THE EFFECT OF USING A SUPPLEMENTARY FEED MIXTURE AND ACIDIFIER ON THE PERFORMANCE OF PIGLETS AND WEANERS

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Abstract

The aim of this study was to determine the effect of using a supplementary feed mixture (MPU) on the rearing performance of weaners. The study was conducted on 1,761 DanBred animals originating from a single parent farm and subsequently kept on one farm. During the study, the animals were divided into two groups: control and experimental. The control group did not receive the mineral supplement in water, whereas in the experimental group it was administered through a dispenser for 29 days from the start of rearing. All weaners were kept in group pens with slatted floors. They were fed three types of complete feed mixtures that fully met their maintenance and production requirements. Feed and water were available ad libitum. To determine daily weight gains, 10 weaners from each group were selected and permanently marked. They were weighed individually once a week. The rearing period lasted two months. After this period, the weaners were transferred to the fattening unit, and both groups were weighed on that day. At the end of the experiment, key performance indicators (KPIs) were analysed: daily weight gain, mortality, feed conversion, and treatment costs. The collected data were statistically analysed using Statistica 13.3. Positive effects of MPU administration were observed in this production group. The experimental group achieved higher daily weight gains, lower mortality, and better feed conversion. Antibiotic use was also reduced. Significant and highly significant differences were found between weekly weight gains depending on the analysed group.

Keywords: organic acids, zinc, acidifier, weaners, production performance

Introduction

The efficiency of pig production depends to a large extent on sow prolificacy (Karpiesiuk et al., 2018a). One of the most critical and stressful periods in the production cycle is piglet weaning. Separation from the sow, a change of environment, mixing of litters, establishment of a new hierarchy, vaccination, transition from sow milk to solid feed, and the decline in passive immunity create a high risk of digestive disorders in 4-week-old piglets whose gastrointestinal tract is not yet fully developed. The consequences may include poorer feed conversion, reduced body-weight gain, diarrhoea, intestinal disease, and mortality (Campbell et al., 2013).

In the past, antibiotic growth promoters (AGPs) were widely used in animal production to reduce the negative effects of the weaning period; their action was based mainly on modulation of the intestinal microflora and growth promotion (Kim et al., 2016). Unfortunately, their long-term use contributed to cross-resistance, including the emergence of drug-resistant bacterial strains capable of transferring resistance genes to pathogens occurring in humans (Looft et al., 2012). Consequently, since 1 January 2006, the use of AGPs in animal feeds has been completely banned in the European Union (Casewell et al., 2003; Chattopadhyay, 2014).

Current pig nutrition aims to balance feeds in terms of nutrient value and mineral content, including zinc, whose requirement depends on the animals' age, physiological status, and production purpose (Karpiesiuk et al., 2018b; Świątkiewicz et al., 2021). Zinc performs numerous biological functions: it participates in protein, lipid, and carbohydrate metabolism, is a component of more than 200 enzymes, participates in apoptosis, and regulates the activity of hormones such as insulin, glucagon, and sex hormones (Valee and Falchuk, 1993; Rekiel and Więcek, 2005). Recommended zinc contents in pig feed mixtures range from 50–80 mg Zn/kg for weaners to 150 mg Zn/kg for piglets (Pig Nutrition Standards, 2014). The main sources of zinc in animal diets are cereals, legumes, and ingredients of animal origin. Plant feed materials contain approximately 30–40 mg/kg of this element (with 60% bioavailability), whereas animal-derived materials contain 80–120 mg/kg. The enzyme phytase is added to feed to increase zinc availability (Adeola et al., 1995).

Proper nutrition is particularly important during weaning, when the piglet gastrointestinal tract is not yet fully mature. According to EU regulations, piglets should not be weaned before 28 days of age unless there is a justified risk to the health of the sow or offspring. In Poland, weaning at 21 days of age is permitted provided that appropriate housing conditions are ensured (Regulation of the Minister of Agriculture and Rural Development of 15 February 2010). Weaned piglets are exposed to post-weaning stress caused by dietary and environmental changes and separation from the sow, which promotes diarrhoea and reduces body-weight gains (Rajchert et al., 2011). Maintaining dry, warm rooms with low humidity and thorough cleaning and disinfection of buildings reduce the risk of colibacillosis (Rowles, 2014). In addition, reducing dietary protein content and feeding more frequently or providing feed ad libitum have a more beneficial effect on piglet health than feeding only twice daily (Laine et al., 2008).

In young piglets, the transition from milk to solid feed, combined with low hydrochloric acid secretion, causes the pH in the stomach and intestines to rise above 5, which disrupts digestive enzyme activity. The optimum pH for conversion of pepsinogen to pepsin is 2.0–3.5; therefore, organic-acid-based feed additives are used in practice. Without them, piglets may digest only about 60% of the feed consumed for several days (Rajchert et al., 2011; Suiryanrayna and Ramana, 2015). Undigested feed residues ferment in the intestine, providing a substrate for pathogens such as E. coli and Salmonella (the pH favouring their proliferation is 5.8–6.5).

Organic acids are carboxylic compounds consisting of a hydrocarbon chain terminated by a carboxyl group. Short-chain acids containing up to six carbon atoms play a particular role in the body: formic, acetic, propionic, butyric, lactic, malic, oxalic, citric, fumaric, and sorbic acids. Butyric acid is an important stimulator of intestinal epithelial development. Acetic acid serves as an energy source for liver cells (hepatocytes) and is also a substrate for cholesterol and long-chain fatty-acid synthesis. Propionic acid acts as a precursor in hepatic gluconeogenesis (glucose formation).

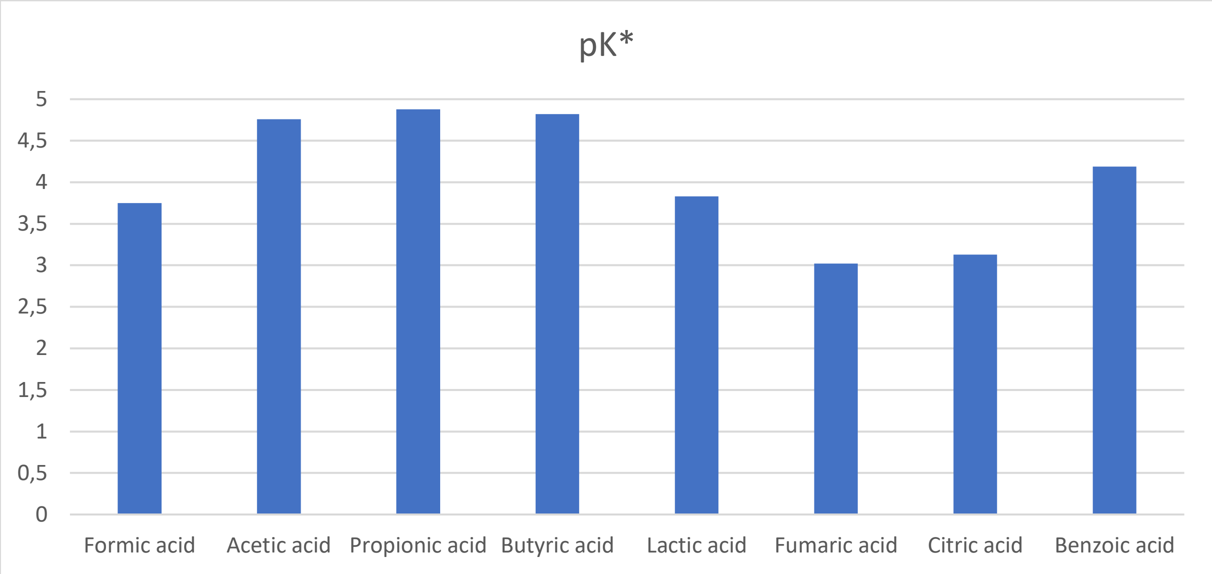

Chart 1. Acid strength (pK)

The minimum inhibitory concentration (MIC) is the lowest acid concentration that inhibits bacterial growth. The lower the pK value, the stronger the acidifying properties. At pH 4.5, the MIC for E. coli is approximately 0.15% for formic acid, 0.20% for propionic acid, and 0.40% for lactic acid. This information is essential when formulating feed mixtures and water acidifiers. Organic acids also influence feed acceptance: a sour taste, intensified for example by citric or tartaric acid, increases feed palatability in pigs (Woźniakowska et al., 2017). Moreover, some acids can reduce pathogen numbers; selected acids have been shown to decrease shedding of Salmonella Typhimurium or E. coli (Lückstädt, 2009).

Because antibiotics had been widely used for years as growth promoters, contributing to the development of cross-resistance, the EU banned antibiotic growth promoters (AGPs) in 2006. Since June 2022, the use of zinc oxide has also been prohibited, and the European Union aims to reduce overall antibiotic use in animal production by 50% by 2030. Producers are therefore seeking alternatives to antibiotics in the form of feed additives such as organic acids and their salts, eubiotics, synbiotics, essential oils, and zinc and copper chelates. In response to these needs, a production trial was designed in weaners of commercial DanBred crossbred lines to evaluate the effects of a feed mixture containing zinc and copper chelates and the addition of organic acids to drinking water on production performance. The research hypothesis assumed that supplementation with the supplementary feed mixture and acidifier would have a positive effect on weaner rearing performance.

Materials and methods

The experiment was conducted on 1,761 weaners of commercial DanBred crossbred lines originating from a single parent farm. The animals were weaned at 28 days of age and transported to one farm. Rearing began in May and ended in July. Immediately after transport, their body weight was measured and the mean total weight of the herd was calculated. The weaners were randomly divided into two groups:

1. Control group (n = 1,223) – without the supplementary feed mixture (MPU) or acidifier,
2. Experimental group (n = 538) – receiving MPU at 1,500 ml/1,000 l of water together with 500 ml acidifier/1,000 l drinking water via a dispenser for 29 days from the start of rearing.

The animals were housed in two buildings of different floor area; therefore, group sizes were unequal.

Acidifier and supplementary feed mixture

Acidifier

Before the experiment began, indicator strips were used to determine the acidifier dose so that the pH at the drinker was <3.8. Organic acids predominated in the acidifier composition (Chart 2), while glycerol and propylene glycol served as carriers.

Supplementary feed mixture (MPU)

MPU was administered exclusively to the experimental group. Its analytical and zootechnical composition is presented in Table 1. The components included, among others, magnesium and sodium chlorides, zinc and copper chelates, amino acids, and copper hydrate.

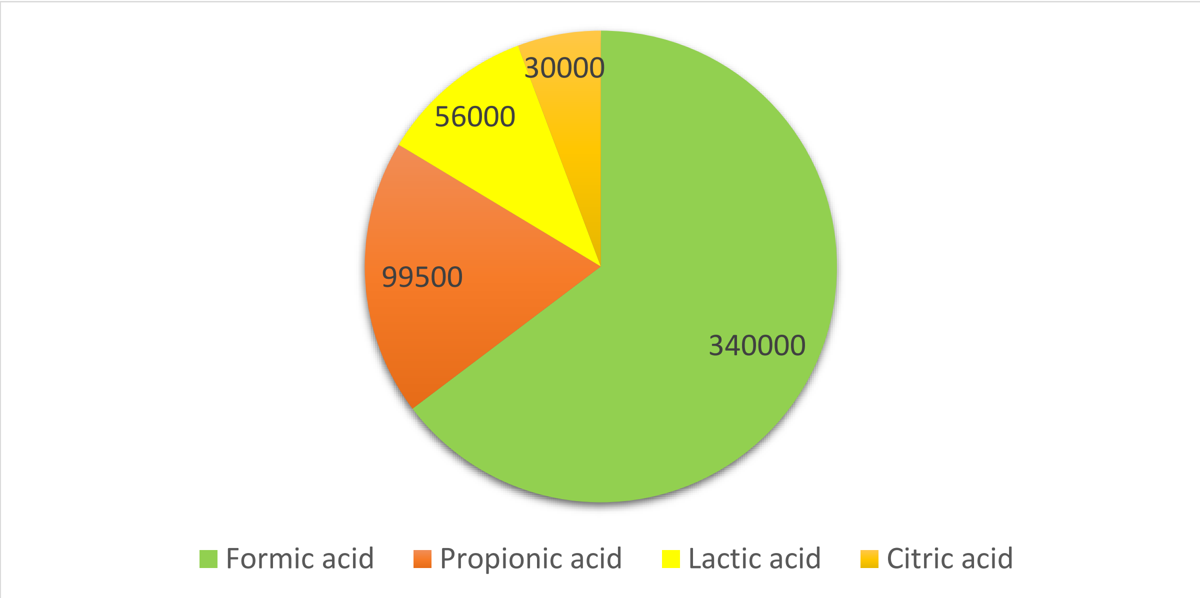

Chart 2. Acidifier composition

Table 1. Chemical composition of MPU

Analyte	Content
Crude protein	< 1,00%
Crude fibre	< 1,00%
Crude fat	< 1,00%
Crude ash	< 1,00%

Moisture content	70,90%
Lysine	4,00 g/kg
Methionine	2,00 g/kg
Sodium	98,00 mg/kg
Magnesium	120,00 mg/kg

Housing and feeding conditions

All animals, irrespective of group, were housed in group pens with slatted floors (80 animals per pen) under similar microclimatic conditions. Housing conditions and microclimate parameters, regardless of the room in which the animals were kept, complied with legal regulations (Regulation of the Minister of Agriculture and Rural Development of 15 February 2010 on the requirements and procedures for keeping species of farm animals for which protection standards are laid down in European Union legislation, Journal of Laws 2010.56.344). The animals were fed three complete feed mixtures (Prestarter, Starter, and Finisher) in accordance with the recommendations of the Seges Pig Research Centre (SPRC), available ad libitum. Their ingredient composition is presented in Table 2 and their chemical composition in Table 3. During the first two weeks of rearing, the animals received Prestarter feed, followed by Starter until week 7. During the final two weeks on the farm, the weaners were fed the Finisher mixture.

Each of the feed mixtures contained cereals: wheat, barley, and maize; the Finisher additionally contained triticale and rapeseed cake. Diets for weaners weighing more than 15 kg included soybean meal, by-products of the bakery and flour industries, and magnesium oxide. The youngest animals were fed high-protein ingredients such as potato protein, soybean protein concentrate, and blood products (poultry-derived in the Prestarter and porcine-derived in the Starter). Diets for weaners weighing below 15 kg also contained pure distilled vegetable fatty acids and calcium formate. Vegetable oils and fats, sodium chloride, calcium carbonate, and monocalcium phosphate were also used in feed mixtures for this production group.

Table 2. Component composition of complete feed mixtures

Item (%)	Prestarter	Starter	Finisher
Wheat	28,00	30,00	25,00
Barley	18,00	15,00	12,00
Maize	12,00	15,00	15,00
Triticale	0,00	0,00	14,00
Rapeseed cake	0,00	0,00	7,00
Soybean meal, >46% CP	8,00	12,00	20,00
By-product of the confectionery industry	12,00	13,00	0,00

Fish meal (60% protein)	4,00	3,00	0,00
Processed protein (53%)	5,00	3,00	0,00
Potato protein	2,50	1,00	0,00
Spray-dried blood plasma	2,50	0,00	0,00
Premix*	4,00	4,00	4,00
Fat	4,00	4,00	3,00

Table 3. Chemical composition of feed mixtures (g/kg)

Analyte	Prestarter	Starter	Finisher
Crude protein	168,00	175,28	169,71
Crude fat	59,33	42,10	47,49
Crude fibre	33,63	38,53	39,08
Crude ash	48,10	44,92	47,59
Lysine	11,44	12,10	11,20
Methionine	4,37	4,62	3,67
Calcium	7,00	6,20	6,91
Phosphorus	4,83	4,51	4,81
Sodium	3,00	2,62	2,00

Measurement of weight gain and animal identification

Before representative animals were selected, two pens with identical equipment were chosen in each building. Subsequently, 10 animals from each group (5 gilts and 5 barrows) were selected and marked with an additional ear tag to facilitate identification. This number of weaners was chosen for organisational reasons. Individual weighing was performed weekly (from weeks 2 to 9 of rearing) using an electronic scale accurate to 0.05 kg. The entire rearing period lasted two months.

Health monitoring

Zootechnical and veterinary supervision was maintained throughout the experiment. When necessary, animals were treated by injection or collectively, vitamin supplementation was used, and drinking water was acidified. At the end of rearing, the weaners were transferred to the fattening unit, both entire groups were weighed again, and mean body weight was calculated.

Statistical analysis

The collected data were subjected to statistical analysis. One-way analysis of variance was performed, and the significance of differences between means was determined using Duncan's test and verified at two significance levels: P≤0.05 and P≤0.01. Statistical calculations were performed using Statistica PL 13.5.

Results

Table 4 presents the daily weight gains of each analysed group in the individual weeks of weaner rearing. In week 2 of the nursery period, significantly higher daily gains were recorded in the control group than in the experimental group. In weeks 5 and 6, however, animals receiving the supplementary feed mixture and acidifier showed highly significantly higher daily gains than animals that did not receive these supplements.

Table 5 presents the values of key performance indicators for each analysed group. The animals were weaned at the same time and age and had similar body weights. However, one of the analysed values differed. Mortality in the experimental group was 0.84 percentage points lower than in the control group. This may have been associated with a better immune response to injectable treatment. Treatment costs and the amount of antibiotics used in therapy were also lower in animals receiving the feed additives. Mean daily gains were higher in the experimental group. This group also had a lower, and therefore more economically favourable, feed conversion ratio.

Table 4. Daily gains in individual weeks of rearing

Week of rearing	Mean daily gains (g)	
	Control group	Experimental group
2.	192,750^{a} s=71,599 V=37,146	145,900^{b} s=54,800 V= 37,559
3.	177,650 s=72,186 V=40,634	224,650 s=93,255 V=41,511
4.	265,100 s=81,716 V=30,825	225,750 s=95,707 V=42,395
5.	336,850^{B} s=112,185 V=33,304	449,100^{A} s=86,138 V=19,180
6.	310,750^{B} s=155,672 V=50,096	438,000^{A} s=96,853 V=22,112
7.	392,050 s=144,567 V=36,875	459,700 s=129,564 V=28,184
8.	522,750 s=200,988 V=38,448	523,150 s=196,917 V=37,641
9.	501,000 s=125,214 V=24,993	517,500 s=166,068 V=32,090

a, b (P≤0.01) and A, B (P≤0.05) differ statistically significantly.
s – standard deviation, V – coefficient of variation.

Table 5. Production results in the analysed groups

Item	Control group	Experimental group
No. of piglets placed (head)	1223	538
Average body weight of piglets (kg)	6,881	7,126
Mortality (%)	4,74	3,90
No. of weaners sold (head)	1165	517
Average body weight of weaners (kg)	32,083	33,050
Daily gains (g/day)	355	365
FCR (kg feed/kg gain)	1,603	1,536
Treatment cost (PLN/head)	2,52	1,97

Discussion

Upadhaya et al. (2016) reported a beneficial effect of acidifying feed additives on increasing daily weight gains and improving feed intake. Feed additives also help prevent gastrointestinal diseases, which is particularly important in piglet rearing (Pejsak and Porowski, 2023). The experimental weaners achieved clearly more desirable values of key performance indicators. Similar results (lower FCR and lower mortality) were also observed in other tests of this additive (https://www.kantersanimalhealth.com/research/intesti-forte-reduces-weaning-diarrhoea-and-mortality-in-piglets/). Beneficial effects of other feed additives have likewise been reported. When weaners were fed zinc oxide at 150 mg/kg from weaning to week 4, mean gains of 350 g/day, an increase in feed intake of 120 g, and improved feed conversion were recorded. At a Zn dose of 3,000 mg/kg, the animals gained an average of 460 g/day (Case and Carlson, 2002). The efficacy of zinc in combination with CuSO4 at 250 mg/kg was also analysed, and higher production-performance values were achieved in that experiment as well (Hill et al., 2000). Zinc was also found to be effective in preventing dysentery; however, because of the narrow margin between the therapeutic and toxic dose, the final effects are not always fully apparent (Zhang et al., 1995). High doses may cause ulceration of the gastric mucosa and consequently mortality of fattening pigs, reducing production efficiency (Valee and Falcluk, 1993). Studies have also examined the effects of acids in pig nutrition. Formic acid has been shown to provide the best production results in fattening pigs (Partanen and Mroz, 1999). Other organic acids also have a positive effect on pig rearing performance. Acidifying feed with 0.6–1.2% formic acid has been shown to increase daily body-weight gain by up to 20%. The best effects of organic-acid supplementation in weaners are observed between weeks 2 and 4 after weaning.

Hanczakowska and Świątkiewicz (2012) also reported positive effects of feed additives on piglet rearing performance. In their experiment, animals in the experimental group received aqueous herbal extracts of sage, lemon balm, nettle, and purple coneflower. Higher body-weight gains and a 10% improvement in feed conversion were recorded compared with the control group. The use of herbs has a positive effect on pig welfare, immunity, and health, and they have been proposed as an alternative to antibiotics (Adamczyk et al., 2023).

Similarly to the present study, Boma and Bilkei (2009) demonstrated beneficial effects of trace-element supplementation. They compared two groups of animals: those receiving adequate amounts of mineral elements and those receiving lower amounts. Animals fed diets poorer in zinc, manganese, and copper required treatment more frequently and achieved lower body-weight gains. These trace elements perform numerous functions and are essential for normal body function, and therefore must be supplied in the diet (Mirowski, 2023).

Summary and conclusions

The study demonstrated a positive effect of a supplementary feed mixture containing zinc and copper chelates together with an acidifier on weaner rearing performance. Such supplementation can provide both nutritional and economic benefits. In addition:

1. Significant and highly significant differences in daily gains between the analysed groups were found in individual weeks of rearing;
2. Weaners receiving the test MPU and acidifier were characterised by higher mean daily gains, a lower mortality rate, and better feed conversion;
3. Fewer antibiotics were used during rearing in the experimental group, which is consistent with the Green Deal strategy aimed at reducing antibiotic use;
4. Further studies are warranted to determine the effects of feed additives on the rearing performance of weaners and subsequently fattening pigs. Such studies should be conducted on a larger and more balanced sample.

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SUMMARY

The aim of this study was to determine the effect of using a supplementary feed mixture (MPU) on the rearing performance of piglets. The study was conducted on 1,761 DanBred animals from a parent farm and then continued on a farm. During the course of the study, the animals were divided into 2 groups – a control group and an experimental group. The first group did not receive the mineral water supplement, while in the second group it was administered via a dispenser for 29 days after the start of rearing. All piglets were kept in group pens with a slatted floor. They were fed 3 types of complete feed mixtures that fully met both their maintenance and production requirements. Feed and water were available *ad libitum*. To determine daily weight gain, 10 piglets from each of the groups studied were selected and permanently labelled. They were weighed individually each week as a control. The rearing period was 2 months. After this period, the piglets were moved to the fattening pens. On this day, both groups were weighed. At the end of the experiment, the values of the most important production indicators (KPIs) were analysed: daily gains, mortality, feed conversion ratio (FCR) and treatment costs. The collected data was statistically analysed using Statistica 13.3. Positive effects of MPU administration on the feeding of this trial group were observed. Higher daily weight gains, lower mortality and better feed conversion were achieved in the trial group. The use of antibiotics was also reduced. Significant and statistically highly significant differences were found between the gains per week depending on the group analysed.

Keywords: organic acids, zinc, acidifier, weaners, production performance