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in

Aumaître A. (ed.).
The production of pig meat in Mediterranean Countries

Paris : CIHEAM
Options Méditerranéennes : Série Etudes; n. 1989-I

1989
pages 157-164

Article available on line / Article disponible en ligne à l'adresse :

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To cite this article / Pour citer cet article

Zivkovic S., Kovcin S. **Recent achievements in rearing and feeding of early weaned piglets.** In : Aumaître A. (ed.). *The production of pig meat in Mediterranean Countries.* Paris : CIHEAM, 1989. p. 157-164 (Options Méditerranéennes : Série Etudes; n. 1989-I)



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Recent achievements in rearing and feeding of early weaned piglets

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The age of three to four weeks is now accepted as an optimum for early weaning of piglets. This is probably the best age from the standpoint of number of farrowings and total number of piglets produced per sow per year. However, from the standpoint of development of both the immunological system and the digestive tract, it is one of the most critical periods in the life cycle of pigs, and it hardly could be seen as an optimum for early weaning. Many producers are having serious problems in the rearing and nutrition of piglets, particularly in the first 10 to 15 days after weaning when there is high mortality.

The most frequent problems after weaning are disturbances in the digestive tract and the appearance of scour in young piglets. During the first 10 to 20 days after weaning, they are the main cause of high mortality (Mehle and Hribovšek, 1985; Martinja, 1985; Bilić and Zutić, 1985). On some the losses range from 2 - 15%. These are very high and there is no way to compensate for them later. Because of this much more attention will be given here to nutrition from the standpoint of maintaining good health and successful survival of piglets during the first two to three weeks after weaning, and less from the standpoint of production itself and high daily gains.

I - Physiological aspects of postnatal development in piglets

1. Weaning and stress

Stress is known to have a general adverse effect on all body functions, including the digestive system. It also affects the production of certain hormones which reduce the resistance of animals to disease.

There are many stress factors both physical and social, which may provoke short-term specific reactions within the animal. These changes, within the body systems, result in physiological and behavioural aberrations. In young piglets stress also affects the gastrointestinal tract.

The possible reasons for stress in young piglets are: separation from their mothers and loss of milk, change of environment, mixing piglets with those from other litters, change of food, low ambient temperature, draught, high humidity, dirty and wet floor, etc. The effect of such stress, particularly over a long period, could be a general lowering of resistance to scouring. It is necessary

that the whole digestive system adapts itself to the new feed and to the new feeding regime. All the factors mentioned above, and some others which vary from one farm to another, may cause stress and may completely change the requirements for some nutrients (Kelley, 1980).

There are considerable differences among piglets of the same age, even among piglets in the same litter, in their capability to tolerate different stress factors and to withstand different illnesses. It is thus necessary, for every particular farm, to determine the diet, feeding regime and management which will give an opportunity to all piglets to survive the critical period, not only those which are capable to adjust to the new conditions.

2. Development of the digestive tract and enzymatic system in piglets

At birth, the digestive tract of the piglet has a very limited capacity but it develops quickly over the first few weeks of life. Its digestive system corresponds exactly to that which the milk requires for its breakdown and absorption.

In piglets on the sow, milk is provided at hourly intervals so each feed is relatively small and demand on the digestive system is fairly uniform. After the weaning, however, it is almost impossible to avoid considerable fluctuations in feed intake, which may result in temporary overloading of the digestive system. After early weaning the digestive tract of the piglet is supposed to cope with a complete change of diet and feeding regime.

In the first few weeks of life of piglets, the digestion of food depends mainly on the effectiveness of enzyme activity. In this period, considerable quantitative and qualitative changes in the production of digestive enzymes take place and they are closely related to changes in the diet itself. There is considerable data describing the development of the enzymatic system in the digestive tract of young piglets (Aumaitre, 1969, 1983; Jańczyk, 1971; Vapa and Tarasenko, 1985).

During the first two weeks of life, milk is the main part of piglet's diet. At this stage of unweaned piglets, more than one half of the dietary energy available is in the form of lipids. Since the sow's milk is digested with almost 100% efficiency, suckling pigs secrete large amounts of pancreatic lipase, amylase and proteolytic enzymes. Starch digestion of the baby pigs is limited because the

amylolytic enzyme activity of the pancreas is very small until about 20 days of age. The digestion of starch, originating from grains and cereal products, develops at a much later stage, when the appropriate amount of enzyme amylase is produced.

The lipase content of pancreas juice is very high at birth and no increase is shown during the suckling period. The content of proteolytic enzymes of the pancreas juice varies according to the age and to the level of crude protein in the diet.

The proteolytical activity of pepsin depends on optimal pH which is necessary for pepsin to be activated. There is a large difference in pH between piglets and adult pigs. In the stomach of piglets, the optimal pH is 2, and it is achieved in about two weeks of age. The activity of proteolytical enzymes is affected by the type of feeds given to the animal. Both the activity and volume of pancreatic juices increases with the switching from milk to feeds of plant origin.

The different carbohydrases represent a typical variation during the early period of piglets' lives; intestinal lactase activity is at the highest point at birth and seems to be constant with age. Maltase of the small intestine and pancreatic amylase activity increase markedly with age and according to the variation of the feed composition given to the pig.

The digestion of carbohydrates is not only affected by the age of animals. It is also affected by the solubility of carbohydrates and their botanical origin and by the mode of former technological handling.

Physiopathological disturbances have been found associated with a lack of enzymes in the small intestine. Aumaitre (1969) indicated that a very low level of pancreatic amylase may be associated with either diarrhoea or acute gastroenteritis of recently weaned piglets.

Efird *et al.* (1982) reared piglets by the sow with no access to the creep feed. The piglets were weaned at 16 and killed at 22 days of age. Stomach pH was higher in weaned pigs than in sow reared pigs at 22 days. Weaned pigs had more activity in the intestines than sow reared pigs.

For successful control of digestive disorders and Colibacillosis in weaned piglets, Vapa and Tarasenko (1985) and Korošek (1985) emphasized

maintaining high acidity in the stomach of the pigs.

Decreased immunological ability of the body may also play a role in causing some problems in the health of young piglets and their digestive disturbances. The amount of antibodies in the blood of piglets, received through the colostrum, is still decreasing and at the fourth week of age it is very low (Frenye *et al.* 1981). At the same age, the production of antibodies in piglets just starts. This means that there is a short period in which they are without immunological protection. The weaning of piglets at three weeks of age is the most critical period of immunological protection.

In view of what is mentioned above, the technology of rearing and feeding early weaned piglets should follow the natural pathway of development of the digestive system and capability of piglets to adjust themselves to new conditions.

3. Intestinal microflora

Diarrhoea and enteritis are considered the major problems in pigs at birth and weaning, particularly at early weaning (Bilić and Zutić, 1985; Hribovšek, 1985; Ducluzeau, 1985). Weaning at three to four weeks of age is a stress on young piglets. In such a case they are removed from their sources of immunity and milk before they start producing sufficient amounts of antibodies for protection from enteric diseases. At the same time insufficient amounts of enzymes are produced for the digestion of some of the nutrients in cereal based diets. The environmental conditions are usually less than optimal (Krivec, 1985), and the diet is changed from easily digested milk to a dry feed of different origin and nutrient content (Fowler, 1980; Aumaitre, 1983; Underdahl, 1983).

When piglets are weaned at three weeks of age, the environment in the lumen of the intestines is drastically altered. The change from an hourly feeding regime and the replacement of highly digestible by less digestible nutrients may create some problems for the immature digestive system. The bacterial flora may be altered in a way which can give an opportunity for potentially pathogenic *E. Coli* to cause a digestive disorder.

The absorption and hydrolysis of fat, carbohydrate and protein is almost completed in the small intestine. Organic matter passing into the large intestine is fermented rather than absorbed. This

fermentation sustains the large bacterial population of the lower part of the gut. A sudden change of nutrients present in the lumen, particularly if this involves the presence of large quantities of readily fermentable substances, will change the flora and some species may suddenly proliferate. The presence of large quantities of soluble carbohydrates in the distal part of the small intestine or in the large intestine is particularly likely to result in a rapid increase in the *E. Coli* population. If a potentially pathogenic strain of *E. Coli* multiplies excessively in the large intestine, it can also colonise the small intestine resulting in scouring (Kidder, 1982).

Whether a given diet will contribute to a digestive disorder depends not only on the nutrients but also on the way they are fed and their physical form and palatability. The amount of food consumption and regular emptying of digesta from the gut are very important factors in controlling bacterial flora in the gut.

Factors by which it is possible to regulate fermentation levels in the hind gut and gastric digesta are the following: pH changes, changes in feeding method (for example, restricted and *ad libitum* feeding), increasing protein and crude fibre levels of the diet, modifying the physical form of either the cereal component or the whole diet.

Some data suggest that there is a relationship between food intake and gastric emptying. The greater the concentration of energy in the gastric content, the slower the volume rate of its transfer to the duodenum, per unit of time. However, McNut and Evans (1984) found that the rate of passage of digesta is proportionally increased with increased food intake. Tkachev *et al.* (1982) found in early weaned piglets that the evacuation of stomach content into the intestine decreased after they were deprived of feed or water, or both, for one or two days. Secretion of pancreatic juice decreased by 25-70% after feed deprivation, and from 42-55% after water or feed deprivation for one to two days respectively. Enzyme activity of the juice decreased by 60-83% in piglets deprived of feed and water for one to two days.

In the study of the aerobic fecal microflora under different dietary regimes in pigs weaned at three weeks of age or left with the sow, Etheridge *et al.* (1984) found significant differences in the bacterial counts in the fecal material. The coliforms were lower in pigs remaining with the sow as compared with early weaned ones.

Ducluzeau (1985) reported that among the environmental factors, temperature might play an important role. According to some investigations, the number of coliform bacteria is slightly higher in the digestive tract of animals kept in a cold environment. However, Bolduan and Jung (1980) suggested that new diets, for pigs weaned at five weeks of age, should be tested mainly for their effects on the passage through the digestive tract and on the gastric acid balance.

II - Technological aspects of feeding and rearing of piglets

1. Pre-weaning feeding

There is no clear information on the effect of feeding before weaning upon the post weaning performances of pigs. The daily growth rate of suckling pigs depends mainly on their birth weight and the amount of sow milk consumption. Several researchers showed little benefit on post weaning performances resulting from creep feeding of pigs weaned at three or five weeks of age. However, some other workers have shown a benefit on post weaning performances from creep feeding.

Creep feeding should give an opportunity to suckling pigs to grow faster and to have higher live weight at weaning. However, early presentation of feed is also important to ensure that piglets adjust to a solid feed and eat enough after weaning. If it is properly done, pigs will consume about 100 grams of solid feed per day by the time they are weaned. Early consumption of solid feeds will also prepare the digestive system for the coming changes in feed after weaning, and will stimulate development of the microflora and enzymes for carbohydrate digestion. Therefore, creep feed should be of the same composition as the diet which will be fed after the weaning.

The pre- and post-weaning periods in the piglet's life are usually observed as being separate (from the physical standpoint) since piglets are usually removed to another type of pen. However, in terms of the growth of piglets, it is more useful to think of these two periods as one continuous phase. It is thus vital that any changes in the diet are made as gradually as possible.

2. Restriction of feed intake after the weaning

If the post weaning diet is offered *ad libitum*, some pigs may eat too much, which can lead to digestive disturbances and scours caused by an overloading of an immature digestive system. This problem occurs particularly if piglets have consumed very little solid feed before the weaning. Thus, when sudden changes of the diet take place at weaning, the result can be an overconsumption of feed in relation to the capacity of the digestive system, and post weaning diarrhoea and death are often the final consequences.

The incidence of post weaning digestive disorders can be minimised by stimulating high consumption of creep feed before weaning and continuing to feed the same feed, for some time after weaning. The ability of the digestive system to cope with high intakes of feed after weaning, is increased by the intake of the same feed prior to weaning. Thus, when high feed intakes are achieved before weaning, in the post weaning period there should be less need to restrict feed intake because the digestive system will be better prepared to deal with such a condition.

When applying feeding restrictions, the most common question is which restriction regime to use and for how long. In the literature available, there is not much data about this problem (Nielsen *et al.*, 1976; Smajlović, 1985; Rotar Iva, 1985). In this field, practical experience is quite different, and one general recommendation can hardly be given. On some large scale farms, where piglets are weaned at three to four weeks of age, very good results are achieved by using the following restriction regime: the first three days after weaning the piglets receive 100 g of feed per day and per animal, but divided into four to five rations. From day four onwards, the daily amount of feed is increased to 50 g per pig, and seven to ten days after weaning the piglets are fed *ad libitum*. If everything is all right, eight to ten days after weaning, the piglets should consume, on average, 300-350 g of feed per day (Kovčín *et al.*, 1985).

Some producers used to leave piglets with no feed during the first couple of days after weaning. Tkachev *et al.* (1982) clearly showed that this is not a good idea because unfed piglets do not produce enzymes or juices for digestion, which are normally secreted when food is present in the stomach. The piglets treated in such a way are denied both vitamins and minerals and loss of

electrolytes and general weakness may appear (Zivković *et al.*, 1985).

The restrictive feeding regime has a favourable effect on appetite. The piglets receive food divided into several rations and thus it is always fresh and much more palatable. Being fed below their appetite, piglets wait for the next meal with much more greediness. Every new ration is a new stimulation for secretion of digestive enzymes and juices. The food which remains for a long time in the feeders is not readily accepted by piglets.

For applying the restrictive feeding regime in the few first days after the weaning, it is important that all piglets have enough space on the feeder and can all eat at the same time. Because of this, pig troughs are more readily accepted than self feeders.

3. Composition of rations for early weaned pigs

The formulation of diets for early weaned piglets, for those weaned either at three or five weeks of age, requires very careful consideration of all physiological changes arising between these two periods.

It is desirable that diets for early weaned piglets be composed of nutrients which will meet all the requirements and which will ensure the corresponding pH in the stomach of the pigs. The diets should also be palatable, easily digested and should not contain anti-nutritive or toxic materials. Very convenient feeds for early weaned piglets are as follows: dried skim milk, dried whey, yeast, fish meal, soybean meal, fat and oil.

Dried skim milk is a contradictory feed for use in the diets of early weaned piglets. It is easily digested in the food tract of young pigs, but its price is very high in comparison to similar feeds. Many producers are still wondering whether or not to introduce it into diets and, if so, at what levels. The results of some extensive investigations at the Livestock Institute of Novi Sad, showed that the inclusion of 10% of dried skim milk in the diets of early weaned piglets has a significant effect on the daily gain and feed conversion ratio, but the economic effect is doubtful because of its high price. Inclusion of 5% of dried skim milk had no effect on the performances of piglets. In an experiment with weaned pigs at 21, 25 and 35 days of age, Bertrand *et al.* (1981) did not show significantly improved

performances by the addition of 10% of skim milk powder.

Many large scale farms in Yugoslavia where early weaning is practiced at 21-28 days of age, recently started to use diets for piglets based on soybean meal, without skim milk powder. With such a feeding system the rearing is very successful. Fekete *et al.* (1981) reported impressive results of experiments with a total of 3,096 piglets weaned at 28 days of age. They reach very high performances using the simple diets composed of cereals and soybean meal, i.e., feed consumption of 900-1,000 g/day/pig and a daily growth rate of 400-600 g/day.

Soybean meal is a very good source of protein for young pigs, but it needs to be thermally treated to destroy the growth depressing activity of trypsin inhibitors present in raw unheated soybean. Most producers of soybean meal have modern equipment and produce excellent soybean meal, but some still use old equipment and the trypsin inhibitor's activity is not eliminated. It was suggested that the growth depressing activity of trypsin inhibitors could be the result of an excessive endogenous loss of essential amino acids derived from the hyperactive pancreas, because of the effects of trypsin inhibitor. However, Yen *et al.* (1975) reported that soybean constituents other than the soybean trypsin inhibitors and the inhibitor of the intestinal proteolysis in the pig may be a major cause for reduced growth when either raw soybean or thermally untreated soybean meal is fed.

Dried yeast has been recognized for many years as a valuable and excellent source of protein and vitamins for many years. The value of single cell yeast protein as a partial replacement of soybean meal in the diet for piglets, was investigated in many experiments (Braude and Mitchell, 1975). Tegbe and Zimmerman (1977) replaced soybean meal with 0%, 26%, 53% and 80% single cell protein: the average daily gain increased with increasing proportion of the SCP in the ration; with increasing SCP in the ration, feed conversion also increased.

The introduction of a certain amount of sugars in the diets of early weaned piglets to improve the palatability of the diet, was quite a common custom for many producers of feedstuffs, and some of them are still doing it. However, this practice was not proved useful by the experiments of Lavorel *et al.* (1981), when 0%, 4% and 8% of

sucrose was added to the diets of early weaned piglets. Aherne *et al.* (1969) fed two and four day old piglets synthetic milk diets containing 56.6% of sucrose or fructose. The addition of sucrose in the diets of very young piglets resulted in reduced daily gain, decreased feed efficiency and a higher mortality rate compared with pigs fed similar diets where glucose or lactose were the main sources of carbohydrate.

Numerous comparative investigations have been done with maize, barley and wheat in the diets of weaned piglets. O'Grady and Bowland (1964), compared diets containing either barley or wheat. They observed no difference in consumption or in average daily gain between the groups. However, Quemere *et al.* (1979) found that barley, with less energy and more protein, was better suited in the early stages after the weaning, while maize became preferable later on.

O'Grady and Bowland (1972) found that the optimum DE level for maximal gain of early weaned pigs was 3.2 to 3.4 Kcal/kg. Digestibility of dietary protein increased with increasing DE content. Very high mortality was experienced at low energy levels. Mc Connel *et al.* (1982) found the best average daily gain and feed conversion on diets at ME of 3,520 Kcal/kg. They stated that for young pigs weighing 10-20 kg the energy requirements for maximum gain and feed efficiency are higher than currently recommended.

There are a lot of published data about quite simple diets for early weaned piglets which showed high performances. Our experience, on large scale farms, is somewhat different. Most probably because of the very high concentration of piglets on large scale farms and the permanent presence of clinical and subclinical diseases, the requirements for nutrients and additives of these piglets are a bit higher than for piglets reared on small private farms.

Reasonable use of additives in the nutrition of weaned pigs could be of great help in promoting good health and stimulating good production of such animals (Zivković, 1984). However, in this field things went the wrong way. Instead of trying to ensure optimal conditions for rearing and nutrition, many producers more often tried to solve all these problems by using high levels of antibiotics and other additives. As such, things are getting even worse and the performances of animals has decreased even more. There is a need

to distinguish between the therapeutic additives or medicaments and the stimulants of production. Continual usage of high dosage of antimicrobial additives is counter productive because it stimulates the growth of resistant microorganisms and is very uneconomical.

4. Optimal daily gain required in weaned piglets from 5 to 25 kg of live weight

The data from several experiments show that the early growth of pigs is of great importance for their subsequent performance (Elsley, 1983; Nielsen, 1964). Rapid gain, up to 20 kg of live weight, was associated with a slower subsequent gain, a higher feed conversion rate and with a poorer quality carcass, including thicker backfat, smaller area of eye muscle and greater area of fat overlying the eye muscle (Smajlović, 1985).

Unfortunately, these excellent results did not attract the attention of research workers, and this question is not yet sufficiently explored. Data available are not sufficient to generally recommend the longer period of restriction after the weaning of piglets and increasing their age at 20 kg of live weight. However, the problem is very acute and it requires much more attention.

Today average daily gains in early weaned piglets weighing 5 to 25 kg range from 300 to 450 g. The average daily gains below 350 g are not sufficient and cause divisions among the piglets in their live weights and some of them become stunted. According to our experience, it seems that the optimal growth rate is between 360 and 400 grams per day. Such daily gains allow normal growth for most piglets with minimal separation in live weight. For weaned piglets weighing from 5 to 25 kg, an average daily consumption of feed should be from 800 to 900 grams.

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