Effect of colostrum supplementation on baby pig performance

by

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Abstract

Two experiments evaluated the effect of colostrum and energy supplementation on the performance and immune response of baby piglets. In Exp. 1, 301 newborn pigs (Line 600 × 241; DNA, 1.48 kg) were used in a 21-d study. Pigs were weighed and allotted to one of three treatments at 6-h of age in a randomized complete block design with 23 replications (litters) per treatment. Piglets were blocked by weight and randomly assigned a treatment. Runt piglets (birthweight < 0.8 kg) were tested in experiment 1 and 2. Dietary treatments were a control with no dietary supplementation, an energy supplement (1.5 ml containing glucose, dried milk, medium chain triglycerides, and tea extract), and bovine colostrum (30 ml). The supplements were given as an oral gavage. A single treatment was administered at 6-h after birth. At 30-h of age approximately 1ml of blood was obtained for an immunocrit assay of serum. The glucose based energy supplement (milk protein, medium chain triglycerides) had no (P > 0.05) effect on weight or ADG at any of the weigh periods (30-h, d 5, d 7, d 14, and weaning), immunocrit ratio, or survival rate. The bovine colostrum treatment had a negative (P < 0.05) effect on weight at 24-h, d 5, and d 7, immunocrit ratio, and survival rate. There was no (P > 0.05) effect of treatment on weight at weaning. . In Exp. 2, 364 newborn pigs (Line 600 × 241; DNA, 1.48 kg) were used in a 21-d study. Pigs were weighed and allotted to one of three treatments in a randomized complete block design with 25 replications (litters) per treatment. Dietary treatments were a control with no dietary supplementation, an energy supplement (1.5 ml, glucose based, containing milk protein, medium chain triglycerides, and tea extract), and bovine colostrum (10 ml). The supplements were given as an oral gavage. A single treatment was administered at 6-h after birth. At 30-h of age blood was collected for analysis of serum immunocrit. Body weights, ADG during the duration of the trial, immunocrit ratio, and survival rates were similar (P > 0.05) for the treatment groups. In both experiment 1 and 2 there were no treatment by weight group interaction. In summary, under the conditions of these experiments supplementation of 30 ml of bovine colostrum had a negative effect ($P < 0.05$) on immunocrit ratio and survival rate ($P > 0.05$), of the treatments affected on weaning weights when compared to the control.

Key Words: bovine colostrum, immunocrit, immunoglobulins, neonatal piglet

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Dedication

There are many people that have helped me get where I am today but none as supportive as my family who this is dedicated to.

Chapter 1 - General Review of Literature

Importance of Colostrum Intake

It is well established that the greatest mortality loss for swine producers occurs within the first few days after birth and one of the most important factors influencing piglet survival is colostrum intake (Le Dividich et al., 2005).

The baby pig is born with low body energy stores and devoid of serum immunoglobulins (Le Dividich et al., 2005). Colostrum, the first secretion of the mammary gland, is characterized by high concentrations of immunoglobulins, and contains lower concentrations of lactose and lipids than milk (Quesnel et al., 2012), colostrum provides energy and antibodies to newborn piglets. Since piglets are born without plasma immunoglobulins, due to the epitheliochorial placenta (Bland et al., 2003), passive immunity from the sow is important. In addition to its immunological role, colostrum has a marked stimulating effect on the growth and maturation of the neonatal gastrointestinal tract (Jensen et al., 2001). On a per body weight basis energy requirements are greatest at birth. Intake of colostrum is vital to survival and piglets usually start to nurse within twenty to thirty minutes of birth. The intake of colostrum largely depends on the sow's ability to produce colostrum and the piglet's ability to reach a teat and extract it. Birth weight is positively correlated to colostrum intake, heavier piglets are more competitive and effective at nursing than lighter piglets of the same litter. Though, the probability of low performance is lower in heavier birthweight piglets compared to lighter birthweight piglets regardless of the amount of colostrum intake, making lighter birthweight piglets more dependent on colostrum intake for survival and growth (Ferrari et al., 2014). Low colostrum intake presents less chance of survival for smaller piglets because of a relatively larger body surface area, which results in a greater relative heat loss (Noll et al., 1979). Litter weight gain within the first 24 hours is a good indicator of colostrum intake by the pig (Le Dividich et al., 2005).

Other factors negatively affecting colostrum consumption are cold exposure and splayed limbs at birth, which both decrease colostrum consumption by the newborn piglet. Primiparous sows can also have an impact on birthweight and colostrum production compared to multiparous sows. Piglets from primiparous sows have lower birthweight compared to piglets from multiparous sows (Carney-Hinkle et al., 2013). Also, primiparous sows produce less milk (Beyer, et al., 2011) however serum IgG concentration is similar in primiparous and multiparous sows (Ferrari et al., 2014).

A factor that does not affect the amount colostrum intake is birth order. The piglets that are toward the beginning of the birth order are sated and less active when later piglets are born, creating less competition for teats. However, piglets later in birth order are allowed colostrum of lower IgG concentration therefore have lower reduced plasma IgG concentration (de Passille et al., 1988).

Because of increased prolificacy, the number of piglets born weak has increased due to decreased birthweight and since colostrum production is independent of litter size, therefore the larger the litter the less colostrum per pig. This creates a problem for producers as 50% of pre-weaning mortality occurs within three days of birth (Tuchscherer et al., 2000). Insufficient colostrum intake is one of the major causes of neonatal mortality (Edwards, 2002). In a more recent study, (Devillers et al., 2011), they aimed to determine the minimum amount of colostrum that suckling piglets should ingest to ensure their survival and optimum performance. This study was done on naturally suckling piglets, which is scarce, because it is more difficult to measure intake compared to controlling intake via force-feeding or bottle feeding. Devillers et al., (2011), found piglets that died before weaning had lower birth weights, more difficulty taking their first breath and a higher occurrence of splay leg compared to piglets that survived until weaning. It was also observed that piglets that died before weaning had a lower colostrum intake, lower weight gain, lower rectal temperature, and lower plasma IgG and glucose concentrations than piglets still alive at weaning. In Deviller et al., (2011), study, they found the two largest causes of death were weakness (49.5%) and crushing by the sow (34.7%). Birthweight, rectal temperature, and plasma glucose and IgG concentrations were positively correlated with colostrum intake. Deviller et al., (2011), found colostrum intake also had a lasting effect on growth. Piglets that received greater than 290 grams of colostrum weighed an average of 12.34 kg at 42 days compared to piglets that received less than 290 grams of colostrum that weighed an average of 10.45 kg at the same age. This shows that growth is also affected by colostrum intake. In this study, piglets that consumed at least 200 g of colostrum had a 7.1% mortality rate before weaning, where piglets that consumed less than 200 g of colostrum had a 43.4% mortality rate before weaning. Devillers et al., 2011, suggest that after about 200 g of colostrum is consumed the plasma IgG concentration does not increase anymore, therefore a minimum of 200 g of colostrum is recommended, but studies have shown consumption from 0 to 700 grams of colostrum when colostrum supply is not restricted (Le Dividich et al., 2005). In another study, that showed similar results, piglets that consumed greater than 250 grams of colostrum within their first 24 hours increased their weight at 42 days of age compared to piglets that consumed less than 250 grams of colostrum (Ferrari et al., 2014).

Long-term effects have been studied that look at the relationship between day one piglet serum immunoglobulin immunocrit levels and its effect on subsequent growth, age at puberty, litter size and lactation performance. Vallet et al., (2015) found the results indicated that low day immunocrits were subsequently associated with reduced growth (P < 0.01), increased age at puberty (P < 0.01), reduced number born alive (P < 0.05), reduced litter average immunocrit (P < 0.05), and reduced litter average preweaning growth rate during lactation (P < 0.05, Vallet et al., 2015). This relationship shows it could be especially beneficial for adequate colostrum intake in gilts slated to be replacements in the breeding herd.

Since production of colostrum by the sow is highly variable, it can be difficult for many sows to produce enough colostrum for large litters (Devillers et al., 2011). On the basis of a piglet receiving 250 grams of colostrum, at least one-third of sows do not produce enough colostrum to fulfil the needs of their litter (Quesnel et al., 2012). Since energy storage is so low in a newborn baby pig (Le Dividich et al., 2005) it may be difficult for a piglet to survive without receiving colostrum, especially in a cold environment. With gut closure beginning at 24 hours after birth (Speer et al., 1957), it is essential for baby piglets to receive necessary immunoglobins. Colostral IgG absorption may be important not only for passive immunity but also for the development of active immunity (Markowska-Daniel et al., 2010). Markowsa-Daniel et al., (2010), showed a positive correlation with piglets that had higher levels of IgG in their serum at 7 days also had a higher level of IgG concentration at 56 days of age, compared to piglets that showed lower levels of serum IgG concentration at day 7 and day 56.

Immunoglobulin Role and Absorption

The immunological role of colostrum provides high levels of immunoglobulin (Ig) G and lower levels of IgA and IgM, which are more prevalent in mature milk (Klobasa et al., 1987). IgG is the main colostrol Ig and constitutes 74% of all Ig in the sows first colostrum (Markowska-Daniel et al., 2010). All Ig levels decrease from time at birth to 24 hours post-partum and most significantly concentration of IgG levels declines exponentially during the 24 hours of production (Le Dividich et al., 2005). Within this period, it is critical for a newborn piglet to receive passive immunity. In modern pig production, an increase in average litter size has further increased the risk for newborn piglets to die from starvation and lack of passive immunity (Jensen et al., 2001), so with more prolific genetic lines it is important to find a way for every piglet to receive enough colostrum to survive. There has been an increase of research done to find alternative ways to rear piglets. Le Dividich explains that while immunoglobins from bovine or ovine sources supplemented to piglets have shown improvements in success, there is an advantage of supplementing porcine IgGs both in survival and absorption of IgGs, shown by Drew and Owens 1988, and Gomez et al., 1998. This is further supported by a study done by Jensen et al., 2001, that states it is essential that newborn piglets receive porcine Ig to achieve a sufficient degree of passive immunization.

To determine the ideal time to administer supplementation Cabrera et al., (2012), conducted a study to determine the effect of time and feeding state on IgG absorption, intestinal morphology, and expression of IgG receptors in the first 24 hours post birth. This study used defatted porcine colostrum gavaged in two doses of 16 ml each, one hour apart to piglets at 0 hours old and 12 hours post birth. It was observed that the greatest IgG absorption was seen when piglets were supplemented immediately after birth. The piglets supplemented at birth expressed higher villi height than those supplemented at 12 hours after birth. Also, the piglets supplemented at birth had a greater percentage of IgG transported in the blood when compared to those supplemented at 12 hours after birth. These authors suggest the best time to supplement piglets with additional colostrum should occur immediately following birth. This study only further confirms the importance of early colostrum intake in a newborn piglet. Also when nursing is delayed by 8 to 12 hours amount of colostrum intake does not differ compared to piglets that were allowed to nurse right at birth, however due to the colostrum IgG levels decreasing after birth, serum IgG levels in the piglets that were delayed nursing were delayed (Bland et al., 2003).

Vallet et al., (2015), at the U.S. Meat Animal Research Center, in Clay Center, Nebraska have developed a process called "immunocrit" to determine immunoglobulin content in the nursing piglet. This process takes a blood sample from a piglet bled on day one after birth then mixed with ammonia sulfate to precipitate immunoglobulin, put into a microcapillary tube, and spun so the precipitated immunoglobulin settles to the end of the tube. It is then measured as a percentage of the total volume in the tube by dividing the precipitate by the total volume in the tube. This is the best indicator of colostrum intake and has studies have shown the amount of colostrum in a piglets belly directly correlates with the immunocrit percentage (Avant, 2012).

Supplements

Supplemental IgG can come from different sources. Campbell et al., (2012), designed a study to evaluate orally fed colostrum supplements with different energy sources and IgG from porcine plasma on piglet serum IgG content and absorption of IgG compared to pooled sow colostrum. They concluded that pooled sow colostrum was comparable to colostrum supplements derived from porcine plasma, in delivering absorbable IgG to the baby pig.

Because of commercial availability bovine colostrum has been looked at as a possible alternative to rear piglets artificially or supplement piglets to increase survival. The nutritional benefits of bovine colostrum, bovine milk and milk-related products have been acknowledged for hundreds of years, although the potential for these products to affect the immune system and gastrointestinal structure have only recently been identified (Pluske, 2001). Supplemental bovine colostrum has been shown to reduce the incidence of diarrhea thereby increasing weight gain during the first week of life and reducing mortality (Noll, 1979). Work by Morel et al., (1995), showed that oral provision of bovine IgG increased the local concentration of IgG in the gastrointestinal tract, especially the proximal portion of the small intestine. Further work by King et al., (1999), showed that supplementing a colostrum based product to nursing piglets that contained either 75 g/kg or 150 g/kg bovine IgG enhanced gut structure at weaning. A study by Gomez et al., (1998), compared the effects of feeding different sources of immunoglobulins: sows colostrum by nursing, no colostrum, bovine colostrum, and porcine immunoglobulins. All the pigs that received sow colostrum and porcine immunoglobulins survived the end of the trial at day 19, compared to an 80% survival rate for piglets given bovine colostrum, and only 30% of the treatment group that received no colostrum survived until the end of the trial. Research by Drew et al., (1988), studied the effects of porcine, bovine and sow milk replacer on piglet growth and immune response. The 28-day trial showed significant growth differences with the control group that was only fed sow milk replacer gaining 83.9 grams per day, the bovine immunoglobulin piglets gaining 140.6 grams per day and the porcine immunoglobulin treatment group gaining 169.8 grams per day. They also found porcine immunoglobulins were absorbed at a much greater rate than bovine immunoglobulins. Piglets in the porcine immunoglobulin group had a serum IgG concentration of 19.7 mg/d at one day of age compared to 5.0 mg/d for the piglets fed bovine immunoglobulins. It is conceivable that enhanced performance in young pigs given bovine IgG products may be an overall consequence of an improved gut environment, such as enhanced intestinal immunity, reduced proliferation of enteric bacteria, or any combination of these factors (Pluske, 2001)

Bovine colostrum and immunoglobulins can prove to be effective when artificially rearing piglets when compared to piglets not given any colostrum or immunoglobulins but studies have proven porcine colostrum and immunoglobulins are the most effective way to increase growth and decrease mortality in baby piglets.

Summary

In conclusion, colostrum intake as soon after birth as possible is most beneficial for the piglet to receive the best passive immunity from the sow by getting colostrum that has the highest levels of IgG. Especially for low birthweight pigs it is important for them to receive colostrum not only for immunoglobulins but for energy for thermoregulation as low birthweight pigs have a relative greater surface area compared to heavier birthweight pigs. Though it is beneficial for heavier birthweight pigs to receive colostrum it has been shown that they have a better chance of survival compared to low birthweight piglets regardless of colostrum intake. Supplementation has been shown effective on low birthweight piglets, with immunoglobulins from porcine origin having the most positive effect on serum IgG levels.

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Chapter 2 - Effect of Colostrum Supplementation on Baby Pig Performance[1]

Abstract

Two experiments evaluated the effect of colostrum and energy supplementation on the performance and immune response of baby piglets. In Exp. 1, 301 newborn pigs (Line 600 × 241; DNA, 1.48 kg) were used in a 21-d study. Pigs were weighed and allotted to one of three treatments at 6-h of age in a randomized complete block design with 23 replications (litters) per treatment. Piglets were blocked by weight and randomly assigned a treatment. Runt piglets (birthweight < 0.8 kg) were tested in experiment 1 and 2. Dietary treatments were a control with no dietary supplementation, an energy supplement (1.5 ml containing glucose, dried milk, medium chain triglycerides, and tea extract), and bovine colostrum (30 ml). The supplements were given as an oral gavage. A single treatment was administered at 6-h after birth. At 30-h of age approximately 1ml of blood was obtained for an immunocrit assay of serum. The glucose based energy supplement (milk protein, medium chain triglycerides) had no ($P > 0.05$) effect on weight or ADG at any of the weigh periods (30-h, d 5, d 7, d 14, and weaning), immunocrit ratio, or survival rate. The bovine colostrum treatment had a negative ($P < 0.05$) effect on weight at 24-h, d 5, and d 7, immunocrit ratio, and survival rate. There was no ($P > 0.05$) effect of treatment on weight at weaning. . In Exp. 2, 364 newborn pigs (Line 600 × 241; DNA, 1.48 kg) were used in a 21-d study. Pigs were weighed and allotted to one of three treatments in a randomized complete block design with 25 replications (litters) per treatment. Dietary treatments were a control with no dietary supplementation, an energy supplement (1.5 ml, glucose based, containing milk protein, medium chain triglycerides, and tea extract), and bovine colostrum (10 ml). The supplements were given as an oral gavage. A single treatment was administered at 6-h after birth. At 30-h of age blood was collected for analysis of serum immunocrit. Body weights, ADG during the duration of the trial, immunocrit ratio, and survival rates were similar ($P > 0.05$) for the treatment groups. In both experiment 1 and 2 there were no treatment by weight group interaction. In summary, under the conditions of these experiments supplementation of 30 ml of bovine colostrum had a negative effect ($P < 0.05$) on immunocrit ratio and survival rate ($P > 0.05$), of the treatments affected on weaning weights when compared to the control.

Key Words: bovine colostrum, immunocrit, immunoglobulins, neonatal piglet

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Introduction

Over the last three decades the number of pigs weaned per sow per year has increased from around 20 to around 30 pigs weaned per sow per year (Koketsu et al., 2017). With increased genetic selection pressure that number could be even higher in the future. In today's swine industry the variability in birth weight and pre-weaning mortality have been a negative side effect of selection for hyper-prolificacy (Moreira et al., 2016). A commonly used tool in measuring swine production efficiency is measuring the number of pigs weaned per sow per year. The increase in the number of pigs weaned per sow per year creates concern with an increasing variability in pig birth weight. Feldpausch (2015) identified pigs that are born at less than 1.1 kg have a substantially higher preweaning mortality compared to pigs born at a birthweight greater than 1.1 kg. Low birthweight piglets have reduced viability because of low colostrum immunoglobulin and energy intake (Bikker et al., 2010). Piglets that do not have adequate colostrum intake do not receive passive immunity from the sow predisposing them to sickness also inadequate energy intake can cause starvation and increased crushing (Ferrari et al., 2014).

Thus, we conducted this experiment to focus on increasing growth, immune response, and survival. The supplementation of bovine colostrum has been suggested as a viable way to increase performance and survival of young pigs at such a critical time. We hypothesized that supplementing additional bovine colostrum or an energy supplement would improve performance and survival of nursing piglets.

Materials and Methods

Experiment 1

The primary objective of this study was to evaluate the potential impact of different types of supplementation to nursing piglets in comparison to piglets that received no supplementation. This report describes the growth performance, immune response and survival of nursing piglets and the effects of bovine colostrum or energy supplementation on growth performance, immune response and survival.

The protocol for this experiment was approved by the Kansas State University Institutional Animal Care and Use Committee #3750. The study was conducted at the K-State Swine Teaching and Research farm nursery in Manhattan, KS.

A total of 301 newborn pigs (Line 600 × 241; DNA, Columbus, NE; initially 1.48 kg BW) were used in a 21 d study. There were 23 replications per treatment. A total of 23 sows (DNA Line 241) were utilized within the farrowing complex at the K-State Swine Teaching and Research farm. Sows were observed around the clock when they neared farrowing. Time of the first pig born was recorded. Sows that had less than 9 live pigs or farrowing duration extended for more than 6 hours were not included in this study. Pigs that were cross-fostered were only moved after blood had been collected at approximately 30 h old.

Six hours after the birth of the first pig, individual pigs from an entire litter were weighted at 6-h of age and allotment divided pigs into a light, medium, and heavy block, within each litter, based off initial BW. Within their respective weight block piglets were randomly assigned one of three treatments.

The three dietary treatments consisted of either no additional supplementation, 30 ml of bovine colostrum, mixed at 60% solid 40% liquid (Bovine IgG 15%, Crude Protein 47%, Crude Fat 23%, Saskatoon Colostrum Company, Saskatoon, SK, Canada), or 1.5 ml energy supplement (EXP Early Pig Supplement, TechMix, LLC, Stewart, MN). Due to pending patents a total ingredient analysis is unavailable on the "EXP Early Pig Supplement" product.

The experimental treatments were administered one time approximately 6 h after the time of the first pig born. The piglets receiving bovine colostrum and the energy supplement were orally gavaged then immediately placed back into the crate.

At approximately 24 h post treatment, blood was collected from the cephalic or mammary vein (1ml) of each pig. Then serum was separated by centrifugation (18,000 x g, 4°C). Serum was pipetted into 1.7 ml tubes and frozen at -80°C until analysis. The serum was then combined with 40% (wt/vol) ammonium sulfate in distilled water (50µl each). Precipitated samples were loaded into a hematocrit centrifuge tube and centrifuged (12,000 x g) for 10 min at room temperature. Immunocrit was determined by the ratio of the precipitate length divided by the total length of the serum in the column.

Average body weight and average daily gain(ADG) were determined by individually weighing pigs. Initial weight was determined at approximately 6 h after birth when subsequent weights taken at 30 h, d 5, d 7, d 14 and weaning.

Experiment 2

The primary objective of Exp. 2 was to evaluate the potential effect of different types of supplementation to nursing piglets in comparison to piglets that received no supplementation. Because of adverse effects of gavaging 30ml of colostrum in Exp. 1, there was a change in the protocol that adjusted the dose to 10ml of bovine colostrum.

The protocol for this experiment was approved by the Kansas State University Institutional Animal Care and Use Committee #3750. The study was conducted at the K-State Swine Teaching and Research farm nursery in Manhattan, KS. Procedures were similar to Exp. 1.

A total of 364 newborn pigs (Line 600 × 241; DNA, Columbus, NE; initially 1.48 kg BW) were used in a 21-d study. There were 25 replications per treatment. A total of 25 farrowing crates were utilized within the farrowing complex at the K-State Swine Teaching and Research farm. Each pig was weighted at 6 h old and allotment divided pigs into a light, medium, and heavy block based off initial BW within each litter. Within their respective weight block piglets were randomly assigned one of three treatments.

Six hours after the birth of the first pig, individual pigs from an entire litter were weighted at 6-h of age and allotment divided pigs into a light, medium, and heavy block, within each litter, based off initial BW. Within their respective weight block piglets were randomly assigned one of three treatments.

The three dietary treatments consisted of either no additional supplementation, 10 ml of bovine colostrum, mixed at 60% solid 40% liquid (Bovine IgG 15%, Crude Protein 47%, Crude Fat 23%, Saskatoon Colostrum Company, Saskatoon, SK, Canada), or 1.5 ml energy supplement (EXP Early Pig Supplement, TechMix, LLC, Stewart, MN). Due to pending patents a total ingredient analysis is unavailable on the "EXP Early Pig Supplement" product.

The experimental treatments were administered one time approximately 6 h after the time of the first pig born. The piglets receiving bovine colostrum and the energy supplement were orally gavaged then immediately placed back into the crate.

At approximately 24 h post treatment, blood was collected from the cephalic or mammary vein (1ml) of each pig. Then serum was separated by centrifugation (18,000 x g, 4°C). Serum was pipetted into 1.7 ml tubes and frozen at -80°C until analysis. The serum was then combined with 40% (wt/vol) ammonium sulfate in distilled water (50µl each). Precipitated samples were loaded into a hematocrit centrifuge tube and centrifuged (12,000 x g) for 10 min at room temperature. Immunocrit was determined by the ratio of the precipitate length divided by the total length of the serum in the column.

Average body weight and average daily gain(ADG) were determined by individually weighing pigs. Initial weight was determined at approximately 6 h after birth when subsequent weights taken at 30 h, d 5, d 7, d 14 and weaning.

Statistical Analysis

The weight of the pig measured over the length of the trial was considered a one-way treatment and randomized complete block design with split plot and repeated measure over six-time periods. In SAS, we used PROC GLIMMIX with each piglet as an experimental unit. The model included type of supplementation as the main effect, litter as block, and weight group as sub plot. The Kenward-Roger adjustment for denominator degrees of freedom was used because sows did not have the same number of piglets. Least squares means were compared using the pdiff option of SAS. We considered $P < 0.05$ as significant.

Results

Experiment 1

For the first three weigh periods (30 h, d 5 and d 7), pigs supplemented with 30 ml of bovine colostrum had smaller ($P < 0.05$) body weights compared to pigs given no supplementation. At d 14 and at weaning there were no ($P > 0.05$) difference in body weight between the treatments. For all weigh periods (30 h, d 5, d 7, d 14 and weaning) piglets given the energy supplement had similar ($P > 0.05$) body weights to piglets in the control group. For the first two weigh periods (6 h to 30 h, and 30 h to d 5) pigs supplemented with 30 ml of bovine colostrum had less ($P < 0.05$) ADG compared to pigs in the control group. For periods d 5 to d 7, d 7 to d 14, and d 14 to Weaning there were no ($P > 0.05$) difference in ADG among the treatment groups. There were no weight group by treatment interactions.

An immunocrit assay performed on serum taken from piglets at 30 h old indicated that pigs supplemented with 30 ml of bovine colostrum had lower ($P < 0.05$) on immunocrits when compared to pigs in the control group. Immunocrits for pigs given the energy supplement were not ($P > 0.05$) different from controls.

Survival of pigs from birth to weaning was less ($P < 0.05$) for pigs given 30 ml of bovine colostrum compared to piglets in the control group. Survival of pigs given the energy supplement were not ($P > 0.05$) different from controls.

Experiment 2

For all weigh intervals (30 h, d 5, d 7, d 14, and Weaning), body weight was similar ($P > 0.05$) among the three treatment groups (Control, Energy Supplement, and 10 ml bovine colostrum). For all weigh periods (6 h to 30 h, 30 h to d 5, d 5 to d 7, d 7 to d 14, and d 14 to Weaning) there were no differences ($P > 0.05$) in ADG for the treatments. There were no weight group by treatment interactions.

An immunocrit assay performed on serum taken from piglets at 30 h old indicated that pigs in all treatment groups had a similar ($P > 0.05$) immunocrit ratio.

Survival of pigs from birth to weaning was similar ($P > 0.05$) between the three treatment groups.

Discussion

With increasing litter size and variation in birth weight causing increased competition for colostrum further research is needed to find potential supplementation or alternatives to reduce production losses in the lactation phase. With the greatest percentage of death loss occurring from birth to weaning (Le Dividich et al., 2005) this is an important time to capitalize on making sure piglets receive adequate energy and passive immunity, thus giving them the start they need to maximize performance throughout their life. Because of its commercial availability bovine colostrum was used in this study to determine if we could find success in increasing performance in neonatal piglets.

Casellas et al., (2005), reported that administering medium and long-chain triglycerides for the first 3 days of life reduced mortality in neonatal piglets. In the current experiments we found that administering the energy supplement containing medium chain triglycerides, one time at 6 hours after the start of farrowing, had no effect ($P > 0.05$) on reducing mortality or increasing performance or immunocrit ratio.

It has been shown that supplementing bovine colostrum can be an effective way to provide an immunoglobulin source in colostrum deprived neonatal piglets (Gomez et al., 1998). Jensen et al., (2017), showed similar results, finding that bovine colostrum was an effective alternative to porcine milk, porcine plasma, and milk replacer. However, when compared to porcine colostrum, IgG from the bovine colostrum was not absorbed as efficiently. Drew et al., (1988), found the same result when porcine and bovine serum were supplied to piglets, concluding porcine immunoglobulins were absorbed at a much higher degree than bovine immunoglobulins. In experiment 1, piglets provided no additional supplementation had a higher immunocrit ratio compared to piglets supplemented with bovine colostrum.

In experiment 1, the 30-ml dose gavaged to the piglet was calculated based on the body weight of piglets compared to the recommended dose for a newborn calf as recommended by Dr. Debbie Hanes (personal communication). When administering the treatment, some pigs had a difficult time consuming that much colostrum. After the treatment of colostrum piglets were placed back in the crate and seemed lethargic and most proceeded to sleep for long periods of time and appeared not to nurse as aggressively as the control group. This lack of nursing the sow and the fact that bovine IgG is not absorbed as efficiently as porcine IgG could explain the why the piglets treated with bovine colostrum had a reduced immunocrit ratio when compared to the control piglets. This could also be due to the change in sow colostrum composition. According to a study by Markowska-Daniel et al., (2010), IgG concentrations in colostrum rapidly decrease after parturition, which could suggest why piglets in the current experiment have missed the opportunity to receive sow colostrum that contained the highest immunoglobulin concentration.

Because of the negative effect on growth, survival and immunocrit ratio, of supplementing 30ml of bovine colostrum the protocol for experiment 2 was reduced to 10ml of colostrum supplementation, with the same 60% solid 40% water composition. Since colostrum release is relatively short, approximately 24 hours after parturition (Le Dividich et al., 2005) we thought that a lesser dose would allow piglets to regain an appetite faster and receive more of their mother's sow colostrum. In experiment 2 there was no ($P > 0.05$) difference in immunocrit ratio levels between treatments suggesting that piglets supplemented 10 ml of bovine colostrum also received more of the sow colostrum compared to piglets supplemented with 30 ml in experiment 1.

Most data utilizing bovine colostrum on neonatal pigs looks at artificial rearing piglets and studies have shown this can be a viable alternative in artificially rearing colostrum deprived piglets (Jensen et al., 2001, Noll, 1979). However, in the current experiments we used bovine colostrum as a supplement rather than an alternative to sow colostrum. We found that bovine colostrum supplementation and an energy supplement containing milk protein, medium chain triglycerides, and tea extract, did not have positive effects on growth, immunocrit ratio or survival of piglets when compared to piglets receiving no additional supplementation other than their mother's colostrum.

The possibility of supplementing the bovine colostrum after the piglet has a chance to receive as much sow colostrum as possible may be an option. During the first 24 h after farrowing the immunoglobulin content in sow colostrum is the highest so a supplement of bovine colostrum as a source for energy could have a greater effect at 24 h post farrowing compared to 6 h post farrowing.

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Table 1. Effects of colostrum supplementation and energy supplement on growth of baby piglets[1](Experiment 1)

	Treatment [2]			
	Control	Energy Supplement	Colostrum	SEM
BW, kg				
6 hour	1.47	1.47	1.49	0.025
30 hour	1.57[a]	1.55[a]	1.51[b]	0.029
Day 5	2.30[a]	2.26[a]	2.15[b]	0.056
Day 7	2.73[a]	2.69[a]	2.56[b]	0.068
Day 14	4.68	4.58	4.44	0.124
Weaning	5.64	5.49	5.36	0.154

[1] A total of 301 piglets (DNA Line 600 × 241) were used to determine if supplementing colostrum and an energy supplement had an effect on growth performance to weaning.

[2] Two experimental treatments were administered. Energy supplement (1.5 ml, Techmix Global), colostrum (30 ml, Saskatoon Colostrum)

[abc] Least squares means in the same row were considered significantly different at $P < 0.05$, with superscripts designating significant differences.

Table 2. Effects of colostrum supplementation and energy supplement on growth of baby piglets[1](Experiment 1)

	Treatment [2]			
	Control	Energy Supplement	Colostrum	SEM
ADG, kg				
6 hour to 30 hours	0.10[a]	0.09[a]	0.01[b]	0.012
30 hours to Day 5	0.18[a]	0.18[a]	0.16[b]	0.009
Day 5 to Day 7	0.22	0.22	0.20	0.013
Day 7 to Day 14	0.28	0.27	0.27	0.009
Day 14 to Weaning	0.14	0.13	0.13	0.005

[1] A total of 301 piglets (DNA Line 600 × 241) were used to determine if supplementing colostrum and an energy supplement had an effect on growth performance to weaning.

[2] Two experimental treatments were administered. Energy supplement (1.5 ml, Techmix Global), colostrum (30 ml, Saskatoon Colostrum)

[abc] Least squares means in the same row were considered significantly different at $P < 0.05$, with superscripts designating significant differences.

Table 3. Effects of colostrum supplementation and energy supplement on immunocrit ratio and survival of baby piglets[1](Experiment 1)

	Treatment [2]			
	Control	Energy Supplement	Colostrum	SEM
Immunocrit, Ratio	0.173[a]	0.170[a]	0.125[b]	0.007
Survival, %	96.9[a]	97.9[a]	87.9[b]	4.423

[1] A total of 301 piglets (DNA Line 600 × 241) were used to determine if supplementing colostrum and an energy supplement had an effect on growth performance to weaning.

[2] Two experimental treatments were administered. Energy supplement (1.5 ml, Techmix Global), colostrum (30 ml, Saskatoon Colostrum)

[abc] Least squares means in the same row were considered significantly different at $P < 0.05$, with superscripts designating significant differences.

Table 4. Effects of colostrum supplementation and energy supplement on growth of baby piglets[1] (Experiment 2)

	Treatment [2]			
	Control	Energy Supplement	Colostrum	SEM
BW, kg				
6 hour	1.48	1.47	1.49	0.020
30 hour	1.53	1.52	1.55	0.022
Day 5	2.14	2.13	2.16	0.039
Day 7	2.66	2.63	2.67	0.058
Day 14	4.43	4.35	4.41	0.103
Weaning	5.72	5.61	5.69	0.136

[1] A total of 364 piglets (DNA Line 600 × 241) were used to determine if supplementing colostrum and an energy supplement had an effect on growth performance to weaning.

[2] Two experimental treatments were administered. Energy supplement (1.5 ml, Techmix Global), colostrum (10 ml, Saskatoon Colostrum)

[abc] Least squares means in the same row were considered significantly different at $P < 0.05$, with superscripts designating significant differences.

Table 5. Effects of colostrum supplementation and energy supplement on growth of baby piglets[1](Experiment 2)

	Treatment [2]			
	Control	Energy Supplement	Colostrum	SEM
ADG, kg				
6 hour to 30 hours	0.05	0.05	0.06	0.009
30 hours to Day 5	0.15	0.15	0.15	0.006
Day 5 to Day 7	0.26	0.25	0.26	0.012
Day 7 to Day 14	0.25	0.25	0.25	0.007
Day 14 to Weaning	0.19	0.18	0.18	0.007

[1] A total of 364 piglets (DNA Line 600 × 241) were used to determine if supplementing colostrum and an energy supplement had an effect on growth performance to weaning.

[2] Two experimental treatments were administered. Energy supplement (1.5 ml, Techmix Global), colostrum (30 ml, Saskatoon Colostrum)

[abc] Least squares means in the same row were considered significantly different at $P < 0.05$, with superscripts designating significant differences.

Table 6. Effects of colostrum supplementation and energy supplement on immunocrit ratio of baby piglets[1] (Experiment 2)

	Treatment [2]			
	Control	Energy Supplement	Colostrum	SEM
Immunocrit, Ratio	0.173	0.179	0.168	0.006
Survival, %	95.1	91.7	95.0	2.228

[1] A total of 364 piglets (DNA Line 600 × 241) were used to determine if supplementing colostrum and an energy supplement had an effect on growth performance to weaning.

[2] Two experimental treatments were administered. Energy supplement (1.5 ml, Techmix Global), colostrum (10 ml, Saskatoon Colostrum)

[abc] Least squares means in the same row were considered significantly different at $P < 0.05$, with superscripts designating significant differences.