Institutionen för husdjursgenetik

Behaviour and growth of piglets weaned at 5 and 7 weeks of age in an organic environment

by

Maria Eriksson

Supervisors:
Lotta Rydhmer
Anna Wallenbeck

Examensarbete 278
2006

Examensarbete ingår som en obligatorisk del i utbildningen och syftar till att under handledning ge de studerande träning i att självständigt och på ett vetenskapligt sätt lösa en uppgift. Föreliggande uppsats är således ett elevarbete och dess innehåll, resultat och slutsatser bör bedömas mot denna bakgrund. Examensarbete på D-nivå i ämnet husdjursgenetik, 20 p (30 ECTS).

Institutionen för husdjursgenetik

Behaviour and growth of piglets weaned at 5 and 7 weeks of age in an organic environment

by

Maria Eriksson

Agrovoc: Piglets, weaning, behaviour, body weight
Övrigt: Organic production

Supervisors:
Lotta Rydhmer
Anna Wallenbeck

Examensarbete 278
2006

Examensarbete ingår som en obligatorisk del i utbildningen och syftar till att under handledning ge de studerande träning i att självständigt och på ett vetenskapligt sätt lösa en uppgift. Föreliggande uppsats är således ett elevarbete och dess innehåll, resultat och slutsatser bör bedömas mot denna bakgrund. Examensarbete på D-nivå i ämnet husdjursgenetik, 20 p (30 ECTS).

Preface

This study was carried out from February to May 2005 at Funbo-Lövsta research center. The research center is a part of the Swedish University of Agricultural Sciences (SLU) and is stationed 10 kilometers east of Uppsala. This work was a part of an organic project called “Ekogris”, which is financed by the Swedish research council for environment, agricultural sciences and spatial planning (FORMAS).

A big thank you to Lotta Rydhmer for all your time and patience spent on me. You have been a invaluable support and help with all your ideas and knowledge during the study, statistical analyses and writing of my work.

Thank you so much Anna Wallenbeck, for all your support and help with the writing, ideas and statistical analyses.

Thanks to Maria Neil for her help with calculations and material on feed intake for the piglets in the study.

I would also like to thank the nice staff at Funbo-Lövsta research center for all their friendly help during weighing and sampling. A special thank to Ulla for her assistance chasing piglets in the straw.

Table of content

1. Sammanfattning

Avvänjning i dagens grisproduktion innebär en abrupt förändring för smågrisarna vid en tidig ålder. Problem som kan uppkomma vid avvänjningen är reducerad tarmfunktion, stressbeteenden och reducerad tillväxt. Enligt svenska djurskyddslagen får smågrisar tidigast avvänjas vid fyra veckors ålder, men många konventionella producenter avvänjer idag vid fem veckors ålder. Enligt KRAVs regler får smågrisar tidigast avvänjas vid sju veckors ålder.

Syftet med den här studien var att jämföra stressrelaterade beteenden och tillväxt för grisar avvanda vid fem respektive sju veckors ålder, i en miljö som är vanlig inom ekologisk produktion.

Suggorna grisade i grisningsboxar och två veckor efter grisning flyttades 4-5 suggor med sina kullar ihop i storboxar med djupströbädd. Smågrisarna hölls kvar i samma grupper under hela försöket. Smågrisarna vägdes dagen de föddes, vid fyra dagars ålder och sedan en gång i veckan från två till nio veckors ålder. Totalt 188 smågrisar avvandes vid sju veckor och 147 smågrisar avvandes vid fem veckor.

Beteendestudier utfördes på smågrisarna i fyra grupper en gång per vecka från fem till åtta veckors ålder. Aktivitet och sociala beteenden studerades på alla smågrisar i dessa grupper. De första två grupperna avvandes vid sju veckors ålder och bestod av fem respektive fyra kullar med 48 respektive 47 smågrisar i varje storbox. I de sista två grupperna avvandes smågrisarna vid fem veckors ålder och bestod av fyra kullar vardera med 43 respektive 45 grisar i varje storbox.

Avvänjningsvikterna var signifikant skilda för de två olika avvänjningsåldrarna. Smågrisarna avvanda vid sju veckor växte bättre än smågrisarna avvanda vid fem veckor. Innan fem veckors ålder fanns inga skillnader i vikt eller tillväxt mellan de två avvänjningsåldrarna. Mellan fem och nio veckor vägde smågrisarna avvanda vid sju veckor signifikant mer än smågrisarna avvanda vid fem veckor. Smågrisarna avvanda vid sju veckor hade en högre tillväxt mellan fem och åtta veckor jämfört med smågrisarna avvanda vid fem veckor. Det fanns en signifikant skillnad i spridningen av vikter inom kullarna. Smågrisarna avvanda vid sju veckor hade en mindre spridning i vikt inom kullarna än smågrisarna avvanda vid fem veckor. Grisarna var mest passiva (de låg i halmen) och minst aggressiva dagen efter avvänjning, oavsett avvänjningsålder. Det fanns en skillnad i mängden buffande på annan smågris mellan de två grupperna. De smågrisar som avvandes vid fem veckor buffade mer än de som avvandes vid sju veckor. Smågrisarna verkade fungera som en enda stor social grupp inom varje box, de följde varandra beteendemässigt.

2. Abstract

Weaning in pig production today is an abrupt change at an early age for the piglets. Problems that can be associated with weaning is behavioral and health problems for the

young pig. Such problems can be impaired intestinal functions, reduced weight gain, and increased stress syndromes. The current law concerning weaning age for pig production in Sweden allows weaning at an age of four weeks, yet the common weaning age is at five weeks of age. According to the organic rules of KRAV, the Swedish certification organization, weaning is not allowed before seven weeks of age.

The aim of this study was to investigate behaviour and growth in piglets weaned at five or seven weeks of age in an environment comparable with organic pig production.

The sows farrowed in farrowing pens and two weeks after birth the piglets and their mother were moved to a loose housing system with deep straw bed. The sows were held in groups of 4-5 sows with their litters. The piglets were held in the same groups during the entire study. They were weighed at birth, four days of age, and once a week from two weeks up to nine weeks of age.

Behavioural observations were made in four groups once a week from five up to eight weeks of age. Activity and social behaviour were observed on all piglets in the groups. The first two groups were weaned at seven weeks of age containing five and four litters, with 48 respectively 47 piglets. In the last two groups the piglets were weaned at five weeks of age. These groups contained four litters, with 43 and 45 piglets.

The weights differed between the two weaning age groups. The piglets weaned at seven weeks grew better than the piglets weaned at five weeks. No differences were found in weights before five weeks of age. There were significant differences in growth rate between five to eight weeks of age. The piglets weaned at seven weeks had a higher growth rate than the piglets weaned at five weeks during these weeks. There was a significant difference in weight variation within litters between the two weaning age groups. The piglets weaned at seven weeks varied less than the piglets weaned at five weeks. There was a difference in belly nosing behaviour at seven and eight week of age; the piglets weaned at five weeks performed more belly nosing behaviour than other piglets. The piglets were most passive the day after weaning regardless of weaning age. They followed similar patterns in activity within pen and seemed to function as one big social group.

3. Introduction

A concern in today's organic pig production is oestrus before weaning in sows. Wecksler (1996) reported that lactation oestrus occurred in 54 % of the sows before the piglets reached an age of seven weeks. According to KRAV (2005) weaning of piglets is not allowed before seven weeks of age. The oestrus before weaning can result in disruption in sow batches which leads to a delay before next parity resulting in economic losses for the producer. On the other hand Dunshea *et al*. (2003) showed that the greatest determinants of piglets post-weaning performance are the age and weight of the piglet at weaning and that the weight at weaning is the key determinant of lifetime growth rate. Disadvantages of early weaning include decreased post-weaning weight gain and

abnormal feed intake that can influence metabolism in the young pig and result in reduced growth performance throughout finishing phase (Hohenshell *et al.,* 2000). Weaning may be a source of distress, causing aggression, digestive disorders and an increase in stress related behaviours. According to Vaarst *et al.* (2004) weaning at an age of seven weeks is therefore better for the piglet than weaning at an earlier age.

3.1 Aims of this study

The aim of this study was to investigate the behaviour and growth in piglets weaned at five and seven weeks of age, held in an environment comparable with organic pig production standards.

4. Literature survey

4.1 Organic organizations

The world market for organic production grows with approximately 20 percent per year and the income for 2004 estimates to about 200 billion SEK. Organic pig production in Europe has also grown over the last years, although it is still a small percentage of the total production (Millet *et al.,* 2004). Organic organizations were inspired by philosophical ideas and affected by the economics and political situation in countries concerned. Because of this diverse background the standards for organic production varies a lot in different countries. Within countries there can also be several different organic organizations, each with their own regulations and standards for the definition of organic production. As a result of these different standards, EU has come up with minimum standards for organic production that must be fulfilled by the countries within EU (Gade, 2002). To ensure a secure trade with organic products all over the world, cooperation with a control system evaluated by independent parties is necessary. The International Federation of Organic Agriculture (IFOAM) has over 700 members in 108 countries all over the world (IFOAM, 2005). In Sweden the biggest organic control system is called KRAV and fulfils the EU standards and IFOAM standards for organic pig production. KRAV finds accreditation according to IFOAM Accreditation Criteria as today's safest evaluation system (KRAV, 2004). In year 2004 there were 104 organic pig producers authorized by KRAV in Sweden (KRAV, 2004). Swedish organic pig production was 21 088 finishing pigs and there were 1046 organic sows in 2003 (Jordbruksverket, 2005). In 2002 organic pig production was 1% of the total pig production in Sweden (Jordbruksverket, 2002).

4.2 Organic pig production

Organic production is based on concern for the environment and animal welfare. There are welfare advantages and disadvantages in both conventional and organic production

systems. Pigs held organically have more possibilities to express their natural behaviours, while there are more difficulties in control and treatment of these pigs. Irrespective of system, management is an important factor in maintaining good welfare (Gade, 2002). In an organic pig production system the pig must have access to an outdoor area (Millet *et al.,* 2004). In Sweden the pigs in organic production must have access to pasture during pasture season. On the pasture land the pigs should have access to a mud bath and be able to seek shadow. According to KRAV (2005) the pigs should also be able to express natural behaviours, such as rooting and searching for food. With regard to the outdoor access there are variations between European countries. Even so, this is a major difference between conventional and organic pig production (Lund, 2003). In organic production it is common to keep sows and their piglets inside in loose housing systems with outdoor access.

4.3 Piglet performance

4.3.1 Growth rate

The pig has a relative high postnatal growth rate. In relation to life span the period of gestation is short for pigs, making them unusual compared with other mammals (Reeds *et al.,* 1993). With optimal conditions piglets are capable of gaining 180-240 g/day between birth and weaning at three to four weeks of age (Gaskins, 1998). This normal growth rate is far below the potential of artificially reared piglets, which can grow with a rate of 400 g/day (Dunschea *et al.,* 2003). Millet *et al.* (2004) showed that feeding an organic nutrition with 15 % lower digestible lysine content compared to a conventional nutrition does not lead to important differences in growth for pigs. He also showed that organic housing can increase feed intake and consequently growth rate. Social environment is another aspect that can affect piglet growth (Giles, 1998). Pen mates in group-housed systems can have negative effects on growth rate for some individuals in the group and in general an increase in group size can result in some reduction in weight gain (Gonyou, 1993). It has also been shown that an increase in stocking density reduce feed intake and pig performance (Giles, 1998). A large litter size can also have a negative influence on growth rate (Auldist *et al.,* 1998).

4.3.2 Milk intake

Sow milk production is the major factor limiting piglet growth up to weaning age (Auldist *et al.,* 1998). Sow milk consist of 10 g protein per MJ. The digestibility is almost 100% and the composition is ideal for the piglet (Simonsson, 1997). The sow produces milk depending on nursing demands of the litter. This nursing demand is in turn influenced by litter size, piglet weight and suckling frequency (Auldist *et al.,* 1998). The duration and intensity of stimulation, such as udder massaging influences the milk production (Pluske *et al.,* 1998). The milk production of different teats varies markedly, affecting piglets differently depending on their teat order (Jensen *et al.,* 1989). Therefore

there can be a large variation in piglet weight within litter (Mason *et al.,* 2003). The sow can decide when to nurse her piglets by walking away or lying on the udder so the young pigs do not reach the udder for massaging (Held *et al.,* 2001). Almost all suckling is terminated by the sow when her litter has reached the age of four weeks (Jensen *et al.,* 1989).

4.3.3 From milk to solid feed

The decrease in frequency of suckling as the piglets grow older initiates a social integration between piglets and motivates them to search for feed elsewhere, increasing the intake of solid feed (Held *et al.,* 2001; Bøe, 1990). Jensen (1988) found that in semi-natural conditions the observed sucklings initiated by the mother decreased from about 60 % of the sucklings the first week of lactation to about 15 % of the sucklings the tenth week of lactation. Most piglets start to consume supplementary solid feed before four weeks of age, even though their main source of nutrition comes from the sow milk (Bøe, 1993). The solid feed intake increases markedly at five and six weeks of age. At an age of six weeks, unweaned piglets consume less than half of their dry matter intake from milk. Some piglets start to eat solid feed earlier than others. There is a wide range in the level of intake between the individuals within and between litters. At four weeks of age some piglets have eaten several kilograms of solid feed whilst others have eaten almost nothing. Differences in level of solid feed intake can depend on maturation of the digestive system, social and environmental factors and feed quality (Fraser *et al.,* 1998). The initiation of solid feed intake can be a result of an optimal foraging decision. The sow affect this decision by acting so that the cost for getting milk is higher than the cost for searching solid feed. The piglets nutritional needs increase with age and if the benefit of suckling decreases there will be a point in time when it is most optimal to stop suckling (Jensen *et al.,* 1989). These differences in time when to start eating solid feed do not seem to be dependent on the sex or birth weight of the piglet (Held *et al.,* 2001), but smaller piglets tend to stop suckling earlier than larger piglets (Algers *et al.,* 1990). According to Jensen (1995) the piglets tend to stay longer on milk rather than start searching for solid feed when they have a highly productive teat. Another study showed that group housing systems cause a decrease in interactions between the mother and her offspring. This decrease seems to result in lower milk consumption and an increase in creep feed intake for the piglets (Hultén *et al.,* 1997).

4.3.4 Feed intake

The feed efficiency and the growth rate of growing pigs in commercial units are far below the potential growth rate of the pigs. Feed intake in pigs is related to a range of dietary, animal and environmental conditions. The potential voluntary feed intake of growing pigs is assumed to be a function of the energy demand. This involves the sum of energy required for maintenance and tissue deposition (Giles, 1998). Pigs weighing less than 20 kg live weight are unable to increase the feed intake to compensate for energy losses associated with lower energy in the feed. They are also unable to compensate with

higher feed intake at lower temperatures (Giles, 1998). Parker *et al.* (1980) showed that pigs which where group-housed and held in cold conditions spent more time huddling than in feeding activity compared to pigs maintained in a thermally comfortable environment. However Millet *et al.* (2004) showed that in an organic loose housing system, piglets weaned at four weeks of age show a faster growth depending on higher intake of feed, overcompensating for the requirements in body maintenance, activity and thermoregulation.

4.4 Weaning

4.4.1 Natural weaning and social behaviour

Weaning describes the transition in young pigs from total nutritional and social dependence on the mother to total independence from her (Held *et al.,* 2001). In some seal species the weaning process is terminated abruptly by the mother leaving the offspring, but in most mammals the weaning is a gradual process that continues over a longer period of time. Natural weaning is a conflict between the interest of the mother and her offspring (Bøe, 1990). Weaning is characterized by a decrease in nursing frequency promoted by the mother and an increase in solid feed consumption by the piglet (Weary *et al.,* 1997). The young pig benefits from a longer period of protection and feeding from the mother than what is optimal from the mother's point of view (Jensen *et al.,* 1989). The optimal time for the sow to leave her piglets is when she has invested enough energy in her offspring so that they have maximum chances of surviving to breed while the sow still has enough energy left to breed again (Held *et al.,* 2001). In nature this transition is completed when the young pigs are between 12-16 weeks of age (Fraser *et al.,* 1998).

Under semi natural conditions, sows give birth to the piglets in a self built nest a bit away from the rest of the group. During the first week of age the piglets stay very close to the nest and their mother. Stangel and Jensen (1991) have found that the time spent by the mother with her offspring decreased from 90 % in day one to 60 % in day ten. In the second week of age the piglets are introduced to the pigs in the rest of the group (Held *et al.,* 2001). Their natural social groups consist of two to five related sows, their most recent litters and juvenile offspring from previous litters (Vaarst *et al.,* 2004). During this introduction period and onwards aggression between the piglets is rare. The aggressive behaviour between the piglets under the introduction week is below 20 % of all social contact and when the pigs have established their social bonds, aggression is no longer required to sort out most disputes (Held *et al.,* 2001 and Algers *et al.,* 1990). Interactions between unfamiliar piglets after 21 days of age involve aggressive behaviour. The piglets within a litter create strong bonds to the sow and between each other. These bonds remains strong even after introduction to the rest of the social group. The piglets stay closely to their mother and interact more with her and with the littermates than with others in the social group until weaning. The bonds between the piglets within litter remain strong even after weaning (Gonyou, 2001). When bonded individuals are

separated vocalization and searching for each other can be followed by a period of energy conserving depression. This means that increased predation risk and high energy costs at searching of other pigs can lead to a period of altered feeding, sleeping patterns and suspension of playing behaviour for the piglets. At longer time of separation the piglets adapt and return to their natural activities. In nature interactions between mother and her offspring often continue after weaning leading to reduced effects of separation patterns (Newberry *et al.,* 2001).

4.4.2 Weaning in commercial pig production

Weaning in pig production today is not a gradual process. Instead it is abrupt, and time for weaning is determined by the caretaker and existing laws. The piglets are separated from the sow when they are still dependent on the mother for social security and when they are still suckling (Held, *et al.,* 2001). In Sweden it is legal to wean piglets from four weeks of age. Yet in conventional production piglets are often weaned at five weeks of age and in organic production the rules of KRAV allows weaning from seven weeks of age. In other countries it is more common to wean at an earlier age, for example three weeks of age in some European countries (Algers *et al.,* 1990).

In conventional pig production the sows are moved to a farrowing pen a few days before expected farrowing. The sows are not separated from each other during farrowing, with the long distances as in the natural environment. In most systems piglets remain with their mother in these farrowing pens until weaning (Gonyou, 2001). For piglets in organic pig production the process of weaning is somewhat more gradual than in conventional pig production. Also here sows farrow in farrowing pen, but after two weeks the sow and her piglets are placed either outside on enclosed pasture or inside in loose housing systems in groups. This is comparable with the natural behaviour during regrouping a few weeks after farrowing in the wild (Vaarst *et al.,* 2004).

4.4.3 Physiological and nutritional changes at weaning

The abrupt replacement of highly digestible milk by solid feed at weaning, changes the environment in the gastrointestinal tract (GI) rapidly. Weaning is one of many factors influencing the structure and function of the GI tract during the period of weaning and causes decreased digestive and absorptive capacity especially in the small intestine (Xu *et al*., 2000; Pluske *et al.,* 1997). The transition from intake of milk to solid feed includes alterations in mucosal structure, cell kinetics and cell phenotype (Kelly, 1998). The colostrum- and milk-borne growth factors, hormones and other bioactive substances play an important role for the development of the small intestine in the suckling pig. At weaning these compounds have disappeared, which makes the piglet vulnerable to infections by pathogens, for example Escherichia coli (E. coli). Weaning causes changes in the small intestine and the most obvious changes are gut atrophy (e.g. reduction in villous height), reduction in brush-border enzyme activity and crypt hyperplasia. This changes lead to a reduction in the absorption capacity for sugar and amino acids (Xu *et*

al., 2000). On the other hand there is a rapid growth of the intestine during this period. This growth compensates some of the reduction of digestive capability and alters the total capacity for digestion and absorption (Kelly, 1998). The structural changes vary along the intestinal tract and are affected by the age of weaning (Xu *et al*., 2000). At weaning the fat accretion temporarily slows down and increases only later when the pig reaches sexual maturity (Reeds *et al*., 1993). Algers *et al.* (1990) showed that teat quality are a determinant in the nutritional change of the piglet at weaning.

4.4.4 Problems associated with weaning

Weaning in pig production may be a potential source of behavioral and health problems in pigs. Pigs vary largely in physiological and behavioural reactions when exposed to a stressful situation such as weaning (Bolhuis *et al.,* 2005). Both genetic and environment factors influence the response of the weaned piglet (O'Conell *et al.*, 2004). The weaning process involves changes that can influence negatively on pig performance and create problems in form of impaired intestinal functions, post-weaning diarrhoea, reduced weight gain, weight losses and stress syndromes. These problems are effects of changes in nutrition and broken bonds to the sow (Algers, *et al.,* 1990 and Pluske *et al.,* 1997). In group housing systems a reduced growth rate was noted especially among heavy piglets after weaning (Hultén *et al.,* 1997). Piglets of a lower weight are more responsive to the maternal separation rather than the nutritional changes at weaning (Algers *et al.,* 1990). To obtain an acceptable growth rate at early weaning it is necessary to have an optimal thermal environment and a high hygiene standard (Bøe, 1990).

Voluntary feed intake varies and is often so low the first five days after weaning that the piglet fails to consume sufficient food and thereby get insufficient energy for body maintenance (Pluske *et al.,* 1997). Even though piglets are offered their feed and water ration, they may have a low intake and poor weight gain for several days after weaning (Fraser *et al.,* 1998). Playing a recording of the nursing vocalizations from the sow can stimulate drinking and eating in newly weaned pigs and reduce some of the problems (Fraser *et al.,* 1998). Overeating resulting in diarrhoea can be seen if the piglets are offered ad libitum (Fraser *et al.,* 1998). Levels of metabolizable energy intake at the end of the first week post-weaning seldom attains the pre-weaning metabolizable energy intake. These piglets have often a reduction in growth rate during a period of three to six weeks post weaning. During this period contribution of protein catabolism to energy metabolism is marginal. In reality this means losses of body fat for the piglet and the losses continuous until a body weight gain of 200 g/day is reached (Dividich *et al.,* 1998). Independent of the diet type, the low energy intake is a major contributor to the reduction in villous height and a decrease in crypt-cell production rate in the small intestine. Separation of the mother can have severe negative effects on piglet health. One example is the "wasting pig syndrome" which means that some piglets fail to grow at normal rates (Fraser *et al.,* 1998). Pigs suffering from wasting pig syndrome are not recovering from the initial growth rate check that comes with weaning (Pluske *et al.*, 1997). This syndrome is associated to changes in the gut morphology and physiology (Fraser *et al.,* 1998).

Re-grouping at weaning increases stress and decreases growth rate (Gonyou, 1993). Mixing with unfamiliar pigs at weaning can also affect the individual behavior, and result in increased aggression. Mixing pigs when they are very young has been shown to give less aggressive behavior at weaning (Pluske *et al.,* 1996). Teat order also affects the behavior in the post weaning period (Mason *et al.,* 2003). Mason (2003) showed that pigs using anterior teats had a higher salivary cortisol levels indicating that these pigs showed a greater physiological stress response to the weaning process. According to Bøe (1993) the environment surrounding the young pigs has a major influence on the abnormal behavior of the piglets at weaning. The bedding in the pen can be a stimulus and reduces abnormal behavior such as tail biting, belly nosing and chewing on pen mates (Bøe, 1993). Belly nosing can be initiated because it is a redirected suckling behavior and the motivation for suckling is high in young weaned piglets (Algers *et al.,* 1990). Worobec *et al.* (1999) has shown that belly nosing can become a habit even when the motivation for suckling is diminished. A way to lower the level of oral behavior towards pen mates is to provide rooting material for the piglets (Algers *et al.,* 1990). The frequency of belly nosing behaviour on pen mates can also be dependent on the weaning age. Bøe (1993) showed that pigs weaned at four weeks of age had a higher frequency of belly nosing pen mates than pigs weaned at six weeks of age. These abnormal behaviors mentioned earlier can occur because of the stress of being separated from the mother and responses to weaning can be dependent on the body weight (Mason *et al.,* 2003).

5. Material and methods

5.1 Animals

188 piglets born in the fourth parity of 14 sows and 147 piglets born in the fifth parity of 9 sows were used in this weight study. The weights were registrered from all piglets in the study and 95 piglets from the fourth parity and 83 piglets from the fifth parity were also used for behavioural observations. The sows were Yorkshire x Landrace crossbreds and they were inseminated with semen from Hampshire boars. On the day of birth the piglets were weighed and tattooed with an id number in the right ear. On the fourth day of age the piglets were weighed, given iron injection and males were also castrated. Their teeth were not clipped. On day fourteen after farrowing (±1 day) the piglets were weighed and pierced in the left ear with a plastic badge that was marked with the id number.

5.2 Housing system

All litters were born and housed in farrowing pens (2.20x3.80 m) until two weeks of age. No farrowing crates were used for the sows. The pens had solid concrete floor and slatted floors over the dunging area. The daily routine included cleaning the pens, supplying new bedding in form of straw and feeding the sows at 8 am and 3 pm. A piglet area with heat

lamp was provided for the small piglets. When the piglets were fourteen days old they were moved with their mother to an unisolated building. The sows and their piglets were held together in a loose housing system in groups of two to five sows with their litters until weaning. Since the piglets were moved on the fourteenth day of age (±1 day), and there was some variation in birth date within the groups, the pigs were introduced to their new pen mates and environment within a period of six days. Weaning was taking place on Thursdays and accomplished by moving the sow to another stable while the piglets stayed in the pen**.** The group pens had concrete floors with a deep straw bed and had a size of minimum 52 m^2 to maximum 114 m^2. The pens were provided with one feeder, two or three water nipples and three lamps in a corner that provided heat for the piglets. The piglets were held in these pens and in the same groups under the entire study, from two weeks of age up to nine weeks of age.

5.3 Treatment

Litters from the fourth parity were weaned at seven weeks of age and litters from the fifth parity were weaned at five weeks of age (see figure 1).

5.3.1 Weight observations

The piglets were weighed once a week from three weeks of age to nine weeks of age. At weighing the pigs were moved from the pen to a corner of the corridor in the stable. Here they were weighed on a scale and than put back into the pen. The scale recorded the weight in kg with a precision of one decimal. The groups were weighed individually one at the time, so that no mixing with unfamiliar pigs occurred.

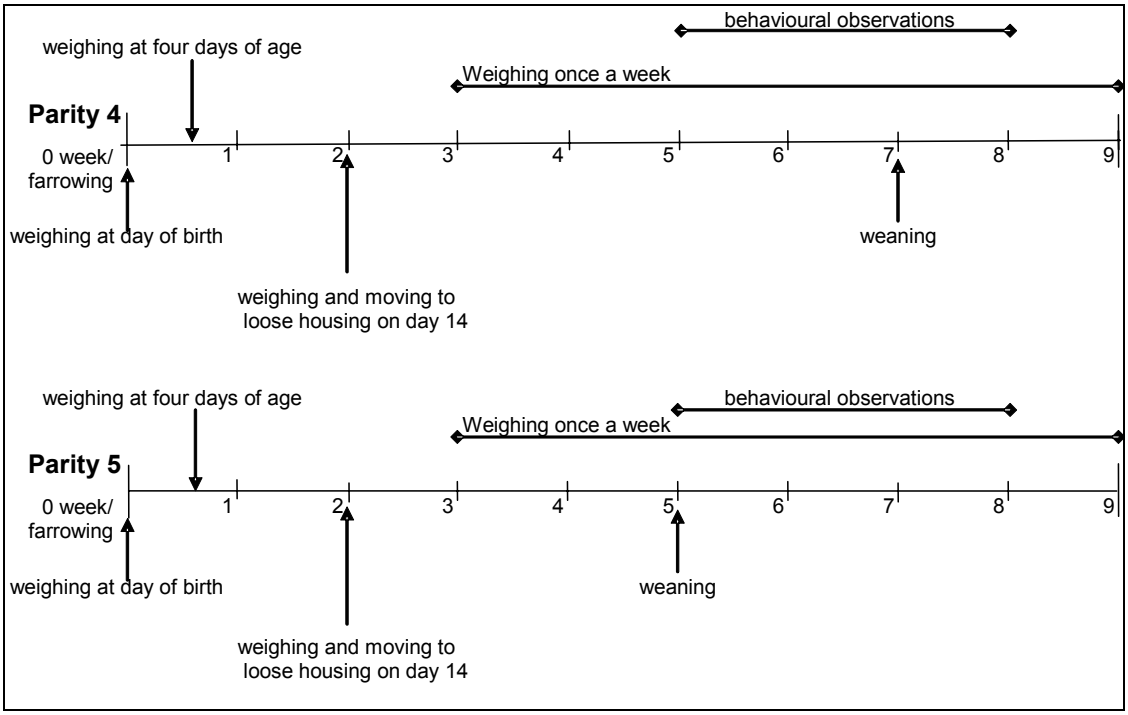


Figure 1. The behavioural observations and weighing in the two weaning age groups.

5.3.2 Behavioural observations

The social behaviour and the activity of the piglets were observed on 183 piglets from 17 litters once a week from five to eight weeks of age. The observation was carried out between 08:30 to 12:30. Four groups were observed. The first two groups observed were weaned at seven weeks of age and contained five and four litters with 48 and 47 piglets respectively. The last two groups observed were weaned at five weeks of age and contained four litters with 45 and 43 piglets respectively. During weighing on the day before the behavioural observations all piglets were colored, each litter with different colors. All piglets in each group were observed simultaneously during 10 minute intervals. Between each 10 minutes interval there was a 10 minutes break. This led to three observation periods in an hour and 12 observation periods per group and observation day. Each observation interval started and ended with an instantaneous scan sampling observation, resulting in 24 scan sampling observations per day and group. The behaviors registered in the instantaneous scan sampling were: resting, activity, rooting in the straw, seeking food in the feeder and seeking water. Between the two scan sampling observations there was an observation period of seven minutes long continuous registration of social behaviors. This led to 84 minutes of continuous registration per observation day and group. Three different social behaviours were registered: aggression, sucking and belly nosing (for the definition of different behaviors, see table 1). The observer was sitting in a high chair outside the pen, having a good overview during the observations. The observer was sitting in the chair 30 minutes before the observation started. The observer had a new protocol for every interval, resulting in 12 protocols for each group and observation day (see Appendix 1).

Table 1. Definition of the behaviours registered in the behavioural observations

Behaviour	Definition
Instantaneous scan sampling observation	
Resting	The piglet was sitting or lying calm and still
Active	The piglet was sitting but moving around, standing, walking or running
Rooting in the straw	The piglet was rooting with the head in the bed of straw, chewing and biting
Seeking food in the feeder	The piglet was standing with the head in the feeder or with the head near the feeder, closer than 30 cm to the feeder
Seeking water	The piglet was standing with the mouth to the water nipple or with the head closer than 30 cm near the water nipple
Continuous observation	
Aggression	The piglet was throwing the head, having the mouth open, towards a pen mate
Sucking	Sucking or biting of any part of a pen mate's body
Belly nosing	Massaging any part of a pen mate's body

5.4 Feeding

The piglets in the two treatments were fed two different kinds of feeds. Litters weaned at seven weeks of age were fed a sow feed used in project "Ekogris". Since there were no such feed left for the fifth parity, litters weaned at five weeks of age were fed a commercial sow feed. The nutritive value of these two feeds are presented in table 2.

Table 2. Calculated content of metabolisable energy, crude protein and selected amino acids in the commercial sow feed Klara and the organic type sow feed 411

	Klara (kg feed)	411 (kg feed)
MJ ME	12.60	12.17
CP[1] (g)	108	122
Lysine (g)	5.4	6.0
Methionine (g)	1.7	2.3
Methionine + cysteine (g)	4.0	4.8
Threonine (g)	3.5	4.5

[1] **Crude protein and amino acids are given as SIS (standardized ileal digestible).**

All sows and piglets were fed *ad lib*, and the stable staff filled the feeders every day at 08:00 in the morning. The feed consumption (kg filled in the feeder) for all the piglets

and sows in each pen were registered by the stable staff. At weaning the feeder was cleaned and thereafter refilled. The feed consumption of the growing pigs was measured for each pen, from birth to weaning and from weaning to 9 weeks of age.

5.5 Statistical analyses

The results from the weight study and the behavioral observations were analyzed with the Statistical Analyzing System (SAS). Mean values, standard deviations, minimum and maximum values of all parameters in this study were calculated by the MEANS procedure. Least square means, p-values and correlations were calculated with the General Linear Model (GLM) procedure. Variation coefficient of weight within litter at nine weeks of age was also calculated with GLM procedure in SAS. Correlations within behaviour, between weeks the behaviour was observed was calculated by MIXED procedure in SAS with REPEATED statement.

Weight and growth rate were analyzed with a model with weaning age as a fix factor. The weight and growth rate were pre corrected mathematically for litter size and for differences in age at weighing before they were used in the model. The behaviour parameters were analyzed in a model with weaning age and pen within weaning age as fix factors. The scan sampling was pre corrected for litter size and then multiplied with a factor 10 before used in the model. The multiplication with factor 10 resulted in a theoretical litter size of 10 piglets in all litters. This theoretical litter size made the comparison between the litters easier. The mean values for social behaviours was divided and multiplied with factors resulting in mean values per hour and pen. The calculations on variation coefficient of weights within litter were based on raw data for weights at nine weeks of age. The variation coefficient of weights were then analyzed with a model were weaning age was a fix factor.

To pre correct the weight data for litter size, 8230 weight observations on piglets born at Funbo-Lövsta research center from 1993-2000 were used to calculate correction numbers for different litter sizes. Least Square mean values for litter sizes were calculated by the GLM procedure in SAS. These calculations were based on weight registrations made on piglets at birth, three weeks, six weeks and nine weeks of age. Year of registration, litter size, breed, batch and castration were fix factors used in the model. This least square mean values were then used to make correction values for different litter sizes on weight values for piglets used in the study. For weight values at birth and one week of age in this study, the correction values based on calculations made on birth weights were used. For correction calculations on weight values at two, three and four weeks of age in this study, the correction values based on calculations on three week weights were used. For weight values at five, six and seven weeks of age in this study, the correction values based on weaning weights were used and for weight values at eight and nine weeks of age in this study, the correction values based on nine week weights were used. The correction values are shown in table 3.

Table 3. Correction values for growth rate and weight at different litter sizes

Total number of born piglets	Number of litters	Weight 0-1 week	Weight 2-4 week	Weight 5-7 week	Weight 8-9 week
4	1	0.86	0.72	0.71	0.75
5	1	0.86	0.79	0.77	0.81
10	2	0.94	0.91	0.91	0.94
12	1	1	1	1	1
13	1	1.05	1.06	1.06	1.05
14	2	1.04	1.07	1.05	1.06
15	3	1.10	1.09	1.07	1.09
16	7	1.11	1.10	1.11	1.12
17	2	1.14	1.13	1.14	1.15
20-	3	1.24	1.27	1.16	1.15

Pre calculations were made to correct for the age of piglets on the day of weighing. There were differences from -6 to +4 days of age between the litters since we only weighed once a week. Mean values on growth rate/day in the relevant two weeks period were multiplied with the numbers of days differing from the given age. This correction was either withdrawn or added to the actual weight at the week of age counted for.

6. Results

6.1 Weight

The number of piglets per litter at birth ranged from four to 21 piglets. Before one week 71 died, giving at total of 263 piglets at one week. During the study there was a range in litter size from four to 14 piglets per litter. Table 4 shows the mean values of weight at different ages for all pigs in the study.

Table 4. Mean values, standard deviations, minimum and maximum values of weight at different ages

Weight, kg	N[2]	Mean[1]	SD	Min	Max
Birth	334	1.8	0.43	0.6	2.7
One week of age	263	2.5	0.60	1.2	3.9
Two weeks of age	250	5.8	1.32	2.2	9.2
Three weeks of age	242	7.4	1.84	1.7	12.7
Four weeks of age	240	10.0	2.20	4.0	16.9
Five weeks of age	240	12.2	2.74	4.0	18.7
Six weeks of age	239	14.9	3.31	4.4	22.6
Seven weeks of age	239	18.3	4.20	5.1	28.0
Eight weeks of age	238	21.9	4.90	6.5	34.7
Nine weeks of age	238	25.7	5.41	8.1	40.2

[1]The mean values, standard deviation, minimum and maximum values are pre corrected for litter size and for difference in daily age at weighing on Thursdays.
[2]N are the number of piglets used in the weight study.

There was no significant difference in weight for the two weaning age groups between births up to five weeks of age. Piglets weaned at seven weeks weigh more from six weeks up to nine weeks of age, compared with piglets weaned at five weeks ($P<0.001$). At nine weeks of age the difference in weight between the two weaning age groups was 4.3 kg ($P<0.001$). Figure 2 shows least square means on weight for the two weaning age groups. Two litters weaned at four weeks of age were excluded in the figure.

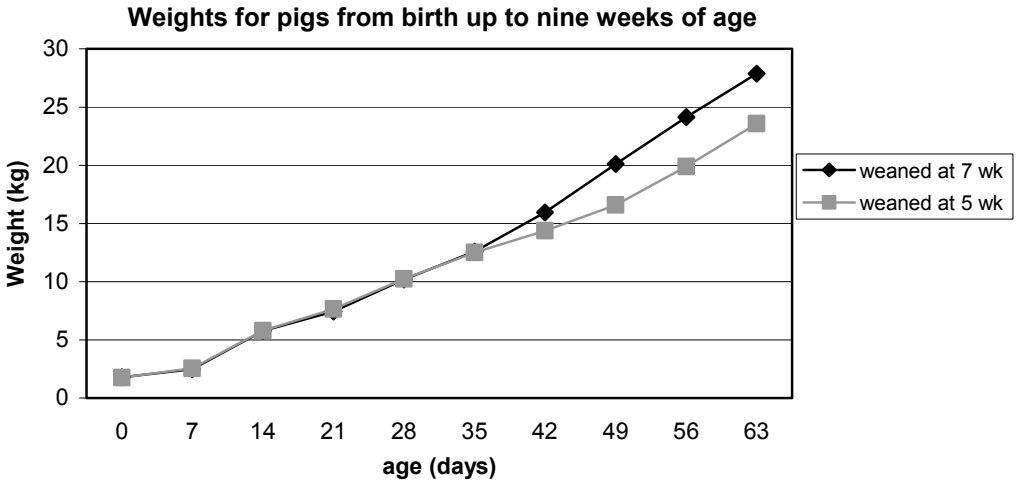


Figure 2. Weights for the two treatments under the entire study (ls-means).

There was a significant difference in weight variation within litters between the two weaning age groups. The piglets weaned at seven weeks had an average variation coefficient of 13.1 % at nine weeks, while piglets weaned at five weeks had an average coefficient variation of 17.1 % at nine weeks. Two small litters from the group weaned at seven weeks were excluded in this calculation, since their litters only contained four and five piglets.

6.2 Growth rate

Table 5 shows the mean values of the daily growth rate at different ages for all piglets in the study.

Table 5. Mean values, standard deviations, minimum and maximum values of growth rate at different ages N=238

Daily growth rate*, g/day	Mean	SD	Min	Max
Between birth and one week of age	178	87	-155	391
Between first and second week of age	387	126	-40	736
Between second and third week of age	232	127	-311	517
Between third and fourth week of age	368	152	56	1610
Between fourth and fifth week of age	312	168	-669	736
Between fifth and sixth week of age	382	186	-95	855
Between sixth and seventh week of age	478	202	75	1027
Between seventh and eight week of age	528	162	-477	962
Between eight and ninth week of age	533	197	-715	1266

*The mean values, standard deviation, minimum and maximum values are pre corrected for litter size and for difference in daily age at weighing on Thursdays.

The first five weeks there was no difference in the daily growth rate between the two treatments. There was a decrease in the growth rate for both weaning age groups the first week in the family pens. Piglets weaned at seven weeks had a higher growth rate between five to eight weeks of age, compared with piglets weaned at five weeks ($P<0.001$). There was no difference in growth rate between the two treatments the last week of the study. There was a reduction in the growth rate for both treatments the first week after weaning. The piglets weaned at five weeks had a decrease in growth rate of 17.8 % compared with the growth rate the week before weaning. The piglets weaned at seven weeks had a decrease in growth rate of 3.5 % compared with the growth rate the week before weaning. Piglets weaned at seven weeks had an average growth rate of 399 g/day from birth up to nine weeks of age. Piglets weaned at five weeks had an average growth rate of 328 g/day from birth up to nine weeks of age. Figure 3 shows daily growth rate for the two treatments. Two litters weaned at four weeks of age were excluded in the figure.

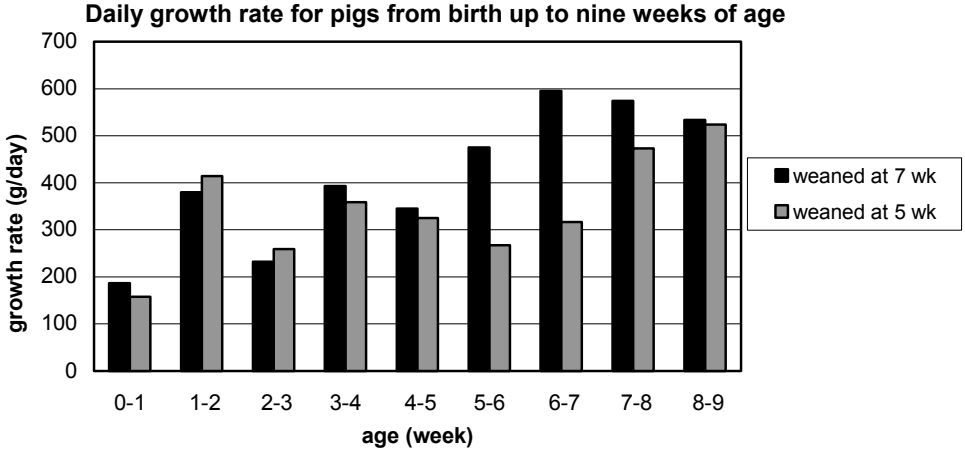


Figure 3. Growth rate for the two treatments in the study.

The energy intake in MJ OE/ kg growth for the piglets in the two treatments did not differ much. Piglets weaned at seven weeks of age had an average intake of 32.4 MJ OE/kg growth and the piglets weaned at five weeks of age had an average intake of 32.3 MJ OE/kg growth.

6.3 Activity

All parameters used in the scan sampling study of the active behaviours are presented in table 6 as mean values of all registrations on piglets from both weaning treatments. The mean values are the number of piglets per litter in each activity, at each scan.

Table 6. Mean values, standard deviations, minimum and maximum values of the scan sampling observations on pigs N=68 (17 litters observed 4 times)

Activity behaviour	Mean[1]	SD	Min	Max
Resting	4.5	1.5	2.1	7.8
Active	2.6	1.3	0.5	6.0
Rooting in the straw[2]	1.5	1.1	0.1	5.0
Seeking food in the feeder[2]	1.0	0.4	0.3	2.0
Seeking water	0.3	0.2	0	1.0

[1]The mean values, standard deviations, minimum and maximum values has been pre corrected for litter size and multiplied so that all litters were in a theoretical size of 10 piglets.
[2]N=63, no registrations on these two behaviours were made in week 5 for piglets weaned at 7 weeks in pen 1.

Number of piglets resting under one behavioural observation at eight weeks is presented in figure 4, as mean values of all piglets.

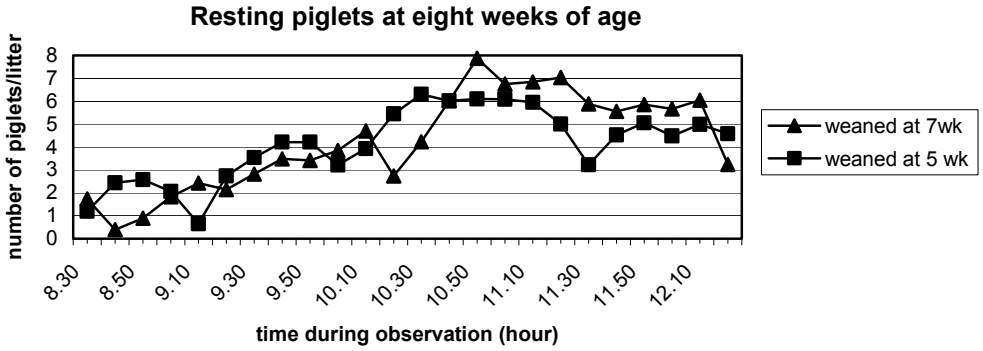


Figure 4. Numbers of piglets resting during the observation period. The mean values have been pre corrected for litter size and multiplied so that all litters were in a theoretical size of 10 piglets.

Figure 5 shows the mean values of piglets resting per box at different weeks, for the two weaning age groups.

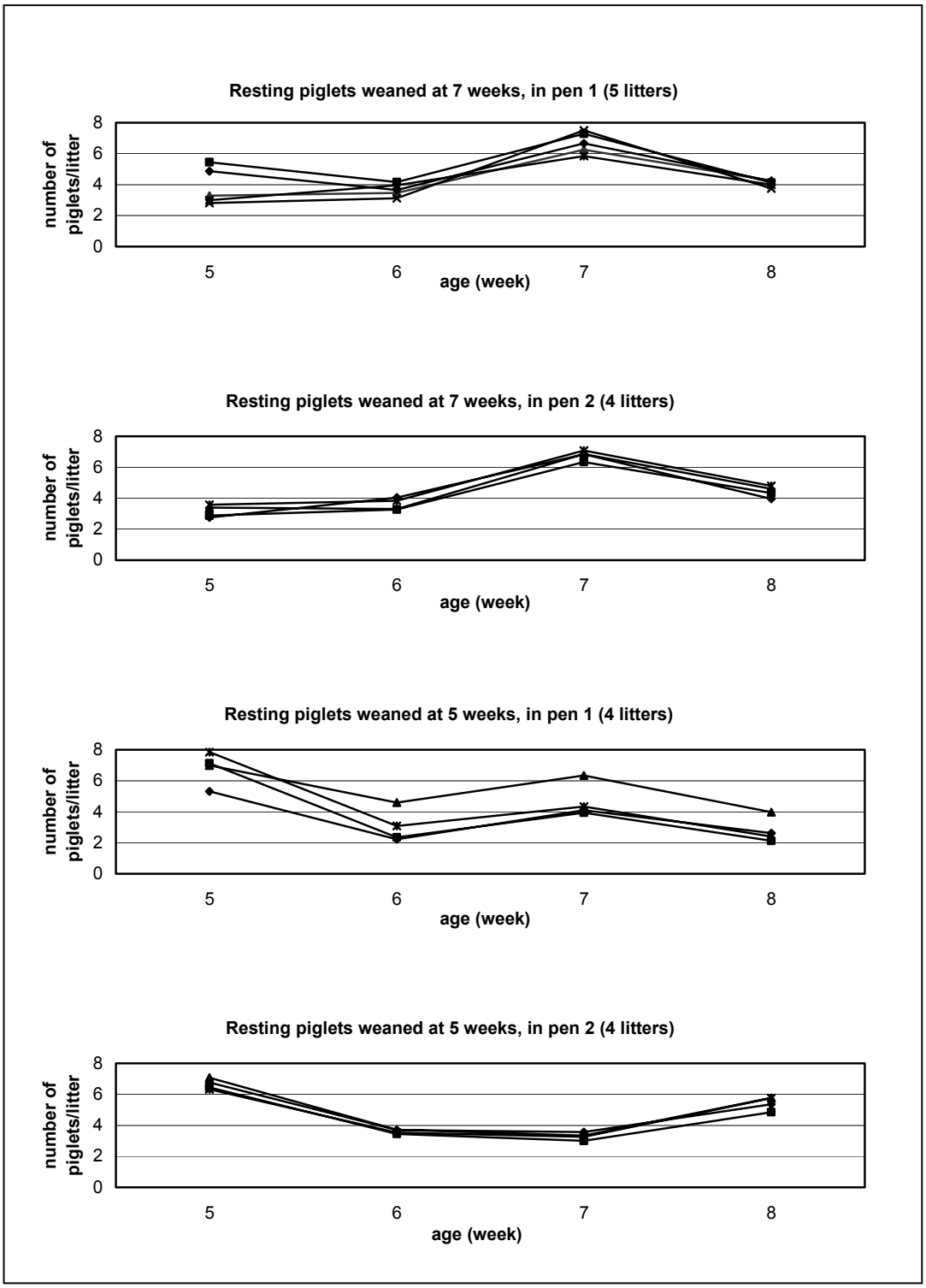


Figure 5. Mean values of registrations of resting piglets.

The day after weaning piglets from both weaning age groups were resting more, than the other weeks of the study ($p<0.001$). At five weeks of age, the piglets weaned at five weeks were resting more compared with the piglets weaned at seven weeks ($p<0.001$). At seven weeks of age the piglets weaned at seven weeks were resting more compared with the pigs weaned at five weeks ($p<0.001$). During week six, seven and eight of the scan sampling the piglets weaned at five weeks were rooting more in the straw than piglets weaned at seven weeks ($p<0.001$). At six, seven and eight weeks of age the piglets weaned at seven weeks were more active than the piglets weaned at five weeks ($p<0.001$). If activity and rooting in the straw are added together in the analyses there was no significant difference in activity between the two treatments at six, seven and eight weeks of age. The first two weeks of the scan sampling, during five and six weeks of age, the piglets weaned at five weeks were more often at the water nipples than the piglets weaned at seven weeks ($p=0.002$ and $p=0.011$). At eight week of age the piglet weaned at seven weeks were more in the feeder than piglets weaned at five weeks ($p=0.002$). Figure 6, 7, 8, 9 and 10 shows the least square mean values of the activity behaviours recorded in the scan sampling observation for the two weaning age groups.

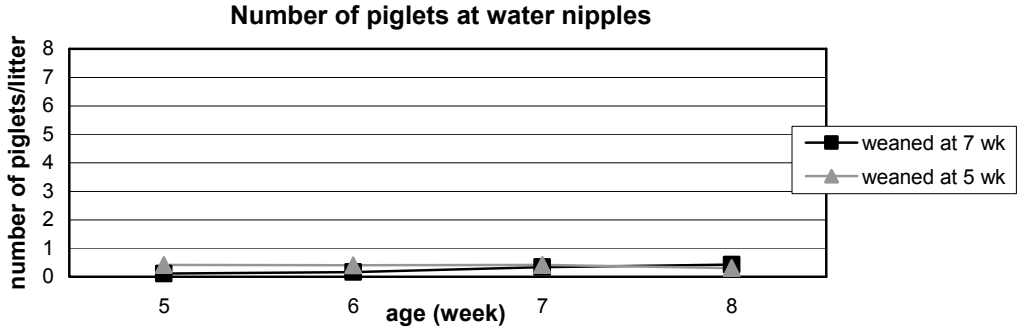


Figure 6. Number of piglets at water nipples.

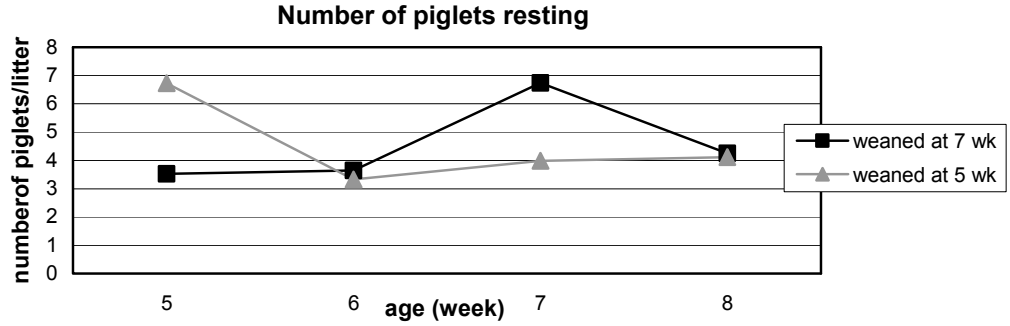


Figure 7. Number of piglets resting.

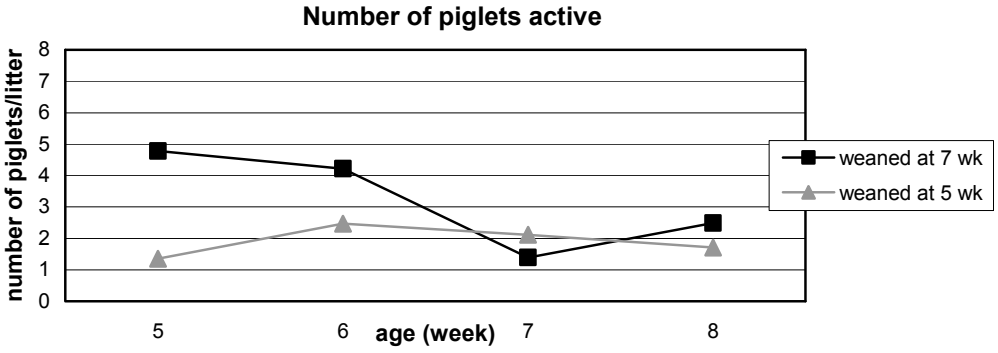


Figure 8. Number of piglets active.

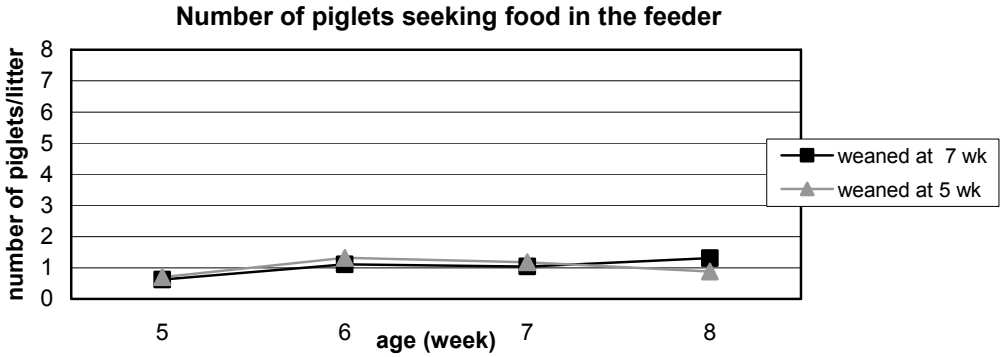


Figure 9. Number of piglets seeking food in the feeder.

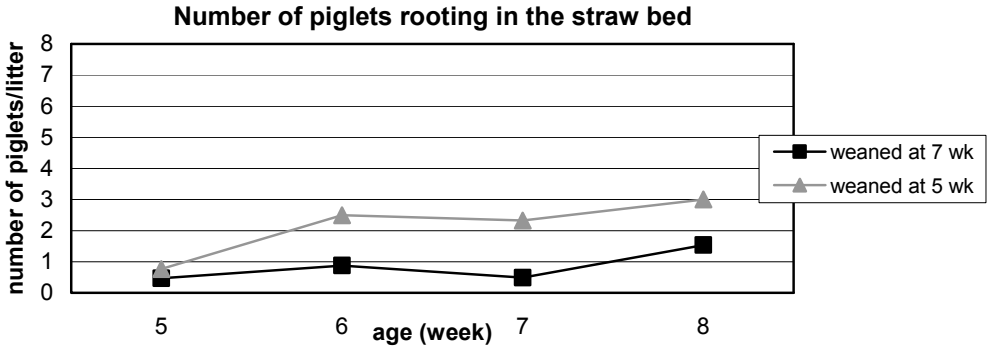


Figure 10. Number of piglets rooting in the straw bed.

6.4 Social behavior

The three parameters used in the social behaviour observation of the piglets are presented in table 7 as mean values of all registrations for both weaning age groups, e.g. all piglets

in the study. The presented mean values are the total number of social behaviour carried out during one hour of piglets in one pen.

Table 7. Mean values, standard deviations, minimum and maximum values of the number litters and observation for each of the social behaviours N=68 (17 litters and 4 observations)

Social behaviour	Mean[1]	SD	Min	Max
Aggression	10.7	6.3	1	27
Belly nosing	2.2	4.5	0	26
Sucking	1.5	1.8	0	8

[1]The mean values, standard deviation, minimum and maximum values are pre divided and multiplied with factors so that the values are per hour.

There was a significant difference in aggression between the two weaning age groups at five weeks in the behavioural observations, the newly weaned piglets were less aggressive ($p<0.001$, see figure 11). At six and eight weeks of age the piglets weaned at five weeks had a higher frequency of sucking compared with the piglets weaned at seven weeks ($p<0.001$). The piglets weaned at five weeks also had a higher frequency in belly nosing behaviour at six and eight weeks of age compared with the piglets weaned at seven weeks ($p=0.023$ and $p=0.029$). At seven week of age there was no significant difference in sucking and belly nosing behaviour between the two weaning age groups. Figures 11, 12 and 13 show the least square mean values of the social behaviours recorded for the two weaning age groups.

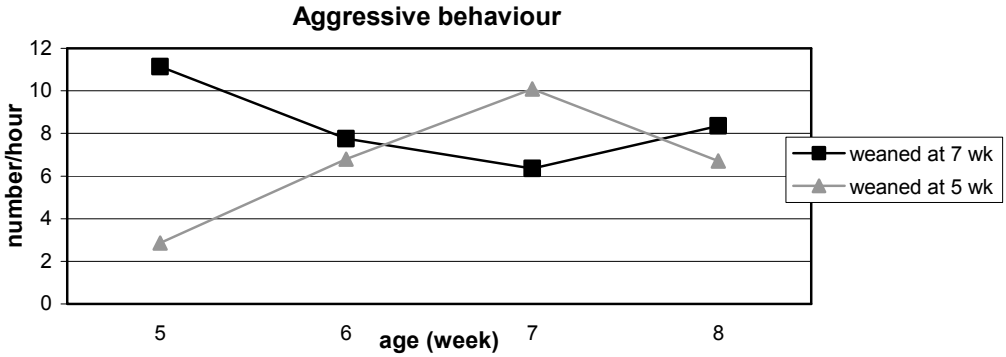


Figure 11. Least square mean values on aggressive behaviour for the two weaning age groups.

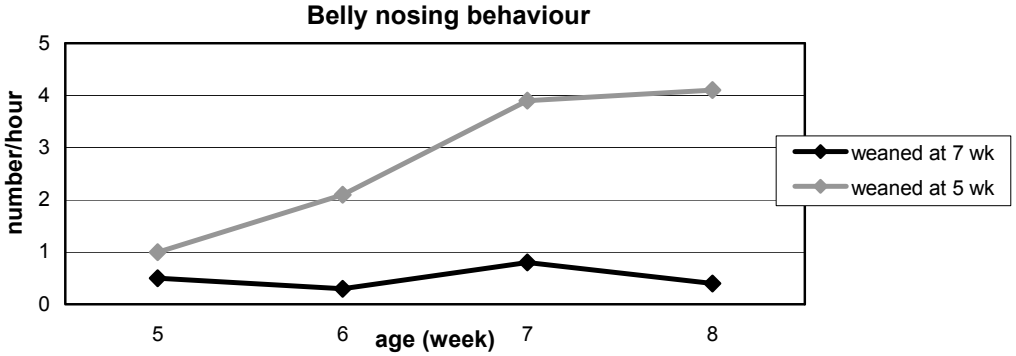


Figure 12. Least square mean values on sucking behaviour for the two weaning age groups.

Figure 13. Least square mean values on belly nosing behaviour for the two weaning age groups.

There was a difference in belly nosing at seven and eight week of age, for the piglets weaned at five weeks in pen 2 compared with the other piglets ($p<0.001$ and $p=0.002$). Two of the four litters in this pen were weaned at four weeks of age. Figure 14 shows the least square means on belly nosing for the piglets in different pens.

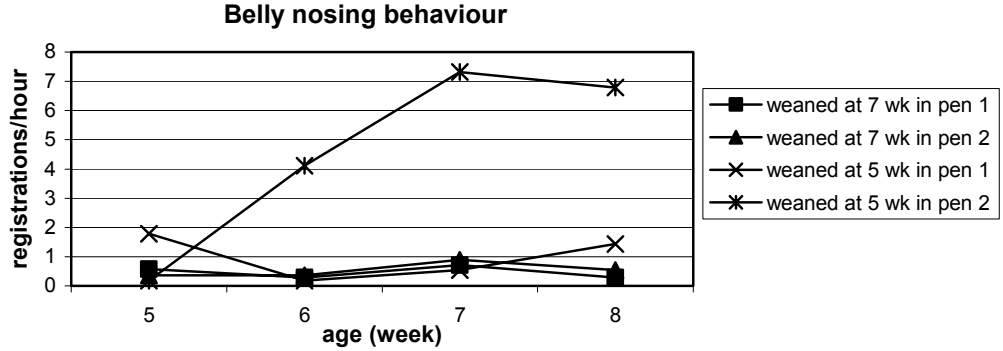


Figure 14. Least square mean values of belly nosing behaviours for all piglets.

Figure 15 shows the mean values of the registrations on belly nosing behaviour for the litters weaned at 5 weeks in pen 2.

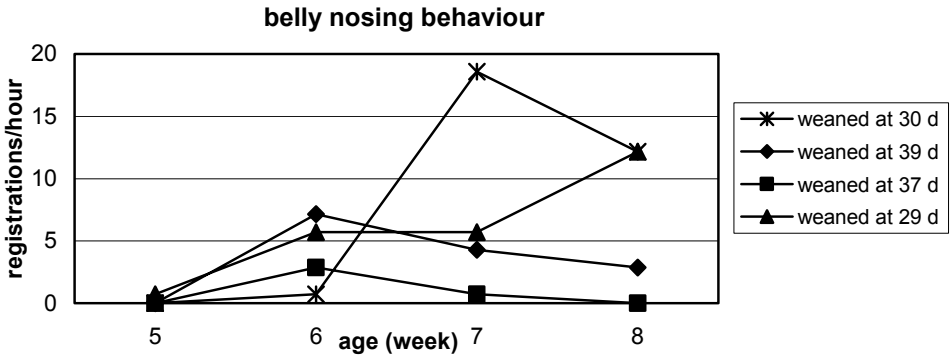


Figure 15. Mean value of belly nosing behaviours for piglets weaned at 5 weeks in pen 2.

6.5 Correlations between parameters

There was a positive correlation between aggressive behaviour and sucking behaviour for piglets weaned at seven weeks (p=0.028). No other significant correlations between the social behaviours were found. There were no correlations found between the different behaviours and growth rate. Correlations were found within some behaviours between weeks of observations (see table 8).

Table 8. Correlations between behaviours registered several times

Behaviour	Correlations (week in the study)		
	5 to 6	6 to 7	7 to 8
Aggressive	0.28	0.34	0.39
Resting	0.04	0.81	0.27
Seeking feed in the feeder	0.66	0.25	0.09

7. Discussion

7.1 Weight and growth rate

A high growth rate was found for both weaning age groups. The piglets weaned at five weeks grew 328 g/day in average and the piglets weaned at seven weeks grew 399 g/day in average. The average growth rate of piglets born at Funbo-Lövsta, from birth to nine weeks of age is 275 g/day (Rydhmer, 2005).

There was a difference in weights between the two weaning age groups from 6 weeks up 9 weeks of age. The piglets weaned at seven weeks had a higher growth rate from five to

eight weeks of age compared with the piglets weaned at five weeks. Many factors surrounding the piglet can affect its growth. According to Auldist *et al.* (1998) litter size can affect growth. To reduce the effect of litter size pre corrections were made for both weaning age groups. According to Gonyou (1993) and Giles (1998) group size can also have affects on piglet growth. In this study the group sizes per pen are very similar between the two weaning age groups and should not influence on growth of the piglets.

Jensen *et al.* (1989) and Mason *et al.* (2003) showed that teat order affects piglet growth within litters. There were significant differences between the two weaning age groups in variation of weight within litter. At nine weeks of age piglets weaned at five weeks seemed to vary more in weight within litter than the piglets weaned at seven weeks. At five weeks of age there was no difference in variation of weight within litter. Lower variation in weight within litters can be of importance at the time for moving pigs to finishing phase. The lower variation can result in a decreased amount of regrouping and splitting familiar groups at this phase. This can in turn lead to lower aggression and stress as a result of the decreased regrouping and meeting with unfamiliar pigs.

The piglets weaned at five weeks of age were from a higher parity number than those weaned at seven weeks of age. According to Neil (1998) there can be differences in the growth of piglets depending on which parity they are from. Piglets from lower parities tend to grow better than piglets from higher parities. Calculations of the possible effect of parity number on piglet weight were made on data from 2045 piglets born on Funbo-Lövsta research center from 1993-2000. Least square mean values of weight for fourth and fifth parity were calculated with the GLM procedure in SAS. There were no significant differences in weight at birth, three and nine weeks of age between parity four and five. A significant difference was found for weight at weaning (five to six weeks of age). No information on weights at seven weeks of age was available. Since the only difference appeared at five to six weeks of age it is difficult to compare with the piglets in this study as they are weaned at five and seven weeks of age. No pre correction was made for the difference in parity number between the two weaning age groups.

My aim was that the environment surrounding the piglets should be as similar as possible for the two weaning age groups. Both groups were held in the same pens, with similar amount of straw. The temperature was rather low during the entire study. No daily registrations on temperature were made. However registrations were made when the weather was very cold. I think the temperature was lower for the piglets weaned at seven weeks of age compared with the piglets weaned at five weeks of age. In this case there should be a negative effect on the growth for piglets weaned at seven weeks of age since they would use more energy for maintenance than the piglets weaned at five weeks of age. The temperature could affect the growth of the piglets, if the need for body maintenance increased at these temperatures. The temperature should be around 25-30˚C for piglets with a weight of 4-6 kg. For finishing pigs the ideal temperature is between 9˚C and 17˚C. However the bedding and heat lamps helps maintaining the temperature to a thermo neutral zone (Vaarst *et al.,* 2004).

The piglets were fed ad libitum. Thus the piglets were able to compensate for the differences in energy concentration between the two feeds used in the study. Giles (1998), McDonald *et al.* (1995) and Millet *et al.* (2004) showed that piglets could compensate for changes in energy concentrations of the feed by changing their feed intake. But if the energy concentration in the feed is too low (<9 MJ DE/kg), the compensation is incomplete and intake is reduced (McDonald *et al.,* 1995). The results for calculations of net energy intake in this study showed that the amount of energy intake did not differ between the two weaning age groups. The piglets fed the diet with a lower energy concentration seemed to compensate with a higher intake. The energy content in both feeds for the piglets in this study is over 12 MJ OE/kg feed and there should not be a problem of reduced intake as a result of low energy content in feeds.

Piglets have a high demand for amino acid content in the feed and the need is higher for younger piglets (see table 9). If the piglets are given a feed with a too high content of protein there is an increased risk for the piglet to develop diarrhoea (Simonsson, 1994). The main deficiencies in case of available protein in the feed for pigs are of lysine, methionine, threonine and tryptophan. There are some other essential amino acids as well, but the need for these is accomplished by counting for crude protein content in the feed (McDonald *et al.,* 1995). There seemed to be no diarrhoea for any of the piglets in this study, although that is just a visual impression. The lysine and methionine content for the two feeds in this study is lower than the needs for lysine and methionine at weight between 11 and 23 kg, according to table 2 and 9. The feed Klara has a lysine, methionine and threonine content of 54, 65 and 140 % according to the needs and feed 411 has a content of 61, 95 and 185 %. At nine weeks of age both weaning age groups have a similar growth rate but there is differences in growth rate from five to eight weeks of age. The differences in amino acid contents in the two feeds can be one reason for the differences in growth rate between the weaning age groups. It would of course have been better if both groups could have been fed the same feed.

Table 9. Amino acids recommendations for piglets from 3 to 22 kg (Tokach *et al.*, 2003)

Amino acids	Weight range (kg)			
	3 to 5	5 to 7	7 to 11	11 to 23
Lysine*	1.0	1.0	0.8	0.8
Methionine	0.3	0.3	0.2	0.2
threonine	0.6	0.6	0.5	0.2
Tryptophan	0.2	0.2	0.1	0.1

*True digestible amino acids in g/MJ metabolizable energy for growing pigs.

The piglets weaned at seven weeks of age had a two week longer period of nursing and milk intake than the piglets weaned at five weeks of age. This can be an important factor influencing the difference in weight and growth between the two treatment groups. Piglets weaned at seven weeks had a 3.5 % decrease in growth rate the first week after weaning. The piglets weaned at five weeks had a 17.8 % decrease in growth rate the first week after weaning. According to the result in the behavioural study there seemed to be no difference in the time spent at the feeder for the two weaning age groups at six weeks of age. Perhaps both weaning age groups are eating similar amounts of feed at this time even though one group is still not weaned. According to Brooks *et al.* (1998) piglets that

eat more solid feed one week pre weaning gain more weight in the two weeks following weaning. On the other hand Brooks *et al.* (1998) also think that if the piglets can choose between milk from the sow and solid feed they prefer milk from the sow. Still there are big differences in solid feed intake within and between litters at six weeks of age. If the piglets are given more feeder space there seems to be an increase in pre weaning intake of solid feed. In this study the piglets had access to much space at the feeder allowing both sow and her litter to feed at the same time. Perhaps this increases the feed intake before weaning and can be a reason of the low decrease in growth rate post weaning for the piglets weaned at seven weeks. According to Williams (2003) a lower growth check after weaning is beneficial for the long-term growth for the pigs. The piglets weaned at seven weeks have a more mature digestive and absorptive capacity compared with the piglets weaned at five weeks the first week after weaning. This can be one reason for the lower decrease in growth rate under the first week after weaning for the piglets weaned at seven weeks.

7.2 Activity

The time of the day for the observations was selected on the thought of recording both an active and a calm period of the pigs. According to Bøe (1993) one of the most active periods of the day is during the first half of the observation time, from 08:30 to 10:30. In my study the piglets seemed be more active in the beginning of the observation, around 8-9. Around 11 pm the piglets seemed to rest more.

The activities in the pens one day after weaning were very similar between the two weaning age groups. The weaning seemed to have the same effect on both weaning age groups, regardless of age. There was a higher frequency of resting the day after weaning in all groups and pens. According to Newberry *et al*. (2001) reduced activity when separated from the mother could be a strategy to stay safe from predators and save energy. He called these patterns and behaviours "the depressive separation theory". There seemed to be very similar patterns in activity for all litters in the same pen. The piglets seemed to follow each other in type of behaviour and function as a big social group. According to Gonoyu (2001) the piglets within litter have very strong bonds to each other and these bonds stays strong during the growth up to adult age. My visual impression of the piglets in this study is in agreement with this statement. Even though the piglets seemed to function as one big social group in the pen, the litters seemed to stay close together within the big group. Even if there were many piglets resting they seemed to rest with their littermates.

7.3 Social behaviour

The environment affects piglet growth and behaviour (Curtis, 1993). Pigs in semi-natural environment spend most of their time foraging, rooting, chewing and exploring the environment. In intensive husbandry the pigs are highly motivated to obtain these exploring activities, even if access of food and straw are limited. This can create

disturbances in the behaviour for pigs held in barren environment and can result in a manipulative behaviour directed towards pen mates. In organic pig production the pigs are raised in a more enriched housing system. This system improves the welfare of the pigs with increased possibilities for explorative activities and decreased oral behaviour on pen mates (Bolhuis *et al.,* 2005). The pens were of four different sizes located in the same unisolated building. There were no big differences in the behaviour of the litters depending on which pen they were staying in. But there was a higher frequency of belly nosing in pen 2 for pigs weaned at five weeks of age. This higher frequency could depend on the fact that two of the litters in this pen were weaned at four weeks of age. To establish a similar number of litters and pigs per pen between the two weaning ages, two litters were placed in pen 2 one week after the first two litters were established in the pen. The higher frequency of belly nosing was not only performed by the two litters weaned at four weeks. The other two litters in the pen also seemed to be belly nosing more than in other pens. Worobec et al. (1999) showed that redirected suckling behaviour can become a habit.

All pigs were staying in the same groups during the entire study. This was on the thought of reducing the effect on aggressive behaviour at weaning between piglets when they are introduced to new pen mates. Pluske et al. (1996) showed that introduction with unfamiliar pigs at a lower age gives less aggressive behaviours at weaning. There seemed to be no difference in aggression at weaning in this study, between the two treatments and there was no increase in the aggressive behaviour at weaning for any of the treatment groups. Instead there seemed to be a decrease in aggressive behaviour the day after weaning. Registration of aggressive behaviour in this study refers only to piglets that was throwing the head, having the mouth open, towards a pen mate. No severe aggressive behaviour or fights were observed. My impression during this study is that there seemed to be no fights at all and almost no heavier aggressive behaviours in any of the weaning age groups.

The registration of the behaviours differed some from the first observation day compared with the other observation days during the study. Regarding to this difference in registrations an extra observation day before start of the real study would have been good. Perhaps not only for the observer, but also so the piglets would get more used of being watched.

There were correlations between different weeks within behaviour. If the piglets in one litter were aggressive week five they were also more aggressive week six. The correlations between different weeks are very similar for aggressive behaviour, regardless of weaning.

8. Concluding remarks

The results showed that the piglets weaned at seven weeks of age grew better than the piglets weaned at five weeks of age. One reason can be the longer period of nursing by the mother for the piglets weaned at seven weeks of age. Another reason can be that the

weaning age groups were given two different feeds during the entire study. Anyhow the piglets weaned at seven weeks of age seemed to manage the weaning better according to the low reduction in growth rate the first week after weaning.

There seemed to be no large differences in piglet behaviour between the two weaning age groups, leading to the conclusion that weaning age did not affect stress related behaviours and activity. A stimulating environment (straw bed, big groups, large feeders and large pens) may be a reason for the low difference in these behaviours between the two weaning age groups.

This study provides no welfare arguments against a weaning age less than seven weeks in organic production. But the difference in piglet growth should be taken into account when discussing optimal weaning age in organic production.

10. References

Algers, B., Jensen, P. and Steinwall L. 1990. Behaviour and weight changes at weaning and regrouping of pigs in relation to teat quality. Applied animal behaviour science. 26, 143-155.

Auldist, D.E., Morrish, L., Eason, P. and King, R.H. 1998. The influence of littersize on milk production of sows. Animal science. 67, 333-337.

Bolhuis, J.E., Schouten, W.G.P., Schrama, J.W and Wiegant, V.M. 2005. Behavioural development of pigs with different coping characteristics in barren and substrate-enriched housing conditions. Applied Animal Behaviour Science. 93, 213-228.

Bøe, K. 1990. The process of weaning in pigs: when the sow decides. Applied Animal Behaviour Science. 30, 47-59.

Bøe, K. 1993. The effect of age at weaning and postweaning environment on the behaviour of pigs. Acta Agriculturæ Scandinavica. 43, 173-180.

Brooks, P.H. and Burke, J. 1998. Behaviour of sows and piglets during lactation. Wageningen press, The Netherlands. 1998. 17:301-331.

Curtis, S.E. 1993. The physical environment and swine growth. Growth in the pig, 93-106.

Dividich, J.L, Noblet, J., Herpin, P., Van Milgen, J. and Quiniou, N. 1998. Thermoregulation. Progress in Pig Science. 229-264.

Dunshea, F.R., Kerton, D.K., Cranwell, P.D., Campbell, R.G., Mullan, B.P., King, R.H., Power, G.N. and Pluske, J.R. 2003. Lifetime and post-weaning determinants of performance indices of pigs. Australian Journal of Agricultural Research. 54, 363-370.

Fraser, D., Milligan, B.N., Pajor, E.A., Phillips, P.A., Taylor, A.A. and Weary, D.M. 1998. Behavioural perspectives on weaning in domestic pigs. Progress in Pig Science. 121-140.

Gade, P.B. 2002. Welfare of animal production in intensive and organic systems with special reference to Danish organic pig production. Meat Science. 62, 353-358.

Gaskins, H.R. 1998. Immunological development and mucosal defence in the pig intestine. Progress in Pig Science. 81-102.

Giles, L.R., Lorschy, M.L., Bray, H.J. and Black, J.L. 1998. Predicting feed intake in growing pigs. Progress in Pig Science. 209-228.

Gonyou, H.W. 1993. The social environment and swine growth. Growth in the pig, 107-118.

Gonyou, H.W. 2001. The social behaviour of pigs. CAB International 2001. Social behaviour in farm animals. 6:147-176.

Held, S. and Mendl, M. 2001. Behaviour of the young weaner pig. The weaner pig: nutrition and management. 273-297.

Hohenshell, L.M., Cunnick, J.E., Ford, S.P., Kattesh, H.G., Zimmerman, D.R., Wilson,M.E., Matteri, R.L., Carrol, J.A. and Lay, D.C., Jr. 2000. Few differences found between early- and late-weaned pig raised in the same environment. Journal of Animal Science. 78, 38-49.

Hultén, F., Lundeheim, N., Dalin, A.-M. and Einarsson, S. 1997. Pre- and post- weaning piglet performance, sow food intake and change in backfat thickness in a group-housing system for lactating sows. Acta vet. Scand. 38, 119-133.

IFOAM, 2005. http://www.ifoam.org

Jensen, P. 1988. Maternal behaviour and mother-young interactions during lactation in free-ranging domestic pigs. Applied Animal Behaviour Science. 20, 297-308.

Jensen, P. 1995. The weaning process of free-ranging domestic pigs: within- and between- litter variations. Ethology. 100, 14-25.

Jensen, P., and Recén, B. 1989. When to wean- Observations from free-ranging domestic pigs. Applied Animal Behaviour Science. 23, 49-60.

Jordbruksverket. 2002. Byggnader för ekologiska slaktsvin, jordbruksinformation 2-2002.

Jordbruksverket. Swedish board of Agriculture, 2005. Yearbook of agricultural statistics 2004. Sweden.
http://www.jordbruksverket.se/download/18.7502f61001ea08a0c7fff102721/Kap+11.pdf

Kelly, D. 1998. Gut development and regulation. Progress in Pig Science. 103-120.

KRAV, 2005.
http://statistik.krav.se/rPortfolio/generate/paramViewer.asp?ReportName=C%3A%5CProgram+Files%5CCrystal+Decisions%5CReport+Application+Server+9%5CReports%5CLantbruksstatistik%5CDjurhallning%5C1AntalGodkDjurproducenter%2Erpt&ActualHTML=1AntalGodkDjurproducenter

KRAV, regler för KRAV-certifierad production. 2005. KRAV ekonomisk förening, Uppsala.

KRAV, regler för KRAV-certifierad production. 2004. KRAV ekonomisk förening, Uppsala.

Lund, V. 2003. Djurhälsa och välfärd i ekologiskt lantbruk. Centrum för uthålligt lantbruk, CUL. SLU, Uppsala.

Mason, S.P., Jarvis, S., and Lawrence, A.B. 2003. Individual differences in responses of piglets to weaning at different ages. Applied Animal Behaviour Science. 80, 117-132.

McDonald, P., Edwards, R.A., Greenhalgh, J.F.D. and Morgan, C.A. 1995. Animal nutrition, fifth edition. Pearson Education Limited, London, 607 pp.

Millet, S., Raes, K., Van den Broeck, W., De Smet, S. and Janssens, G.P.J. 2004. Performance and meat quality of organic versus conventionally fed and housed pigs from weaning till slaughtering. Meat Science. 69, 335-341.

Neil, M., 1998. Överlevnad och tillväxt hos smågrisar. Slutrapport, 1998.

Newberry, R., Swanson, J. 2001. Breaking social bonds. CAB International 2001. Social behaviour in farm animals. 11:307-331.

O'Connell, N.E., Beattie, V.E., Sneddon, I.A., Breuer, K., Mercer, J.T., Rance, K.A., Sutcliffe, M.E.M. and Edwards, S.A. 2004. Influence of individual predisposition, maternal experience and lactation environment on the responses of pigs to weaning at two different ages. Applied Animal Behaviour Science. 90, 219-232.

O'Connell, N.E., Beattie, V.E. and Weatherup, R.N. 2001. Influence of feeder type on the performance and behaviour of weaned pigs. Livestock Production Science. 74, 13-17.

Parker, R.O., Williams, P.E.V., Aherne, F.X. and Young, B.A. 1980. Serum concentration changes in protein, glucose, urea, thyroxine and triiodothyronine and

thermostability of neonatal pigs farrowed at 25 and 10˚C. Canadian Journal of Animal science. 60, 503-511.

Pluske, J.R., Dong, G.Z. 1998. Factors influencing the utilization of colostrum and milk. Wageningen Pers, 1998, The Netherlands. The lactating sow. 3:45-70.

Pluske, J.R., Hampson, D.J. and Williams, I. H. 1997. Factors influencing the structure and function of the small intestine in the weaned pig: a review. Livestock Production Science. 51, 215-236.

Pluske, J.R. and Williams, I.H. 1996. Reducing stress in piglets as a means of increasing production after weaning: administration of amperozide or co-mingling of piglets during lactation? Animal Science. 62, 121-130.

Reeds, P.J., Burrin, D.G., Davis, T.A., Fiorotto, M.A., Mersmann, H.J. and Pond., W.G. 1993. Growth regulation with particular reference to the pig. Growth of the pig, 1-32.

Rydhmer, L., 2005. Personal communication.

Simonsson, A., 1994. Näringsrekommendationer och fodermedelstabeller till svin. Husdjur 75. SLU info rapporter. Swedish University of Agricultural Sciences, Uppsala, 71 pp.

Simonsson, A., Andersson, K., Andersson, P., Dalin, A.-M., Jensen, P., Johansson, E., Jonasson, L., Olsson, A.-C., and Olsson, O. 1997. Svinboken. LTs förlag. Stockholm.

Spjut, L., Rydhmer, L., Algers, B. and Rundgren, M. 2003. Påverkar suggors grymtande under digivningen smågrisarnas tillväxt? Examensarbete 2003:50, Veterinärmedicinska fakulteten, SLU.

Stangel, G. and Jensen, P. 1991. Behavious of semi-naturally kept sows and piglets (except suckling) during 10 days postpartum. Applied Animal Behvaiour Science. 23, 223-236.

Tokach, M.D., Dritz, R.D., Goodband,R.D. and Nelssen, J.L. 2003. Nutritional requirements of the weaned pig. Wageningen Academic publisher. 2003. Weaning the pig concepts and consequences. 11:259-271.

Vaarst, M., Roderick, S., Lund, V., Lockeretz, W. 2004.Animal health and Welfare in Organic Agriculture. CABI Publishing, Wallingford, UK.

Weary, D.M. and Frasier, D. 1997. Vocal response of piglets to weaning: effect of piglet age. Applied Animal Behaviour Science. 54, 153-160.

Weary, D.M., Appleby, M.C., Fraser, D. 1999. Responses of piglets to early separation from the sow. Applied Animal Behaviour Science. 63, 289-300.

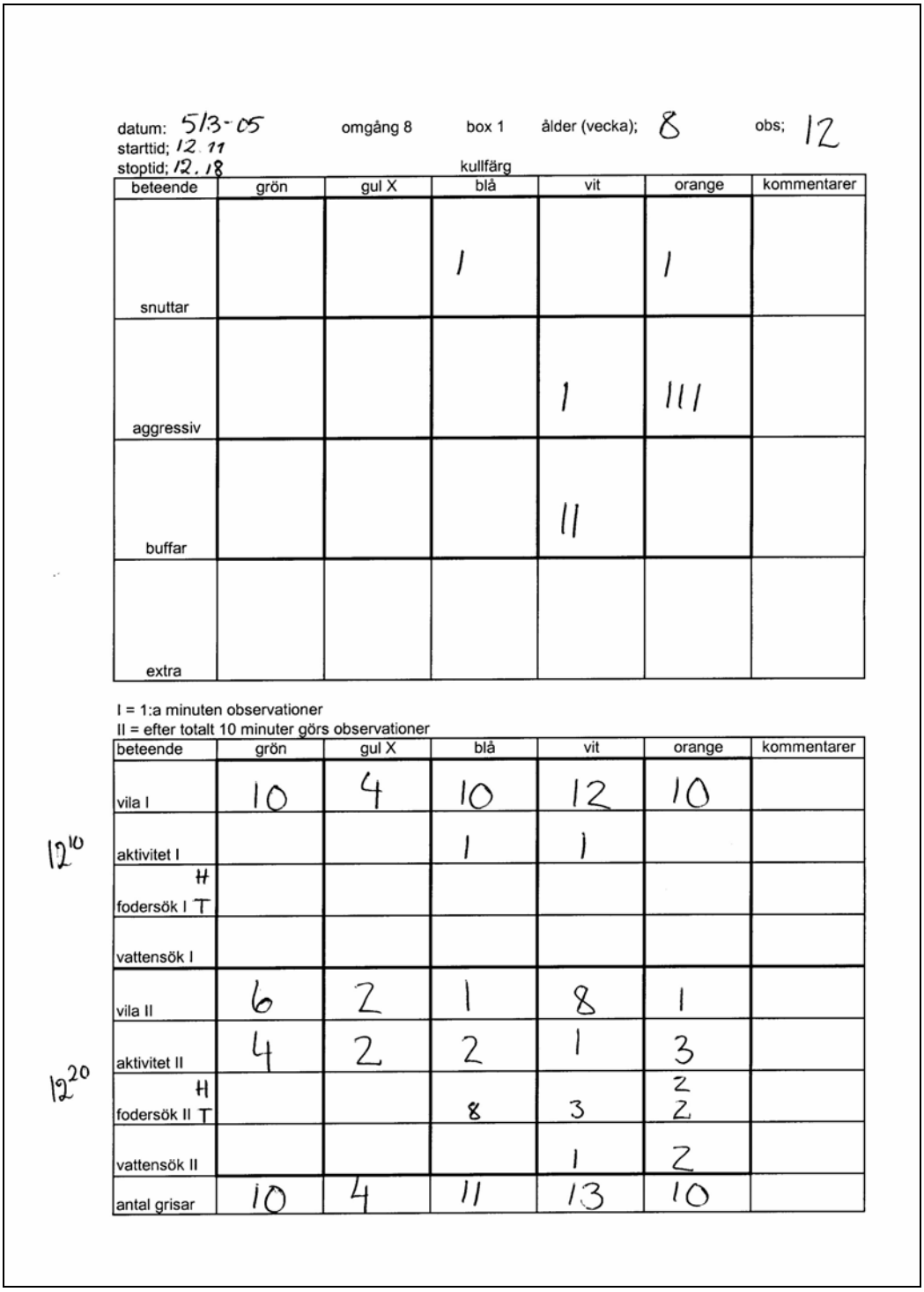
Williams, I.H. 2003. Growth of the weaned pig. Wageningen Academic publisher. 2003. Weaning the pig concepts and consequences. 2:17-31.

Worobec, E.K., Duncan, I.J.H. and Widowski, T.M. 1999. The effects of weaning at 7, 14, and 28 days on piglet behaviour. Applied Animal Behaviour Science. 62, 173-182.

Xu, R.J., Wang, F. and Zhang, S.H. 2000. Postnatal adaption of the gastrointestinal tract in neonatal pigs: a possible role of milk-borne growth factors. Livestock Production Science. 66, 95-107.

Appendix 1

Figure 2. Protocol for behavioral studies.



datum: 5/3-05 omgång 8 box 1 ålder (vecka); 8 obs; 12
starttid; 12.11
stoptid; 12.18
kullfärg

beteende	grön	gul X	blå	vit	orange	kommentarer
snuttar			1		1	
aggressiv				1	111	
buffar				11		
extra						

I = 1:a minuten observationer
II = efter totalt 10 minuter görs observationer

beteende	grön	gul X	blå	vit	orange	kommentarer
vila I	10	4	10	12	10	
12^10 aktivitet I			1	1		
fodersök I H T						
vattensök I						
vila II	6	2	1	8	1	
aktivitet II	4	2	2	1	3	
12^20 fodersök II H T			8	3	2 2	
vattensök II				1	2	
antal grisar	10	4	11	13	10	