Sow influence on neonatal survival: a special focus on colostrum

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The main cause of early postnatal deaths in piglets is hypothermia due to an inadequate intake of colostrum. Colostrum consumption is the outcome of complex interactions between the sow, the piglet, the litter and the environment. The sow may have an impact on many factors that are determinant for colostrum intake and chances of survival, such as piglet weight, maturity and vitality at birth, or within-litter variation in birth weight. Colostrum intake also depends on the ability of the sow to produce colostrum in sufficient quantity to fulfill the needs of the whole litter. Maternal stress during gestation may increase piglet morbidity and mortality up to weaning, presumably by affecting the ontogeny of the fetal immune system, but also IgG contents in colostrum and IgG transfer to newborn piglets. Ways to reduce neonatal mortality through maternal feeding during gestation are largely investigated. Feeding strategies generally failed to increase piglet birth weight but led to more promising results on piglet maturity and vitality at birth and on the acquisition of passive immunity. There is some evidence that maternal feeding during the peripartal period may influence both the quantity and the quality of colostrum; this needs however to receive further attention.

Introduction

Polytocous species like the pig produce a large number of offspring relatively undeveloped (Edwards 2002). Neonates have to compete for maternal resources, and the least able to compete will die shortly after birth. During the last few decades, a substantial increase in piglet mortality before weaning was observed in association with selection of sows to increase prolificacy and carcass lean merit. Piglet mortality has become a major source of economic loss in pig production and a social and ethical problem related to welfare concerns.

There is a large body of evidence that the main cause for piglet postnatal deaths is the lack of recovery from neonatal hypothermia, which is itself due to a low consumption of colostrum by newborn piglets (Edwards 2002, Le Dividich *et al*. 2005). Ultimately, hypothermia leads to starvation and crushing. Colostrum consumption and thus piglet survival are the outcome of complex interactions between the sow, the piglet, the litter and the environment (Figure 1). Colostrum intake depends on the ability of piglets to suckle quickly after birth. It is therefore influenced by piglet birth weight, maturity and vitality. Factors related to litter mainly involve size and within-litter variation in birth weight. Factors related to the sow involve farrowing

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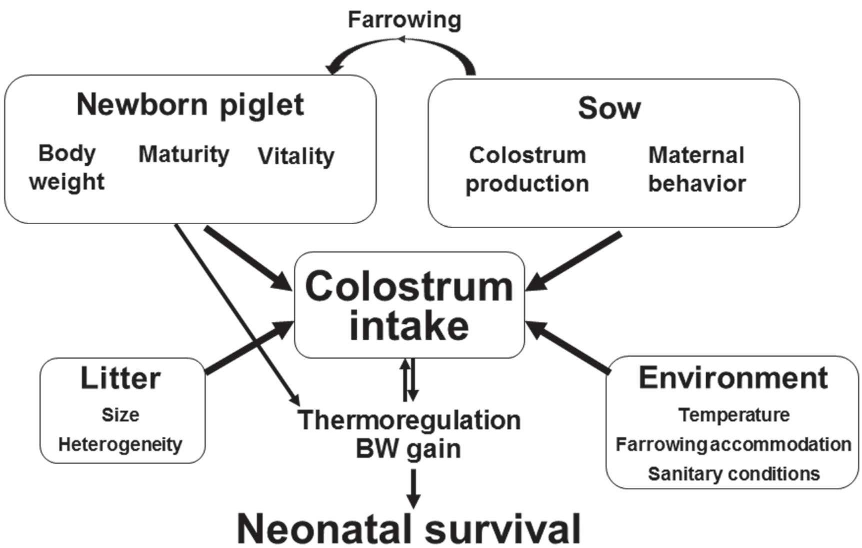

Fig. 1 Schematic representation of the main factors that influence colostrum intake, and thereby piglet survival.

duration, colostrum production, maternal behavior, and health status. Lastly, amongst factors related to environment, ambient temperature and farrowing accommodation could play a major role (for review see Baxter *et al*. 2013).

The purpose of the present review is to briefly update knowledge on the importance of colostrum for neonatal survival and to review the maternal influence on colostrum production and consumption. Clues to increase colostrum intake and neonatal survival via maternal feeding strategies will be discussed. Because survival during the first days after birth was not always recorded, survival performance up to weaning is also considered.

Definition of colostrum

Colostrum is the first secretion of the mammary gland; it is characterized by high concentrations of immunoglobulins (Ig), and contains lower concentrations of lactose and lipids than milk. Lactogenesis starts at about 90 days of gestation in the sow. Lactogenesis I refers to the preparation of mammary tissue for the synthesis of milk components. Lactogenesis II, during which colostrum excretion occurs, starts shortly before parturition and lasts for approximately 24 h after the onset of parturition.

Colostrum intake by individual piglets can be estimated from the piglet weight gain during the first 24 h after birth. A prediction equation method allows this estimation (Devillers *et al*. 2004) and colostrum yield can be calculated as the sum of intakes by each piglet of the litter.

Importance of colostrum in relation with neonatal survival

Roles of colostrum for newborn piglets

Like many mammals, piglets at birth are abruptly exposed to a cold environment, being at least 10°C below their thermal neutrality. Thus, maintenance of homeothermia by activation of thermoregulatory mechanisms is pivotal. Unlike other mammals, the newborn piglet is devoid of thermogenic brown adipose tissue. Moreover, compared to most other mammals, its overall lipid content is low (less than 2%, Seerley & Poole 1974). Hepatic and muscle glycogen thus represent the main stores provisioning heat-producing tissues with energy. In the French Large White breed, selection for reduced carcass fatness has lowered fat and liver glycogen contents (Canario *et al*. 2007), therefore exacerbating the problem for newborn piglets. Energy stores are completely depleted within 12 to 17 h after birth in the absence of colostrum intake (Theil *et al*. 2011). Colostrum is thus essential for early post-natal survival as it will be a substitute to glycogen in providing energy for thermoregulation. Colostrum ingestion also assists the newborn piglets in their physiological adaptation after birth by stimulating energy metabolism and thermoregulatory mechanisms (Herpin *et al*. 2005) and the development of the gastrointestinal tract (Xu *et al*. 2002).

Colostrum is also crucial in providing the newborn piglet with passive immunity. At birth, the pig is devoid of Ig, and its immune system has not been stimulated by antigens (Rooke & Bland 2002). Porcine colostrum is rich in IgG that provide systemic immunity. IgG concentrations in colostrum quickly decrease within 24 h after the onset of farrowing and are low in milk. Porcine colostrum also contains IgA, which play an essential role in protecting the intestinal mucosa from pathogens, thereby preventing neonatal diarrhea and reducing neonatal mortality. Colostrum also contains immune cells and immunomodulatory factors that play a role in the response to pathogens and that may help maturation of the piglet's own immune system (Salmon *et al*. 2009).

Relations between colostrum intake and piglet birth-to-weaning survival

The relations between colostrum intake during the first 24 h after birth and piglet survival and health were recently reviewed (Quesnel *et al*. 2012) and hence will be only briefly summarized in the present paper. Individual colostrum intake during the first 24 h after birth averages 250-300 g (Devillers *et al*. 2007, Quesnel 2011), and ranges from 0 to more than 700 g. A low consumption of colostrum (below 200 g) considerably decreases piglet survival until weaning (Devillers *et al*. 2011). At high colostrum intakes (>400 g), a positive correlation is also observed between colostrum consumption and survival rate during the first day after birth (Theil & Lauridsen 2012). With regard to immunity, plasma IgG concentrations in piglets at 24 h of age increase with colostrum intake (Klobasa *et al*. 1981). Because colostrum IgG concentrations fall rapidly, piglets born later during farrowing may consume a colostrum poorer in IgG and thus have lower plasma IgG concentrations at 24 h than first-born piglets (de Passillé *et al*. 1988, Foisnet *et al*. 2011). However, beyond a certain amount of colostrum ingested (about 200 g), plasma IgG concentrations do not increase further (Devillers *et al*. 2011) so that even a relatively low consumption of colostrum can provide passive immunity to piglets. In conclusion, a suboptimal consumption of colostrum increases the risk of neonatal mortality and may affect the immune status and susceptibility to infections until weaning.

Sow influence on piglet maturity and colostrum consumption

Maternal effect on birth weight and maturity

Birth weight is the most important factor in successful recovery from postnatal hypothermia (Kammersgaard *et al*. 2011) and a critical factor for preweaning survival (Roehe & Kalm 2000, Tuchscherer *et al*. 2000, Baxter *et al*. 2008). The relation between birth weight and piglet survival however does not exist across breeds. For example, Meishan piglets have a better survival rate than piglets from European breeds although they are lighter at birth, because they possess greater lipid stores and have improved hepatic metabolic ability (Fainberg *et al*. 2012). Within a given genotype, Leenhouwers *et al*. (2002) reported that piglets with a higher genetic merit for survival had increased relative organ weights, cortisol concentrations, and glycogen and fat reserves. Therefore, both birth weight and maturity may be predisposing factors for neonatal losses, as previously suggested (van der Lende *et al*. 2001).

One of the reasons for the effect of birth weight on survival is its major influence on colostrum intake. An overall increase in colostrum intake of 28 g per 100 g increase in birth weight was reported (Devillers *et al*. 2007). Colostrum intake by piglets was also shown to be negatively related with within-litter variation in birth weight (Devillers *et al*. 2007). Consistently, an increased within-litter variation in birth weight was identified as a negative factor for piglet survival (Milligan *et al*. 2002, Damgaard *et al*. 2003).

Maternal effect on vitality at birth: influence of the farrowing process

Piglet vitality at birth involves the ability to quickly reach the teat and to extract colostrum. Vitality immediately after delivery is related to the process of fetal maturation (inherent vitality) and to the process of parturition and the associated risk of hypoxia. The degree of intra-partum hypoxia plays a major influence on latency to suckle and thus on survival (Herpin *et al*. 1996). Hypoxia increases with increasing farrowing duration, litter size, and late position in the birth order (Herpin *et al*. 1996).

Colostrum production

Colostrum yield varies greatly among sows, from less than 1.5 kg to more than 6.0 kg, with an average value of 3.5 kg for the 24 h after the onset of parturition (Figure 2). The first step in identifying the factors affecting colostrum yield is to establish whether sow or piglet characteristics are most important. Colostrum is freely available during the first 12 hours after parturition (de Passillé & Rushen 1989) and regular suckling by piglets to maintain lacteal secretion and initiate lactation is not required until 16-24 hours post-partum (Atwood *et al*. 1995, Theil *et al*. 2006). Consistently, litter size and litter weight do not influence colostrum yield or piglet growth during early lactation (Devillers *et al*. 2007, Figure 2). Furthermore, piglets which were bottle-fed with colostrum during the first 24 h after birth and kept in a similar environment to sow-reared piglets, had a voluntary intake exceeding 450 g/kg birth weight, which was twice the average consumption of sow-reared piglets (Devillers *et al*. 2004). Together, these data indicate that the sow likely produces less colostrum than could be consumed by the litter.

Colostrum production is under hormonal control. The prepartum peak of prolactin is essential for lactogenesis in swine and is brought about by the drop in progesterone concentrations (Farmer *et al*. 1998). A very low production of colostrum ($\sim$ 1 kg) was associated with delays in progesterone decrease and in prolactin increase during the prepartum period (Foisnet *et al*. 2010). Furthermore, a reduced growth rate and an increased mortality rate in early lactation were reported in piglets from sows that had greater circulating concentrations of progesterone immediately after farrowing (de Passillé *et al*. 1993, Quesnel *et al*. 2013a). We also recently reported that sows with a lower colostrum yield ($<$ 3 kg) had more stillborn piglets than other sows (on average 1.8 vs. 0.9) and tended to have a slower process of parturition during early parturition, with longer birth interval between the first and the third piglet (95 vs 71 min, Quesnel 2011). Since many hormones involved in parturition are also involved in lactogenesis, one may wonder whether abnormalities in the endocrine status of sows in late pregnancy might have detrimental effects on parturition and on colostrum production.

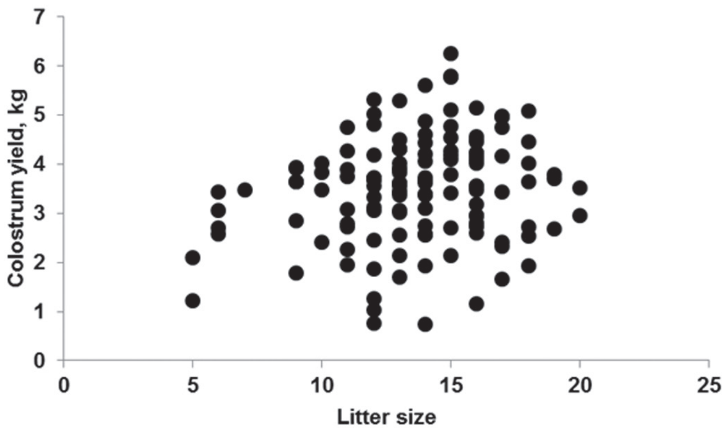

Fig. 2 Estimated colostrum yield during the 24 h after the onset of parturition in relation to litter size. Data was obtained from 134 crossbred Landrace x Large White sows at the INRA herd (Saint-Gilles, France). Colostrum yield was not correlated with the number of piglets nursed ($r = 0.19$, $P > 0.10$, Quesnel, unpublished data).

One factor which could influence colostrum yield is mammary development. Indeed, a greater mammary development can lead to a greater milk yield (Head *et al*. 1991) and, even though it was never specifically looked at, it is likely that this could also hold true for colostrum production. Moreover, there is a correlation between the size of a mammary gland (either in terms of weight or DNA) and its milk yield, as estimated by the average daily gain between days 1 and 24 of lactation for the piglet suckling that teat (Nielsen *et al*. 2001). Nevertheless, it is not known if this is solely related to differences in mammary development already present at farrowing or if it is also linked with the vigor of the piglets massaging the udder. Recent data also indicate that mammogenesis can affect milk yield and, potentially, colostrum yield. When teats were either blinded or not in first lactation, teats which were previously used produced more milk (based on weight gain of piglets from days 2 to 14 of lactation) and were more developed on day 17 of the second lactation (Farmer *et al*. 2012a). Furthermore, piglets suckling teats which were previously used had significantly greater weight gains as early as from days 2 to 4 of lactation, whereas piglets suckling on teats which were not previously used showed behaviors indicative of a greater hunger level on day 3, but not on day 10, of lactation (Farmer *et al*. 2012a). Together, this information suggests that mammary development may have an impact on colostrum production.

Influence of maternal stress

Reproductive sows are often exposed to behavioral (shipping and moving to a new environment, food frustration, social stress due to grouping with unfamiliar conspecifics or competition for the access to feeders) or physical (thermal stress, leg disorders) stressors during gestation. Studies using limited numbers of animals did not report any effect of prenatal stress on neonatal mortality (Jarvis *et al*. 2006, Couret *et al*. 2009a, b). Using slightly greater numbers of animals, Tuchscherer *et al*. (2002) found that repeated restraint during the last third of gestation increased piglet mortality from 6 to 14% during the suckling period. Mortality was probably increased because of the greater susceptibility of suckling piglets to diseases (morbidity was increased from 12 to 28% in this study), but maternal behavior can also be altered, increasing the risk of crushing the offspring (Ringgenberg *et al*. 2012). On the other hand, maternal stress does not affect birth weight. Social stress during mid- or late-gestation (Jarvis *et al*. 2006, Couret *et al*. 2009a, b), repeated snaring during late gestation (Tuchscherer *et al*. 2002) and rough handling during mid-gestation (Lay *et al*. 2008) did not affect piglet birth weight. The only study investigating the factors affecting piglet vitality and latency before the first milk intake did not show any influence of prenatal stress on these traits (Otten *et al*. 2007).

A major consequence of maternal stress for piglet survival is probably related to the acquisition of passive immunity. Heat during the last week of pregnancy or behavioral stressors during the last third of pregnancy decreased circulating IgG concentrations in neonatal piglets (Machado-Neto *et al*. 1987, Tuchscherer *et al*. 2002). This may result from a lower IgG content in maternal colostrum (Machado-Neto *et al*. 1987) or from an altered intestinal transfer of IgG from the gut to the circulation in neonates. In late gestation, a transient increase in maternal glucocorticoids due to maternal stress may mimic the natural cortisol variations which occur around parturition and accelerate gut closure, thus leading to impaired immunoglobulin acquisition after birth (Machado-Neto *et al*. 1987, Bate *et al*. 1991). Maternal restraint and social stressors during gestation were also shown to affect maturation of the piglet's immune system (Tuchscherer *et al*. 2002, Couret *et al*. 2009a, b), but the consequences of these alterations are probably more important for the post- than pre-weaning period.

Feeding strategies to increase neonatal survival

Influence of maternal feeding during gestation on piglet development

Level of feeding, diet composition and specific nutrients provided to the sow during pregnancy may influence fetal growth and the development of specific tissues in offspring (such as muscle fibers which are essentially formed prenatally and affect postnatal muscle growth), and thus maturity at birth. The roles of selected nutrients and amino acid status are reviewed in the present proceedings (Bazer *et al*. 2013, Wu *et al*. 2013) and will therefore not be detailed here. Nevertheless, some examples will be given with respect to predisposing factors for postnatal losses.

Increasing feed supply. When compared with sows fed at levels routinely used for pregnancy, an increased feed supply (+30% to +100%) during early to mid-gestation (d 3 – d 32, Hoving *et al*. 2011; d 0 - d 50, Bee 2004; d 25 - d 50, Dwyer *et al*. 1994, Gatford *et al*. 2003, Nissen *et al*. 2003, McNamara *et al*. 2011) and up to day 85 of gestation (d 50 - d 80; Dwyer *et al*. 1994, McNamara *et al*. 2011; d 45 - d 85, Cerisuelo *et al*. 2009) did not affect birth weight or within-litter variation in birth weight, even in situations where sows in the "plus feed" treatment gained more BW during the experimental period (Hoving *et al*. 2011). In these studies, litter size at birth varied from 9.9 to 14.2 total born, and 9.5 to 12.5 born alive regardless of treatments. Dwyer *et al*. (1994) observed that doubling sow feed intake (5 kg/d) during the second or third quarters of pregnancy tended to increase the number of muscle fibers in the offspring, with a positive effect on postnatal growth rate. Although an increased maternal nutrition during pregnancy may increase the insulin:glucose ratio in maternal blood (Gatford *et al*. 2003), the exact mechanisms by which overnutrition during pregnancy may affect the formation of secondary muscle fibers in developing fetuses, remain unclear. However, more recent studies produced conflicting results with greater (Gatford *et al*. 2003), similar (Nissen *et al*. 2003) or smaller (Cerisuelo *et al*. 2009) numbers of fibers in the muscle of progeny with maternal overfeeding. The possible impacts of these strategies on fat content and muscle glycogen reserves have not been investigated. When feed allowance was increased (+ 780 g/d) in the last 15 days of gestation, there was again no effects on birth weight but an improvement in piglet vitality during the first hours of postnatal life (Quiniou 2005), maybe because the highest feed allowance made sow farrowing easier in this study.

Fat supply. Feeding more energy in the form of added fat during the last quarter of pregnancy did not affect piglet birth weight, total litter birth weight, or piglet survival (Coffey *et al*. 1987, van der Peet-Schwering 2004). Piglets born from sows fed soybean oil (rich in omega-6 fatty acids) had a higher viability score at birth than the progeny from sows fed tuna oil (rich in omega-3 fatty acids) when farrowings were induced on day 113 (Rooke *et al*. 1998).

Dietary protein and amino acid supply. Feeding extra protein with greater digestible amino acids during early gestation (d 3 to d 32) did not influence average birth weight of piglets when compared with a control diet (Hoving *et al*. 2011). Moreover, feeding a high protein:low carbohydrate diet throughout pregnancy resulted in lower (-14%) average birth weights than a control diet, for the same litter size. This was likely due to maternal energy deficit in treated compared with control sows, so that maternal nutrients were partitioned in favor of maternal anabolism (Metges *et al*. 2012). This feeding regimen also reduced body fat (less adipocyte number) and total fiber number in skeletal muscles of the newborn piglets (Rehfeldt *et al*. 2012). A number of experiments also dealt with dietary supplementation of specific amino acids. Many studies showed a positive effect of L-arginine supplementation (25 g/d) from day 14 to day 28 of gestation on the number of fetuses or piglets born alive, without any detrimental effects on individual weight and within-litter variation in birth weight (see review by Le Floch *et al*. 2012). As the nitrogenous precursor of nitric oxide, a vasodilator and angiogenic factor, and polyamines, which are key regulators of protein synthesis and angiogenesis, L-arginine enhances placental growth and regulates multiple metabolic pathways. Positive effects were also observed on embryonic growth when 20 g/day of L-arginine was added to the diet of sows from either day 15 to day 29, day 30 to day 44 or day 15 to day 44 of gestation (Novak *et al*. 2012). When supplementary L-arginine was fed from day 77 up to term, birth weight was unaltered but the coefficients of variation of birth weight of total born piglets were reduced by 3%, when compared with control sows (Quesnel *et al*. 2013b). This effect was significant in litters of less than 17 total born but not in larger litters, which suggests that a physiological limit, presumably uterine capacity, cannot be overcome by nutritional supplementation in those large litters.

Conflicting results were reported using top-dressing with L-carnitine, a derivative from lysine and methionine that may affect the insulin-like growth factor (IGF) system, during gestation. When L-carnitine was fed throughout gestation, individual fetal weight was not affected on day 57 (Waylan *et al*. 2005) but it tended to be greater on day 70 (Brown *et al*. 2008). Providing L-carnitine as a premix during gestation did not affect the number of piglets born and born alive but resulted in greater piglet birth weight (Eder *et al*. 2001, Ramanau *et al*. 2002) or increased the number of piglets at birth while decreasing their individual weights (Ramanau *et al*. 2004).

Influence of maternal feeding on mammary gland development

Mammary development occurs at distinctive periods in swine. The periods from 90 days of age until puberty and throughout the last third of gestation are the two stages of rapid mammary accretion (Sørensen *et al*. 2002) where feeding regimes could have an impact on potential colostrum yield. For the purpose of the current review, the focus will be on feeding of the late-pregnant sow.

Head & Williams (1991) reported that when manipulating the body composition of gilts by changing their protein and energy intakes during gestation, fat gilts produced less milk (7 l/d) than lean gilts (9 l/d) of the same body weight due to alterations in the number of mammary alveolar cells. Weldon *et al*. (1991) also showed that increasing dietary energy (5.76 vs. 10.5

Mcal ME/d) as of day 75 of gestation decreased mammary parenchymal weight by 21% and total parenchymal DNA by 23% on day 105 of gestation. On the other hand, increasing protein intake (330 vs. 216 g CP/d, Weldon *et al*. 1991) or lysine intake (4, 8 or 16 g/d) had no effects on mammogenesis. Crenshaw *et al*. (1989) reported that diet deprivation followed by over-allowance during the growing, finishing and gestation phases increased sow milk yield and modulated the relative expression of casein β in mammary tissue. Using that same feeding regimen in the growing-finishing period (Farmer *et al*. 2012b) or in the gestation period only (Farmer *et al*. unpublished data) had, however, no beneficial effect on mammary development at the end of gestation. It is apparent that the ideal feeding strategy to maximize mammary development in late-gestating sows has yet to be established.

A recent report indicated that nutrition of sows in gestation and lactation can also affect mammary development of their offspring at puberty. Indeed, when 10% flaxseed was fed to sows from day 63 of gestation until weaning, their female offspring showed an increase in mammary parenchymal tissue weight expressed as a percentage of body weight (0.37% vs. 0.27%) at puberty (Farmer & Palin 2008). This programming effect in swine on lactating ability of the offspring opens new avenues in terms of development of maternal feeding strategies to enhance mammogenesis and potential milk/colostrum yield.

Influence of maternal feeding during the periparturient period on colostrum production

The literature on the influence of maternal feeding on colostrum yield is scarce, probably because this trait cannot be measured easily. Most recent findings deal with the impact of the level and source of dietary fat and fiber. Hansen *et al*. (2012) and Theil & Lauridsen (2012) compared five "transition" diets given during the last week of gestation. These diets contained either 3% animal fat (standard diet) or 8% fat from various origins and provided various proportions of medium- and long-chain fatty acids. Colostrum yield was increased by diets containing coconut or sunflower oil (490 g/piglet/d), and was further increased by the diet containing fish oil and octanoic acid (550 g/piglet/d), when compared with the standard diet or the diet containing 8% fish oil (460 g/piglet/d). In contrast, Papadopoulos *et al*. (2009) observed no beneficial effect of feeding sunflower oil compared with fish oil during the last week of gestation on piglet growth and survival. Dietary CLA from day 108 of gestation onward negatively affected colostrum intake by piglets (409 vs 463 g/d) and survival rate during the first week of lactation (82 vs 92%, Theil & Lauridsen 2012).

Feeding high-fiber diets during part of gestation or during the transition period increased piglet weight gain by 14% during the first 5 or 7 days after birth (Guillemet *et al*. 2007, Oliviero *et al*. 2009). Since isocaloric fiber-rich diets tended to increase prolactin concentrations around parturition (Farmer *et al*. 1995, Quesnel *et al*. 2009), the beneficial effect on piglet growth could be related to greater circulating concentrations of prolactin and increased production of colostrum. Our recent findings, however, did not support this assumption, because feeding sows a high-fiber diet (7.9% vs. 3.3% crude fiber) during the transition period had no effect on prolactin concentrations or colostrum yield (Loisel *et al*. 2013). Nevertheless, it increased piglet survival during lactation and colostrum intake by piglets weighing less than 900 g. This effect could not be related to vitality at birth, farrowing duration or sow endocrine or metabolic status, suggesting that it may be related to the beneficial effect of dietary fiber on sow maternal behavior.

The influence of maternal feeding on colostrum composition was more investigated than its effect on colostrum yield. Lipids and immunoglobulins are the two components which are most sensitive to nutritional changes. Supplementing the diet of sows with fat during late pregnancy increases total lipids in colostrum and may increase lipid accretion in piglets, but seems to have no significant impact on piglet weight and survival (for review see Farmer & Quesnel 2009). Many studies considered various ingredients that presumably have immunomodulating effects (e.g., fish oil, fermented liquid feed, mannan oligosaccharides). They reported a significant increase in concentrations of IgG, IgA and/or IgM in colostrum, but in only a few cases were there positive effects on plasma IgG concentrations or body weight gain of piglets (Krakowski *et al*. 2002, Bontempo *et al*. 2004). Unexpectedly, sows fed a high-fiber diet during late pregnancy had lower IgA concentrations in colostrum and milk (Loisel *et al*. 2013). Consequences of such nutritional strategies on piglet survival need to be further investigated.

Conclusion

Neonatal survival largely depends on adequate colostrum intake by newborn piglets and it is therefore essential to increase the amount and quality of colostrum ingested by piglets. Feeding strategies applied to the sow during gestation generally failed to increase piglet birth weight. Vitality and viability, on the other hand, could be influenced by supplementary feeding of specific fatty acids or amino acids. The use of ingredients with potential immunomodulatory effects increased concentrations of immunoglobulins in colostrum and in piglet plasma, yet the impact of such ingredients on neonatal survival needs to be investigated in farms. Lastly, there is some evidence that maternal feeding during the peripartal period may influence both the quantity and the quality of colostrum; this definitely needs to receive further attention.

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