

MICROBIAL CONTAMINATION OF AIR IN PIGGERIES WITH MINIMAL MORBIDITY

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Abstracts

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Microbial contamination of air was compared in conventional piggeries and in piggeries with minimal morbidity. The comparison proved, particularly with piglets reared to 4–5 weeks of age, the effectivity of devices protecting from exogenous microflora such as strict "all in all out" system, careful disinfection of compartments, and, high personal hygiene of staff. In the course of rearing piglets from 5 weeks upwards, some deterioration of air contamination by exogenous and endogenous microbes occurred in piggeries with conventional feeding and housing where the strict "all in all out" system was not held. Best results were obtained in rearing houses with weanlings kept in cages where a mean of 2.2×10^4 microbes/ 1 m^3 were found on MPA. Microbes growing on mannitol agar with salt represented 7.4×10^3 , on Endo agar 7.7×10^3 and 1.9×10^3 respectively, on blood agar with crystal violet 1.8×10^4 , on Czapek-Dox agar 3.6×10^3 microbes/ 1 m^3 air.

Microbial contamination, air, microbial counts.

The microbial contamination of air is a factor affecting the state of health of animals, and particularly of their respiratory system. Faultless air is required above all when sanitation programs are carried out in order to eliminate respiratory disease in young animals.

In pig breeding, sanitation programs to obtain SPF piglets are performed either by hysterectomy or hysterotomy, or by a less radical method successfully used in smaller breeds in Sweden (Stahli 1974; Ravaud 1973).

In our country, a method of early weaning of piglets has been worked out by Goiš and Černý (1974) convenient for piglets to be quickly fattened, and, for sanitation of herds in large-scale farms, the so-called method of breeding pigs with minimal morbidity.

The principle of the method is protection of piglets from exogenous microbial infection. A high level of hygiene of environment is therefore required. Circulating persons, animals, food, and other material are bound to pass a system of sanitary barriers to prevent exceeding contamination of the housing by exogenous microflora.

No data are available concerning microbial air contamination in piggeries with minimal morbidity, in housings for SPF piglets or in piggeries practising the so-called Swedish method. Microbial contamination of air in conventional piggeries has been examined by Gordon (1963), Hoffmann–Richter (1964), Fišer (1969, 1970, 1972), Tarusova et al. (1974), Mehlhorn – Beer (1972), Curtis et al. (1975). Even if their results are not comparable due to different methodical approach, it is obvious that the air is heavily contaminated by microbes in conventional piggeries, particularly when dry food-mixtures are administered.

Our aim was to compare air contamination in large-scale farrowing houses and fattening houses on one hand with air contamination in a farrowing house, cage-equipped rearing house, and gilt rearing house with the minimum morbidity method in force on the other hand.

Table 1
Hygienic parameters of conventional large-scale piggeries and numbers of examinations

Type of piggery and period of examination	Capacity of compartment	Housing	Way of feeding and manure removal	Number of pigs/pen	Volume of housing in m ³ /animal	Type of heating and ventilation	Number/points of examinations
Farrowing houses for 116 sows A - 1972	116 sows with piglets	windowless, litterless housing, „all in, all out“	automatic feeding with dry mixture, mechanical removal of manure	1 sow with piglets	18,7	hot air-automatic forced vacuum	42/8
Farrowing house for 220 sows B - 1967 and 1968	94 sows with piglets	windows, additional straw bedding, „all in, all out“	feeding manually into troughs mechanical removal of manure	1 sow with piglets	20,7	hot air-forced hand operated vacuum ventilation	23/2
Fattening house for 900 pigs C - 1972	450 pigs	windowless, litterless, „all in all out“	automatic feeding with dry mixture, contour-furrow method of removal of manure	27 pigs	1,14	no heating, automatic forced vacuum ventilation	6/1
Fattening house for 1,200 pigs D - 1967 and 1968	1,200 pigs	windows, additional bedding with wood shavings, continual stocking in-out	combined automatic feeding dry mixture with wet mixture into troughs, mechanical removal of manure	100 pigs	1,13	hot air-forced automatic vacuum	19/2

Table 2
Mean number of microbes isolated from 1 m³ air on different substrates

Type of housing	T °C	RH %	MPA	Mannitol agar with 7.5 % salt	Endo agar		Czapek-Dox agar-fungi	Blood agar with crystal violet
					lactose +	total		
Cage-equipped rearing house K	26.0	49.4	2.2 × 10 ⁴	7.4 × 10 ³	1.9 × 10 ³	7.7 × 10 ³	3.6 × 10 ³	1.8 × 10 ⁴
Farrowing house L	19.4	69.2	5.9 × 10 ⁴	9.8 × 10 ³	7.5 × 10 ¹	2.4 × 10 ³	1.1 × 10 ⁴	3.0 × 10 ⁴
Rearing house for gilts M	19.2	65.0	3.8 × 10 ⁴	5.0 × 10 ⁴	2.8 × 10 ¹	1.4 × 10 ³	3.1 × 10 ⁴	2.2 × 10 ⁴
Large-scale windowless farrowing houses A	22.6	50.9	5.1 × 10 ⁵	5.6 × 10 ⁴	4.8 × 10 ³	2.3 × 10 ³	5.7 × 10 ³	7.7 × 10 ⁴
Large-scale window-equipped farrowing house B	21.6	67.7	7.1 × 10 ⁵	1.1 × 10 ⁵	3.4 × 10 ³	2.4 × 10 ³	—	2.6 × 10 ⁵
Large-scale fattening house C	22.7	70.2	4.9 × 10 ⁴	2.4 × 10 ⁴	1.1 × 10 ³	6.1 × 10 ³	9.4 × 10 ³	5.7 × 10 ⁴
Large-scale fattening house D	19.9	75.1	8.5 × 10 ⁴	1.3 × 10 ⁵	7.0 × 10 ³	3.2 × 10 ³	—	5.3 × 10 ⁵

Materials and Methods

Microbial contamination of air was examined by sedimentation method in four conventional large-scale farrowing houses and fattening houses over a long period of time. Temperature and humidity were recorded simultaneously by means of psychrometer. Table 1 shows numbers and sites of measurements, and, data concerning construction and technology.

In the course of 1976–77, microbial contamination, temperature and humidity of air were examined in the same way in housing with minimal morbidity, namely in the farrowing house L, the cage-equipped rearing house for piglets K, and, the rearing house for gilts M.

The farrowing house L is a smaller pigsty forming a link between two conventional timber-made farrowing houses. Its capacity is 10 farrowing sows. It is equipped with a hot-water heating system and ceramic emitters pending on walls. Windows serve for ventilation. Samples of air were collected 11 times on 3 sites.

The cage-equipped rearing house for piglets K is a operationally separated section of a newly constructed rearing house for gilts. It consists of isolated compartments, each accessible from the central passage through its own door. Each compartment includes 10 cages with perforated slot floor and full side walls. At most 3 piglets aged 2–28 days are placed in one cage. A ceramic emitter is situated above each cage, and in addition, the room is heated by radiators of the hot-water system. Measurements were also carried out in another cage-equipped rearing house, reconstructed from a former poultry house, which was in use before the new gilt rearing house became operational. Here, the same cages were installed in 3 compartments and heated by ceramic emitters, but, the room was heated by a stove with flue gas ducting. In the rearing house K, 11 measurements in 3 sites, and in the temporary rearing house, 2 measurements in 5 sites were performed.

The rearing house for gilts M is adjacent to the rearing house for piglets K, and consists of 3 compartments having a central passage with pens on both sides. There are hot-water radiators on the walls, a manually operated forced vacuum ventilation with air taken in through windows and carried away through chimney extractors. Food is supplied through automatic tube feeders, feces from the sledges are removed mechanically. The pens consist of a litterless bed with slotted dunging floor and a feeding place with the trough along the central service passage. Air samples were collected 11 times on 4 sites situated in the central passage.

Petri dishes containing MPA, mannitol agar with 7.5 % salt, Endo agar, blood agar with crystal violet, and Czapek-Dox agar were used for collecting air samples. After exposal, the Petri dishes were kept in incubator at 37 °C, Petri dishes containing Czapek-Dox agar at room temperature. From the results, the mean number of microbes were calculated according the formula by Spurný et al. (1961).

Results

Mean values for contamination, temperature and humidity of air in the piggeries under observation are illustrated in Table 2 and Figure 1.

From Table 2 it is obvious that the best conditions prevailed in the cage-equipped rearing house for piglets K with a mean air temperature of 26 °C and relative humidity of 49.4 %. Air temperature and humidity in the rest of piggeries examined can also be considered convenient for the respective categories of pigs.

In the cage-equipped rearing house K, the lowest microbial contamination of air was recorded, except typical lactose-positive microbes on Endo agar. Related to the number of microbes on MPA, the numbers on mannitol agar with salt, blood agar with crystal violet and Endo agar represents values of 0.03–0.80 to 0.035 resp. in the rearing house for piglets K, of 0.16–0.59–0.004 resp. in the farrowing house L, and, 0.13–0.59–0.004 resp. in the rearing house for gilts M.

Figure 1 demonstrates differences between microbial contamination of air in conventional large-scale farrowing and fattening houses, and the rearing houses with minimal morbidity K, L, and M.

The basic comparative value 0 stands for numbers of microbes from the air in conventional piggeries. In housings with minimal morbidity where the number of microbes was lower, the difference is given on the side (–). Where the number of microbes was higher, the difference is given on side (+). Differences exceeding one mathematical order are considered statistically significant.

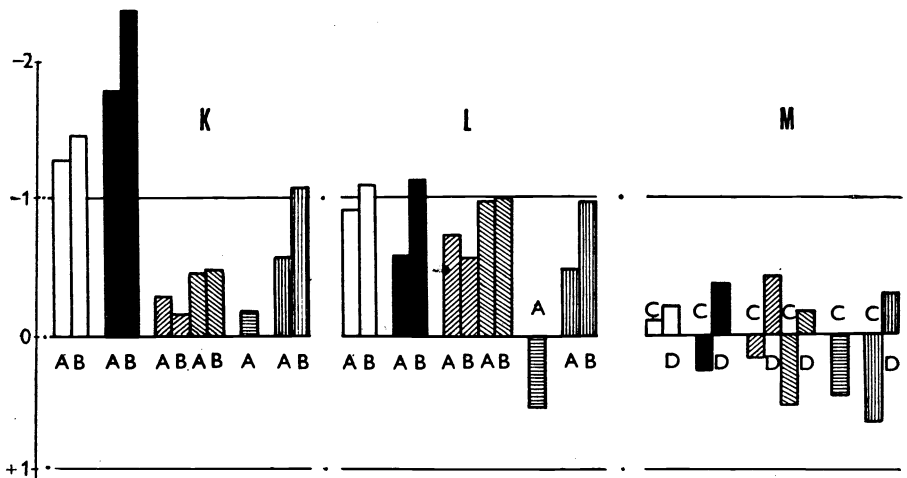




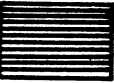
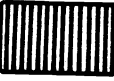


Fig. 1.

Significance of differences in number of microbes/1 m³ air in the cage-equipped rearing house for piglets *K*, farrowing house *L*, rearing house for gilts *M*, and conventional farrowing houses *A*, *B* and fattening houses *C*, *D*.

-  differences in numbers of microbes on MPA
-  differences in numbers of microbes on mannitol agar with 7.5 % salt
-  differences in numbers of typical lactosepositive microbes on Endo agar
-  differences in numbers of microbes on Endo agar in total
-  differences in numbers of fungi on Czapek-Dox agar
-  differences in numbers of microbes on blood agar with crystal violet
- 0 basic comparative value for microbial air contamination in conventional piggeries *A*, *B*, *C*, *D*
- (--) decrease in microbial air contamination by the relevant value of the mathematical order in piggeries with minimal morbidity *K*, *L*, *M*
- (+) increase in microbial air contamination by the relevant value of mathematical order in piggeries with minimal morbidity *K*, *L*, *M*

As it is illustrated in Figure 1, the majority of values for microbial air contamination is lower in the piggeries K and L than in conventional farrowing houses. The differences are shown on side (-). There is a statistically significant difference between microbes growing on mannitol agar with salt and on MPA: -1.82 to 2.37, and, -1.30 to -1.49 of an mathematical order. The number of microbes growing on Endo agar was lower in the rearing house K than in conventional farrowing houses. However, the difference was not larger than 0.15 to -0.48 respectively and consequently could not be evaluated as of statistical significance. A larger difference was observed when comparing microbes grown on blood agar with crystal violet in the rearing house for piglets K and the conventional farrowing house B: -0.59 and 1.09 respectively. This difference is statistically significant.

In the farrowing house L, statistical differences in microbial air contamination were also found only when compared with the conventional farrowing house with windows B, and that with microbes grown on MPA and salted mannitol agar. As for microbes on Endo agar and blood agar with crystal violet, the differences were just on the limits of statistical significance. There was an elevated sedimentation of fungi on Czapek-Dox agar in the farrowing house L compared with the conventional windowless farrowing house A. The difference represented +0.54 of a mathematical order and was thus statistically not significant, its graphical illustration on side (+) nevertheless shows an undesirable deterioration of quality of air in the farrowing house L.

In the rearing house for gilts M, air was contaminated less than in both conventional fattening houses only as far as microbes found on MPA were concerned. The differences of -0.10 and -0.47 respectively were very small and consequently without statistical significance. Compared with the windowless fattening house C, air in the rearing house for gilts M was nonsignificantly more contaminated by the rest of microbial species. The differences are demonstrated on side (+). Compared with the window-equipped fattening house D, air in the rearing house M was less contaminated by these species. The differences are illustrated on side (-).

The differences in results exceed one mathematical order neither on side (+) nor on side (-), and consequently, they are without statistical significance. In the rearing house for gilts M and in the fattening house D, technology of housing and feeding are similar, thus the situation in the rearing house M can be declared more favourable. Nevertheless, a higher contamination of environment was registered in the final phase of rearing gilts in the house M. With regard to the adjacent cage-equipped rearing house for piglets M, this is a most undesirable disadvantage.

Discussion

The significant decrease in air-borne microflora grown on MPA and salted mannitol agar in the cage-equipped rearing house for piglets K and the farrowing house L, as well as the minor decrease in the rearing house L, and the minor decrease in the rearing house for gilts M, demonstrate the effectiveness of sanitary devices observed in piggeries with minimal morbidity, particularly during the critical period to 4-5 weeks of age.

The newborn piglets are immediately transferred into a disinfected compartment in the farrowing house. Special heated and disinfected boxes are used for transportation. In the course of the initial 36-48 hours, the piglets are admitted

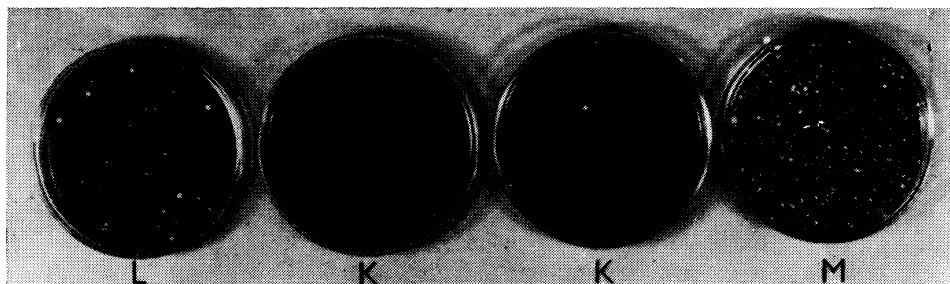


Fig. 2.

Petri dishes with mannitol agar supplemented with 7.5 % NaCl for air microbial sedimentation after the same exposition time in the farrowing house L, in two departments of the cage-equipped rearing house for piglets K, and in the rearing house for gilts M. Of interest is the sporadic occurrence of micrococci in K despite of the strict sanitary measures.

to their mothers for suckling only, and removed again after intake of colostrum. There is a consequent hygienic surveillance of delivery. Following parturition, the pen is cleaned and disinfected, the body surface of the sow and particularly of the mammary gland washed with a 0.5 % Ajatin.

After 48 hours of life, the piglets are transferred to the cage-equipped rearing house and fed a semisynthetic high-caloric milk diet till day 21 of age. Then they shift to feeding mixtures COS I. and COS II. The "all in all out" system is compulsory in rearing houses for piglets, as well as temperature and humidity according the directions ON 467230.

From the cage-equipped rearing house, female piglets are transferred into cleaned and disinfected pens in the rearing house for gilts where they are kept till 6 months of age. In the rearing house for gilts M under our examination, the "all in all out" rule has been violated for operational reasons and lack of capacity. Such a violation creates potential hazards for the gilts reared. With exogenous SPF piglets, Ravaud (1973), quoting Aycardi, considered the period to 6 months of age as particularly critical. In the course of growth to a body mass of 80–100 kg, the endogenous specific microflora develops stability.

The sanitary survey of piglets, successively developing a stock of sows in good state of health, consists of current clinical examinations, a control slaughtering with post mortem examination, and, different laboratory test including serology (Goiš, Černý 1974).

Beer-Melhorn (1977), stated that *Staphylococcus aureus haemolyticus* can be considered the criterion for efficiency of cleaning and disinfection in dairy cow houses. Similarly, in our opinion, the entire family *Micrococcaceae* growing on mannitol agar with 7.5 % salt represents a suitable indication of the hygienic level in housing for farm animals (Fig. 1).

The endogenous microflora grown on Endo agar was more abundant in the rearing house for piglets K than in the farrowing house L. The low differences of -0.29 and -0.15 respectively are illustrated in Fig. 1.

This observation could be explained by the composition of intestinal microflora in adult pigs, in the given case in sows. Unlike as in piglets, the Genus *Escherichia* is not prevalent, and, the number of *Enterococci* and *Lactobacilli* increases faster. *E. coli* is the dominant microbe of intestinal microflora in piglets till shortly after weaning (Salajka 1974).

Fišer (1977) classified air in animal housings as optimum, inconvenient, or tolerable. The limit between the optimal zone and tolerable zone was represented by the concentration of 2.2×10^5 microbes on MPA, 3.7×10^4 on mannitol agar with salt, 1.3×10^3 of microbes in total on Endo agar, and, 7.1×10^1 of typical lactose-positive microbes on Endo agar, isolated from 1 m^3 air by sedimentation method. These values correspond to 1.3×10^3 , 2.5×10^5 , 4.6×10^3 , and, 5.2×10^2 microbes/ 1 m^3 air respectively, calculated by means of the formula by Spurný et al. (1961). The comparison of mean values for air contamination in the examined piggeries with minimal morbidity with the normative values proposed by Fišer (1977), shows that in the rearing house for gilts M, air contamination ranged near the lower limit of tolerable zone. In the farrowing house L and the cage-equipped rearing house for piglets K, air contamination near the lower limit of tolerable zone was registered with typical lactose positive microbes on Endo agar only. The rest of microbial species, growing on MPA, mannitol agar with salt and Endo agar in total corresponded to concentrations within the optimum zone (Table 2).

From comparison of our results with data by Curtis et al. (1975) concerning qualitative proportions of indicator species grown on mannitol agar with salt, blood agar with crystal violet, Endo agar, and total findings on MPA from 1 m^3 air, it is obvious that their values of 0.36–0.13 — less than 0.1, were not exceeded in rearing houses for piglets and gilts except for *Streptococci* growing on blood agar with crystal violet. Values determined for these air-borne species were 0.80 in the rearing house for piglets K, 0.50 in the farrowing house L, and, 0.59 in the rearing house for gilts M.

In air of the conventional large-scale farrowing house and fattening house described here as houses B and D, Fišer (1970), found 0.37 and 0.66 (37 % and 66 %) respectively with microbes grown on blood agar with crystal violet, 0.16 and 0.16 (16 %) resp. with microbes on mannitol agar with salt, 0.003 and 0.004 (0.3 % and 0.4 %) with the total of microbes on Endo agar, and, 0.0005 and 0.0009 (0.05 and 0.09 %) respectively with typical lactose positive microbes on Endo agar. Regarding the latest data, it is obvious that the lowest microbial contamination of air was registered in the cage-equipped rearing house for piglets K where severe sanitary regime was carried out.

Among other indicators of hygiene, the number of fungi per 1 m^3 air was examined. In the farrowing house L and the rearing house for gilts M, amounts of fungi exceeding those in the compared conventional piggeries were indicative for certain hazards. In these cases, it is urgent to concentrate to potential sources of fungi such as straw and feed, and, to eliminate them as far as possible in rearing houses for piglets and gilts.

Mikrobiální kontaminace ovzduší ve stájích pro odchov prasat s minimální nemocností

Srovnáním mikrobiální kontaminace ovzduší konvenčních stájí pro prasata s mikrobiální kontaminací ovzduší stájí pro odchov prasat s minimální nemocností byla prokázána účinnost opatření na ochranu chovu proti exogenní mikroflóře zvláště při odchovu selat do stáří 4–5 týdnů při dodržení turnusového naskladnění a vyskladnění selat, pečlivé dezinfekci stájového oddělení a zvýšené osobní hygieně ošetřujícího personálu. Ve fázi odchovu prasniček s minimální nemocností, která následuje po dosažení věku selat 5 týdnů, vykazuje stájové ovzduší odchovny

prasniček s konvenční technologií krmení a ustájení zvířat při nemožnosti dodržet důsledně turnusové naskladnění zvířat určité zhoršení v kontaminaci exogenní i endogenní mikroflórou. Nejlepší výsledky byly zjištěny v klecové odchovně selat, kde průměrné počty mikrobů zachycených na MPA v 1 m³ vzduchu odpovídají 2,2 · 10⁴. Hygienicky významné skupiny mikrobů zachycené v této stáji odpovídají u mikrobů rostoucích na slaném mannitovém agaru 7,4 · 10², u mikrobů rostoucích na Endově agaru 7,7 · 10² resp. 1,9 · 10², u mikrobů rostoucích na krevním agaru s krystalovou violetí 1,8 · 10² a u mikrobů rostoucích na Czapek-Doxově agaru 3,6 · 10² v 1 m³ vzduchu.

Микробная контаминация атмосферы в свинарниках с минимальной заболеваемостью поросят

Сравнением микробной контаминации атмосферы классических свинарников с микробной контаминацией свинарников для свиней и минимальной заболеваемостью была доказана эффективность мер по охране свиноводства от экзогенной микрофлоры, в особенности при выкорме поросят в возрасте 4—5 недель при соблюдении посменной загрузки и выгрузки поросят, тщательной дезинфекции отделения свинарни и повышенной гигиены обслуживающего персонала. В ходе выкорма свинок с минимальной заболеваемостью, который имеет место после достижения пятинедельного возраста поросят, атмосфера поросятника для выкорма свинок классической технологией и содержания животных при невозможности соблюдения последовательного посменного приема загрузки отличается определенным ухудшением в связи с контаминацией экзогенной и эндогенной микрофлор. Лучшие результаты были выявлены в клеточном поросятнике, где среднее число задержанных в МПА в 1 м³ воздуха микробов соответствует 2,2 · 10⁴. Гигиенически значимые группы микробов, задержанных в упомянутом поросятнике, соответствуют в случае микробов, растущих в соленом маннитном агаре, 7,4 · 10², у микробов, растущих в агаре Энда — 7,7 · 10² или 1,9 · 10², у микробов, растущих на кровяном агаре с кристаллическим фиолетовым — 1,8 · 10² и у микробов, растущих на агаре Чапек-Докса — 3,6 · 10² в 1 м³ воздуха.

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