound feed produced at their own feed mill based on cereal crops, with the addition of "Cehavit pig concentrate starter" from "Cehavekorm" LTD Ukraine. Nutritional value: crude protein content – 182.700 g/kg, metabolisable energy – 3,164.800 kcal/kg. Feed composition (%): wheat – 45.000; barley – 25.000; "Cehavit pig concentrate starter" – 30.000 (quality certificate according to DSTU 4508:2005 (2005)).

The ventilation system in the room with negative pressure was implemented using exhaust fans and intake valves. Air was supplied through the valves, mixed with the existing air, and then

extracted by the fan. The microclimate was regulated by computer equipment. The microclimate parameters complied with the Departmental standards for technological design (Ministry of Agrarian Policy of Ukraine, 2005). Microclimate parameters: air temperature – 22.0-24.0°C; relative humidity – 60.0-80.0%; air velocity – 0.20-0.60 m/s. During the early stages of piglet growth, heating was provided by infrared heaters suspended at a height of 1.2 m. The room was heated by a pyrolysis boiler with a capacity of 100 kW and a two-pipe system. Manure removal from the room was carried out by vacuum-gravity method – as it accumulated under the slatted baths, but no less frequently than once every two weeks. The piglets were delivered to the section every Thursday, immediately after weaning from the sows and weighing. They stayed there for 7 weeks until reaching 77 days of age, after which they were re-weighed and sent for fattening.

The behavioural acts of growing pigs in the experimental groups, depending on the type of enrichment object, were visualised through video monitoring using Boblov KJ21 video recorders (China) (with a resolution of 1920×1080 (Full HD), providing a full view of the objects. Recording was conducted from 8:30 AM to 4:30 PM during full daylight, as pigs virtually do not manipulate enrichment objects during the dark hours. Behavioural observations were carried out through video analysis, focusing on play behaviour, which was defined as any directed action towards the enrichment object, performed deliberately and involving contact by the piglet's snout, head, limbs (pushing, hitting, rubbing), or mouth (chewing, biting, pulling, tearing, shaking). Behavioural sampling was conducted over four continuous one-hour periods, evenly distributed throughout the daylight hours (9:00-10:00, 11:00-12:00, 13:00-14:00, 15:00-16:00) (Ladyka & Khmelnychiy, 2023). Since the frequency of play behaviour in growing piglets from different groups (depending on the type of enrichment object) was analysed in three time periods – 29-35 days (period 1), 50-56 days (period 2), and 70-76 days (period 3) – the analysis was conducted in three stages.

In the first stage, the strength of the effect of the group and the day of the experiment on the variability of the frequency of play interactions in growing piglets was investigated using a two-way analysis of variance algorithm (with fixed factors). In the second stage, the strength of the effect of the group and the experiment period (all data for separate days were combined) on the variability of the frequency of play interactions in growing piglets was determined using a two-way analysis of variance algorithm (with fixed factors). In the third stage, the strength of the effect of the period and the day of the experiment (within each separate period) on the variability of the frequency of play interactions in growing piglets for each of the three groups was determined using a hierarchical two-way analysis of variance algorithm (with fixed factors). All calculations were performed using STATISTICA v. 7.0 software.

Results and Discussion

The results of the first stage of the study indicate a significant impact of the factors being investigated. Table 1 presents the results of the two-way analysis of variance on the effect of the group and the day of the experiment on the duration of play behaviour in growing piglets during period 1.

Table 1. *Results of the two-way analysis of variance on the effect of the group and the day of the experiment on the duration of play behaviour in growing piglets (period 1)*

Source of variance	*SS*	*df*	*MS*	*F*	*P*	h^2, %
Group (A)	153,442.9	3	51,147.6	13,784.8	<0.001	51.7
Day of experiment (B)	101,599.1	6	16,933.2	4,563.7	<0.001	34.2
A × B	39,557.0	18	2,197.6	592.3	<0.001	13.3
Error	2,181.7	588	3.7			0.7
Total	296,780.7	615				100.0

Source: authors' development

The significant effects of the factors "group" and "day of the experiment", as well as their interaction, were established (in all cases: $P < 0.001$). The strongest effect was observed for the factors "group" (51.7%) and "day of the experiment" (34.2%). Figure 4 shows the arithmetic mean values of the duration of play behaviour in growing piglets depending on the group and the day of the experiment during period 1.

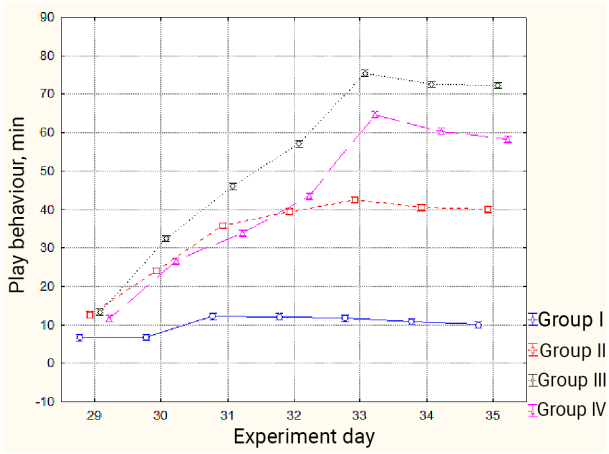

Figure 4. *Arithmetic mean values (±95% CI) of the duration of play behaviour in growing piglets depending on the group and the day of the experiment during period 1*

Note: CI – confidence interval

Source: authors' development

The obtained estimates of the average duration of play behaviour gradually increased during period 1, reaching their peak on days 33-35. This was particularly pronounced for the animals in the three experimental groups (II, III, and IV). There were also clear intergroup differences. The lowest estimates of the duration of play behaviour (6.7-12.2 minutes) were noted for the piglets in the control Group I. Significantly higher estimates were obtained for the animals in experimental Group II (with maximum values during period 1 of 40.0-42.5 minutes), and finally, for the animals in Groups III and IV, the maximum values during period 1 reached 75.4 and 64.6 minutes, respectively, as visualised on day 33 of the experiment.

The next stage of the analysis (period 2) confirmed the trends, but with new emphases. Table 2 presents the results of the two-way analysis of variance on the effect of the group and the day of the experiment on the duration of play behaviour in growing piglets during period 2. Although a significant effect of both main factors and their interaction was also established (in all cases: $P < 0.001$), nearly all the variability in the duration of play behaviour in piglets during this period was associated with intergroup differences – the effect of the "group" factor accounted for 99.0%. Figure 5 shows the arithmetic mean values (± 95% CI) of the duration of play behaviour in growing piglets depending on the group and the day of the experiment during period 2.

Table 2. *Results of the two-way analysis of variance on the effect of the group and the day of the experiment on the duration of play behaviour in growing piglets (period 2)*

Source of variance	*SS*	*df*	*MS*	*F*	*P*	h^2, %
Group (A)	341,171.3	3	113,724.8	30,379.3	<0.001	99.0
Day of experiment (B)	487.9	6	81.3	21.7	<0.001	0.1

Table 2. *Continued*

Source of variance	*SS*	*df*	*MS*	*F*	*P*	h^2, %
A × B	754.8	18	41.9	11.2	<0.001	0.2
Error	2,201.2	588	3.7			0.6
Total	344,615.1	615				100.0

Source: authors' development

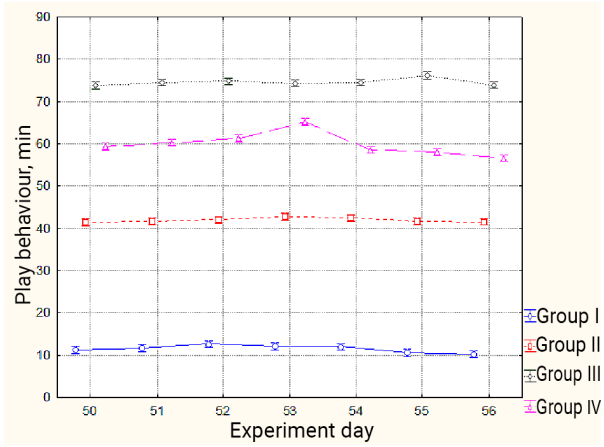

Figure 5. *Arithmetic mean values (±95% CI) of the duration of play behaviour in growing piglets depending on the group and the day of the experiment during period 2*

Note: CI – confidence interval

Source: authors' development

During the specified period, there were very slight fluctuations in the duration of play behaviour in piglets from different groups, against the backdrop of significant differences in the estimates for each group. Again, the lowest estimates of the average duration of play behaviour during period 2 were observed for the animals in the control Group I (10.2-12.6 minutes), with higher estimates for the animals in experimental Group II (41.5-42.7 minutes), even higher estimates for the animals in experimental Group IV (56.6-65.2 minutes), and finally, the highest estimates were visualised for the animals in experimental Group III (73.8-76.2 minutes). It is noteworthy that for the piglets in experimental Group II, these day-to-day fluctuations did not have statistical significance ($F = 1.45$; $P > 0.05$) and were very weak (although statistically significant) for the animals in experimental Group III. In contrast, among the piglets in control Group I and experimental Group IV, the average estimates of the duration of play behaviour during period 2 initially increased (reaching their maximum on days 52 and 53, respectively), but then decreased.

Table 3 presents the results of the two-way analysis of variance on the effect of the group and the day of the experiment on the duration of play behaviour in growing piglets during period 3. Once again, as in the previous experiment period, a significant effect of both main factors and their interaction was established (in all cases: $P < 0.001$), but nearly all the variability in the duration of play behaviour in piglets during this period was also associated with intergroup differences – the effect of the "group" factor accounted for 99.1%. Figure 6 shows the arithmetic mean values (±95% CI) of the duration of play behaviour in growing piglets depending on the group and the day of the experiment during period 3.

Table 3. *Results of the two-way analysis of variance on the effect of the group and the day of the experiment on the duration of play behaviour in growing piglets (period 3)*

Source of variance	*SS*	*df*	*MS*	*F*	*P*	h^2, %
Group (A)	339,694.8	3	113,231.6	26,880.0	<0.001	99.1
Day of experiment (B)	281.6	6	46.9	11.1	<0.001	0.1
A × B	463.1	18	25.7	6.1	<0.001	0.1
Error	2,476.9	588	4.2			0.7
Total	342,916.5	615				100.0

Source: authors' development

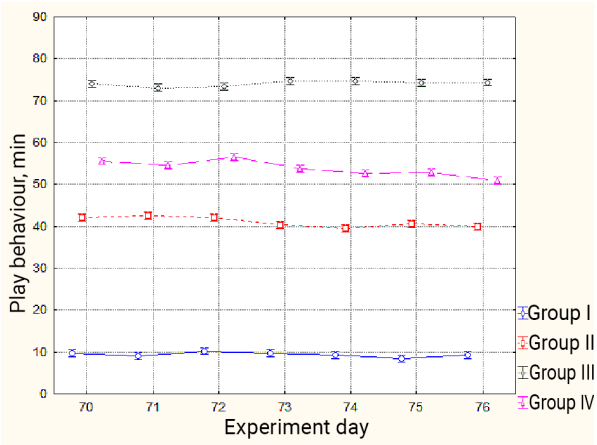

Figure 6. *Arithmetic mean values (±95% CI) of the duration of play behaviour in growing piglets depending on the group and the day of the experiment during period 3*

Note: CI – confidence interval

Source: authors' development

As in the previous experimental period, during period 3, very slight fluctuations in the duration of play behaviour in piglets from different groups were observed, against the backdrop of significant differences in the estimates for each group. The relationship between the estimates for animals in different groups remained the same as during period 2. Notably, for the animals in control Group I and experimental Group III, these day-to-day fluctuations did not have statistical significance (in both cases: $P > 0.05$). To identify long-term trends, an analysis of the effect of the factors "group" and "experiment period" was conducted. When considering the variability of play behaviour duration over a larger time scale (in terms of individual periods), the previously established patterns remained, with a more significant influence of the "group" factor (the effect size was 78.0%) compared to the "experiment period" factor (5.0%). The relatively large proportion attributable to the effect of unorganised factors (14.5%) indicates a certain level of variability in the raw data obtained within each experiment period (Table 4). Overall, the duration of play behaviour in growing piglets, regardless of group membership, demonstrates an increase in estimates during period 2, with either the achieved level being maintained or slightly decreasing (among animals in control Group I and experimental Group IV) during period 3 (Fig. 7).

Table 4. *Results of the two-way analysis of variance on the effect of the group and the experiment period on the duration of play behaviour in growing piglets*

Source of variance	*SS*	*df*	*MS*	*F*	*P*	h^2, %
Group (A)	807,631.8	3	269,210.6	3,295.06	<0.001	78.0
Experiment period (B)	51,542.2	2	25,771.1	315.43	<0.001	5.0
A × B	26,677.2	6	4,446.2	54.42	<0.001	2.6
Error	150,003.3	1,836	81.7			14.5
Total	1,035,854.6	1,847				100.0

Source: authors' development

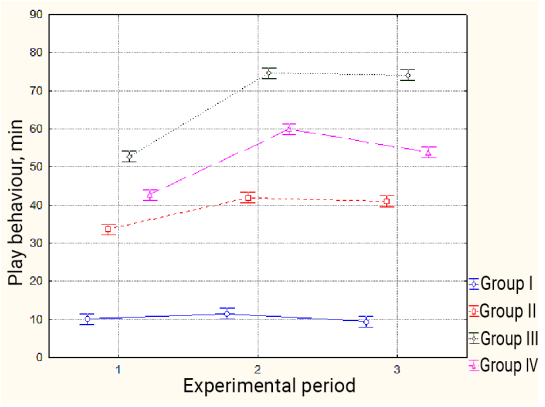

Figure 7. *Arithmetic mean values (± 95% CI) of the duration of play behaviour in growing piglets depending on the group and the experiment period*

Note: CI – confidence interval

Source: authors' development

Additional hierarchical analysis allowed for a deeper assessment of the effect size of each time level. Table 5 presents the results of the hierarchical two-way analysis of variance on the effect of the period and the day of the experiment on the duration of play behaviour in growing piglets. Overall, a highly significant effect was found for both the experimental periods (in all cases: $P < 0.001$) and the day of the experiment within individual periods (in all cases: $P < 0.001$) for the animals in all four groups. More interestingly, the relationship between the influence of these two time scales on the variability in the duration of play behaviour in growing piglets was established among the animals in the control and experimental groups (Fig. 8).

Table 5. *Results of the hierarchical two-way analysis of variance (F; P) on the effect of the period and the day of the experiment on the duration of play behaviour in growing piglets*

Group	Experiment period (A)	Day of experiment within the period (B(A))
I Control	53.28 (<0.001)	15.23 (<0.001)
II Experimental	870.72 (<0.001)	246.60 (<0.001)
III Experimental	5,407.95 (<0.001)	915.48 (<0.001)
IV Experimental	2,839.99 (<0.001)	708.71 (<0.001)

Source: authors' development

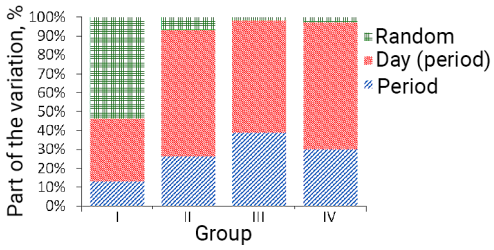

Figure 8. *Estimates of the effect size of the period and the day of the experiment (within individual periods) on the duration of play behaviour in growing piglets*

Source: authors' development

For the animals in control group I, nearly half (53.6%) of the variability in the duration of play behaviour was caused by unorganised factors, i.e., related to interindividual differences. For the animals in the control group, the effect size of differences between individual experimental periods was only 13.0%, while for the animals in the experimental groups, the corresponding estimate was 2-3 times higher. Finally, for the animals in control group I, the effect size of differences between individual days of the experiment (within periods) was higher, at 33.40%, while for the animals in the experimental groups, the corresponding estimate was almost twice as high. Therefore, it can be concluded that the nature of the variability in the duration of play behaviour was more influenced by the presence of the enrichment object in pig housing during the growing phase, rather than the type of enrichment object itself.

The results of the conducted study, which revealed a significant effect of enrichment objects on the duration of play behaviour in piglets, are fully consistent with current views on the importance of the environment in shaping animal behavioural responses. Specifically, the differences observed between the experimental groups, recorded during all observation periods, confirm that the type and availability of enrichment materials determine the level of play activity in growing piglets. J.-M. Beaudoin *et al.* (2019) demonstrated that cleanliness, novelty, and the physical characteristics of enrichment objects critically influence the maintenance of pig interest. In the present study, this was particularly evident for the groups with bottles filled with grain and paper balls, which were regularly updated, stimulating play activity. N. Casal-Plana *et al.* (2017) also emphasised that the use of natural additives combined with enrichment objects positively influences both behaviour and weight gain in the studied groups of pigs. In turn, E. Fàbrega *et al.* (2019) indicated that even under unfavourable climatic conditions, an enriched environment contributes to the improvement of the physiological and productive parameters of pigs. This allows the effect of enrichment to be viewed as a universal tool for enhancing their welfare.

In turn, J. Lee *et al.* (2025) demonstrated that the introduction of enrichment has the greatest impact during the early period of weaning piglets from sows. The increased duration of play behaviour observed in the current study can be explained by a reduction in stress due to the ability to fulfil natural needs for exploration and manipulation. L. Luo *et al.* (2022) also confirm that enrichment enhances the resilience of piglets to social stressors, such as regrouping. The practical significance of the current study is supported by the works of A. Lykhach *et al.* (2022) and R.F. Oliveira *et al.* (2023), who prove that even simple and inexpensive materials, such as plastic bottles filled with grain or wood shavings, are effective behavioural enrichment tools. These reduce aggression levels and maintain animal activity. This is particularly important in the context of current requirements for pig welfare in industrial farming conditions. At the same time, the choice of inexpensive yet effective enrichment objects can be a cost-effective solution for both small and large pork producers.

K. Steinerová *et al.* (2024) emphasised that play behaviour is a biomarker of a positive emotional state, and its presence correlates with physiological indicators of pig welfare. The data from the current study regarding the stable increase in play activity in the experimental groups support this statement. Additionally, as noted by

K.C. Smith & M.K. Pierdon (2024), environmental enrichment contributes to a reduction in the frequency of skin injuries, which is an indirect indicator of decreased aggressive behaviour within the group. Thus, the introduction of enrichment objects can be seen not only as an element of welfare but also as a tool for reducing stress factors and preventing cannibalism. In period 1, it was found that the "group" factor accounted for 51.7% of the variation in play behaviour, "day of the experiment" – 34.2%, and their interaction – 13.3%. In subsequent periods, the effect of the day decreased, while the effect of the group reached up to 99%. The analysis between periods also confirmed the dominant role of the type of enrichment (78% variation). This indicates a trend towards the stabilisation of behavioural responses after adaptation to new conditions, when the piglets had already become accustomed to the presence of objects and were actively using them. Play behaviour in the current study also demonstrated high informativeness in the context of assessing the emotional state of the animals. This is confirmed by the correlation of results between periods, where positive dynamics in play activity were observed in the experimental groups throughout the entire observation period. Meanwhile, in the control group, play remained at a consistently low level, which may indicate background stress and a lack of motivation for social or object-related interaction.

Environmental enrichment not only increases animal activity but also stabilises their behaviour over time. This makes it possible to recommend the regular use of enrichment objects in piglet housing systems as a means of improving welfare domains and reducing stress manifestations. The choice of enrichment type is crucial: objects that can be explored, moved, or destroyed generate more interest and longer play activity. Therefore, considering the specific behaviour of growing piglets when selecting enrichment is critically important. The experience of foreign studies by N. Alvarez-Hernandez *et al.* (2023) has shown that a combination of olfactory, tactile, and visual stimuli has the greatest effect. Furthermore, an important aspect of future research is the development of assessments of the economic efficiency of enrichment, in order to balance the needs for animal welfare with the commercial interests of farms.

In conclusion, the current study makes a new contribution to the field of pig behaviour, confirming that quality enrichment can become an effective strategy for the behavioural and emotional support of animals in industrial conditions. The obtained data suggest the need for improving pig housing systems with the mandatory inclusion of enrichment components, which will not only enhance their welfare but also improve the overall efficiency of pork production.

Conclusions

Summarising the results of the obtained data, a number of key conclusions can be formulated, reflecting the importance of environmental enrichment in shaping the play behaviour of growing piglets and defining the potential directions for practical application of the findings. The study established that the factor "group" has the greatest impact on the duration of play behaviour in growing piglets. Specifically, in period 1, the effect size of this factor was 51.7% of the total variation ($P < 0.001$), while in periods 2 and 3, it accounted for 99.0% and 99.1%, respectively ($P < 0.001$), indicating its dominant significance. The effect of the "day of the experiment" factor was moderate only in period 1, where it explained 34.2% of the variation ($P < 0.001$), and significantly decreased in subsequent periods – only 0.1% in periods 2 and 3, indicating the animals' adaptation to the environmental conditions and the stabilisation of behavioural activity. The interaction of the factors "group × day" had a statistically significant but smaller effect – 13.3% in period 1, 0.2% in period 2, and 0.1% in period 3 (all $P < 0.001$), indicating a moderate impact of daily fluctuations against the backdrop of the stable influence of the type of enrichment.

The lowest average duration of play behaviour was observed in the animals of control group I (ranging from 6.7 to 12.6 minutes in

different periods), while in experimental group II with the rope, the duration increased to 42.7 minutes, in group IV with paper bundles it increased to 65.2 minutes, and the highest values were recorded in group III with grain-filled bottles – up to 76.2 minutes on days 33-53 of the experiment. The summarised results for all periods of the study demonstrate that the "group" factor explained 78.0% of the total variation in play behaviour, while the "experiment period" accounted for only 5.0%, and unorganised factors accounted for 14.5%, indicating a clear dominance of the type of enrichment over time-related changes. Hierarchical variance analysis confirmed that in all groups, there was a highly significant effect of both the period and the day of the experiment (all $P < 0.001$), but the proportion of variation explained by unorganised factors was highest in the growing piglets of control group I – 53.6%, whereas in the experimental groups, it significantly decreased.

Thus, environmental enrichment significantly enhances the play activity of piglets, serves as a means of reducing stress and aggressive behaviour, and is also a reliable behavioural indicator of animal welfare in intensive farming systems. The prospects for future research lie in expanding experimental models to account for individual characteristics of piglets (temperament, gender, genetic origin), including physiological welfare indicators (cortisol levels, immune markers), as well as long-term monitoring of enrichment effectiveness. An important area of research is also the durability of the enrichment effect over time, including the dynamics of decreasing interest in enrichment objects.

Acknowledgements

The authors would like to express their gratitude to the owner and the team of the private leased enterprise "Victoria" for providing the base for scientific research.

Funding

None.

Conflict of Interest

None.

References

[1] Alvarez-Hernandez, N., Vallejo-Timarán, D., & de Jesús Rodriguez, B. (2023). Adapted original music as an environmental enrichment in an intensive pig production system reduced aggression in weaned pigs during regrouping. *Animals*, 13(23), article number 3599. doi: 10.3390/ani13233599.

[2] Beaudoin, J.-M., Bergeron, R., Devillers, N., & Laforest, J.-P. (2019). Growing pigs' interest in enrichment objects with different characteristics and cleanliness. *Animals*, 9(3), article number 85. doi: 10.3390/ani9030085.

[3] Boyle, L.A., Edwards, S.A., Bolhuis, J.E., Pol, F., Šemrov, M.Z., Schütze, S., Nordgreen, J., Bozakova, N., Sossidou, E.N., & Valros, A. (2021). The evidence for a causal link between disease and damaging behavior in pigs. *Frontiers in Veterinary Science*, 8, article number 771682. doi: 10.3389/fvets.2021.771682.

[4] Bucková, K., Muns, R., Ceron, J., & Kyriazakis, I. (2022). Consequences of timing of organic enrichment provision on pig performance, health and stress resilience after weaning and regrouping. *Animal,* 16(10), article number 100637. doi: 10.1016/j.animal.2022.100637.

[5] Casal-Plana, N., Mantecab, X., Dalmaua, A., & Fàbregaa, E. (2017). Influence of enrichment material and herbal compounds in the behaviour and performance of growing pigs. *Applied Animal Behavior Science*, 195, 38-43. doi: 10.1016/j.applanim.2017.06.002.

[6] Colditz, I.G., Campbell, D.L.M., Ingham, A.B., & Lee, C. (2024). Review: Environmental enrichment builds functional capacity and improves resilience as an aspect of positive welfare in production animals. *Animal*, 8(6), article number 101173. doi: 10.1016/j.animal.2024.101173.

[7] Delsart, M., Pol, F., Dufour, B., Rose, N., & Fablet, C. (2020) Pig farming in alternative systems: Strengths and challenges in terms of animal welfare, biosecurity, animal health and pork safety. *Agriculture*, 10(7), article number 261. doi: 10.3390/agriculture10070261.
[8] DSTU 4508:2005. (2005). *Concentrated feed for pigs. Technical specifications*. Retrieved from https://online.budstandart.com/ua/catalog/doc-page?id_doc=54157.
[9] European Union. (2008). *Council Directive 2008/120/EC of 18 December 2008 laying down minimum standards for the protection of pigs (Codified version)*. Retrieved from https://eur-lex.europa.eu/eli/dir/2008/120/oj/eng.
[10] European Union. (2010). *Council Directive 2010/63/EC of 22 September 2010 on the protection of animals used for scientific purposes*. Retrieved from https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32010L0063.
[11] European Union. (2021). *Animal welfare on the farm, ex-post evaluation of the EU legislation. Prospects for animal welfare labelling at EU level – European implementation assessment*. Retrieved from https://data.europa.eu/doi/10.2861/23838.
[12] Fàbrega, E., Marcet-Rius, M., Vidal, R., Escribano, D., Cerón, J.J., Manteca, X., & Velarde, A. (2019). The effects of environmental enrichment on the physiology, behaviour, productivity and meat quality of pigs raised in a hot climate. *Animals*, 9(5), article number 235. doi: 10.3390/ani9050235.
[13] Ibatulin, I.I. (Ed.). (2017). *Methodology and organization of scientific research in animal husbandry*. Kyiv: Agrarian Science.
[14] Ladyka, V.I., & Khmelnychiy, L.M. (Eds.). (2023). *Technology of production and processing of livestock products*. Odesa: Oldi+.
[15] Lee, J., Oh, S., & Kim, M. (2025). Impact of environmental enrichment on growth, behavior, and welfare of weanling piglets from preweaning to 6 weeks of age. *Journal of Animal Science & Technology*, 67(1), 152-163. doi: 10.5187/jast.2024.e1.
[16] Li, J., Han, Q., Zhang, R., Liu, H., Li, X., & Bao, J. (2020). PSV-7 Effects of music stimulus on behavior response, cortisol level and immunity horizontal of growing pigs. *Journal of Animal Science*, 98, 224-225. doi: 10.1093/jas/skaa278.412.
[17] Luo, L., Reimert, I., Middelkoop, A., Kemp, B., & Bolhuis, J.E. (2020) Effects of early and current environmental enrichment on behavior and growth in pigs. *Frontiers in Veterinary Science*, 7, article number 268. doi: 10.3389/fvets.2020.00268.
[18] Luo, L., van der Zande, L.E., van Marwijk, M.A., Knol, E.F., Rodenburg, T.B., Bolhuis, J.E., & Parois S.P. (2022). Impact of enrichment and repeated mixing on resilience in pigs. *Frontiers in Veterinary Science*, 9, article number 829060. doi: 10.3389/fvets.2022.829060.
[19] Lykhach, A., Lykhach, V., Faustov, R., Getya, A., & Lesik, I. (2022). Influence of enrichment materials on the behaviour and productive traits of fattening pigs. *Acta Fytotechnica et Zootechnica*, 25(2), 77-84. doi: 10.15414/afz.2022.25.02.77-84.
[20] Ministry of Agrarian Policy of Ukraine. (2005). *Departmental Norms for Technological Design – Agro-Industrial Complex – 02.05. "Pig-breeding enterprises (complexes, farms, small farms)"*. Retrieved from https://surl.li/utytfa
[21] Mun, H.-S., Lagua, E., Ampode, K.M.B., Chem, V., Park, H.-R., Kim, Y.-H., & Yang, C.-J. (2023). Interactions of environmental conditions, day-night cycles, and growing periods on postural behavior of pigs. *Journal of Animal Behaviour and Biometeorology*, 11(4), article number 2023035. doi: 10.31893/jabb.23035.
[22] Oliveira, R.F., Soares, R.T.R.N., Moreira, R.H.R., Andrade, R.P., Rosenfield, D.A., & Pizzutto, C.S. (2023). Effects of the environmental enrichment on pigs' behavior and performance. *Revista Brasileira de Zootecnia*, 52, article number e20210123 doi: 10.37496/rbz5220210123.
[23] Order of the Ministry for Development of Economy, Trade and Agriculture of Ukraine No. 224 "On Approval of Requirements for the Welfare of Farm Animals during Their Keeping". (2021, February). Retrieved from https://zakon.rada.gov.ua/laws/show/z0206-21#Text.
[24] Pietrosemoli, S., & Tang, C. (2020). Animal welfare and production challenges associated with pasture pig systems: A review. *Agriculture*, 10(6), article number 223. doi: 10.3390/agriculture10060223.
[25] Smith, K.C., & Pierdon, M.K. (2024). Utilization of enrichment objects by growing pigs in a commercial facility and the impact on behavior and skin lesions. *Applied Animal Behaviour Science*, 272, article number 106181. doi: 10.1016/j.applanim.2024.106181.

[26] Steinerová, K., Parker, S.E., Brown, S.E., & Seddon, Y.M. (2024). The promotion of play behaviour in growfinish pigs: The relationship between behaviours indicating positive experience and physiological measures. *Applied Animal Behaviour Science*, 275, article number 106263. doi: 10.1016/j.applanim.2024.106263.

Оцінка ігрової поведінки поросят на дорощуванні за різних стратегій збагачення в контексті імплементації правил благополуччя тварин в Україні

Михайло Ченцов
Здобувач вищої освіти наукового ступеня доктор філософії
Національний університет біоресурсів і природокористування України
03041, вул. Героїв Оборони, 15, м. Київ, Україна
https://orcid.org/0000-0003-1293-1657
Анна Лихач
Доктор сільськогосподарських наук, професор
Національний університет біоресурсів і природокористування України
03041, вул. Героїв Оборони, 15, м. Київ, Україна
https://orcid.org/0000-0002-0472-6162

Анотація. Посилення вимог до благополуччя тварин в Україні вимагає адаптації технологій утримання свиней до стандартів європейської інтеграції. Дослідження було спрямоване на оцінку впливу різних стратегій збагачення середовища на ігрову поведінку поросят на дорощуванні в промислових умовах. Експеримент проведено на чотирьох групах поросят по 22 голови, віком 28 днів на початку, за умов однакової годівлі та утримання. Об'єкти збагачення вводились перед початком відеомоніторингу для забезпечення адаптації тварин. Поведінкові спостереження здійснювались у три періоди: 29-35-а, 50-56-а та 70-76-а доба. Аналіз проведено методом двофакторного дисперсійного аналізу з фіксованими факторами «група» та «доба», а також їх взаємодією «група × доба». Результати експерименту показали, що фактор «група» пояснював 51,7 % варіації в періоді 1, а вже у періодах 2 і 3 досягав 99 % ($P < 0,001$). Тривалість ігрової поведінки у контрольній групі становила 6,7-12,6 хв, тоді як у групі з бавовняною мотузкою – до 42,7 хв, у групі з купками пакувального паперу – до 65,2 хв, а у групі з пляшками, наполовину наповнені зерном – до 76,2 хв. Отримані результати за всі періоди дослідження свідчать, що фактор «група» пояснював 78,0 % загальної варіації ігрової поведінки, тоді як «період експерименту» – лише 5,0 %, а неорганізовані фактори – 14,5 %, що вказує на чітку перевагу впливу типу збагачення над часовими змінами. Ієрархічний дисперсійний аналіз підтвердив, що в усіх групах мав місце високовірогідний вплив як періоду, так і доби експерименту (усі $P < 0,001$), проте частка варіації за неорганізованих факторів найвища у поросят на дорощуванні І контрольної групи – 53,6 %. Ці дані свідчать про значний стимулюючий ефект збагачення середовища на активність поросят. Перевага груп із збагаченням демонструє можливість підвищення поведінкових та емоційних складників благополуччя. Підкреслено, що впровадження доступних і ефективних стратегій збагачення має практичну значущість для модернізації утримання поросят в Україні з урахуванням вимог благополуччя

Ключові слова: етичні стандарти; євроінтеграція; поведінка; свині; сталий розвиток; технологія