Impact of Essential Fatty Acids on Sow and Litter Performance

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TAKE HOME MESSAGES:

1. Sows provided high dietary essential fatty acids (EFA) produced pigs with heavier bodyweights at weaning and litters with greater total gain and ADG throughout lactation.
2. Diets with high linoleic acid and α-linoleic acid increased both colostrum and milk essential fatty acid content.
3. Sow EFA intake and subsequent modifications to the fatty acid profile of colostrum and milk did not influence overall litter survivability, nor did EFA intake influence subsequent reproductive performance of sows.

What are essential fatty acids?

There are two parental essential fatty acids, linoleic acid (LA) and α-linolenic acid (ALA), that must be provided through the diet to the sow.

After consumption, EFA are absorbed into the body and either secreted in milk or incorporated into cell membranes and adipose tissue of the sow. For the neonatal pig, EFA support brain, vision, and immune system development and function (Kaur et al., 2014). Additionally, EFA serve as precursors for prostaglandins that regulate inflammatory responses (Ricciotti and FitzGerald, 2011) and reproductive function (Roszkos et al., 2020) of the sow.

Why are essential fatty acids important for the sow and litter?

Research conducted by Rosero et al., (2015) suggested that sows can enter a state of EFA deficiency during lactation when the outflow of EFA secreted in milk to support litter growth exceeds dietary EFA intake. Currently, lactation diets without supplemental fat or diets that include animal fat sources contain very low concentrations of LA and ALA (Table 1). However, supplemental EFA provided by other fat sources that contain much greater LA and ALA such as fish or vegetable oils can be utilized as a strategy to increase daily EFA intake for lactating sows.

Table 1. Energy content and essential fatty acid composition among common lipid sources[1]

Lipid type	Energy content, ME kcal/kg	C18:2n-6 Linoleic acid, % of fat	C18:3n-3 α-Linolenic acid, % of fat
Animal fats			
Beef tallow	7,835	2.8	0.6
Choice white grease	8,124	9.2	0.4
Poultry fat	8,364	20.6	1.6
Lard	8,123	9.2	0.9
Vegetable oils			
Canola oil	8,384	20.3	9.3
Corn oil	8,579	56.2	1.2
Palm kernel oil	7,119	11.0	0.4
Soybean oil	8,574	53.1	7.4
Animal/vegetable blend	8,225	34.7	---

[1]Adapted from NRC (2012).

Although fat supplementation can increase energy density of the diets, utilization of fat sources with elevated LA and ALA can correct the negative EFA balance that may occur in lactation and provide opportunity for improved subsequent reproductive performance of sows (Rosero et al., 2015). Furthermore, increasing LA intake for lactating sows has been projected to increase the total number of pigs born in subsequent litters of weaned sows (Figure 1).

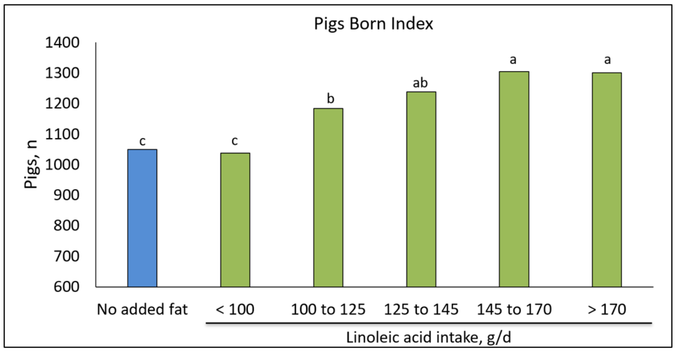

Figure 1. Influence of daily linoleic acid intake during lactation on the total number of pigs born per 100 weaned sows considering subsequent farrowing and total pigs born (Adapted from Rosero et al., 2016a).

As previously mentioned, EFA are primarily secreted in milk during lactation to support litter growth and development (Innis, 2007; Odle et al., 2014). Furthermore, the inclusion of dietary oils that stimulate production of anti-inflammatory compounds and reduce oxidative stress have been observed to positively influence both sow performance and litter survival (Ward et al., 2020). Additionally, researchers from Australia (van Wettere, 2018) have observed a reduction in piglets born dead when sows were fed diets that provided 120 g/d LA intake compared to 70 g/d of LA beginning at the time sows entered farrowing rooms.

It is difficult to fully understand the influence of LA and ALA on survivability of piglets within litters, however, as responses among available literature are not consistent. It's also important to recognize that potential variation of litter survivability responses may be due to differences among oil sources utilized in lactation diets, dietary inclusion rate, timing of pre-farrow supplementation, and basal mortality rates of populations. It is also essential to consider the number of treatment replicates within available literature.

Recent evaluation of EFA-study objectives and design

To further understand the effects of dietary EFA, researchers at Kansas State University recently completed a large commercial study in partnership with Smithfield Foods (Holen et al., 2022). Within this experiment, 3,451 sows and their litters were used over 12 months to determine the impact of fat sources providing low and high EFA intake on sow reproductive performance, piglet growth and survivability, and colostrum and milk composition. At entry to the farrowing room (approximately d 112 of gestation), sows were randomly assigned within parity groups to 1 of 4 corn-soybean meal-wheat-based lactation diets that contained 0.5% (Control) or 3% choice white grease (CWG), 3% soybean oil (SO), or a combination of 3% soybean oil and 2% choice white grease (Combination). Thus, sows were provided diets with low EFA in diets with CWG or high EFA in diets that included soybean oil. Sows received their assigned EFA treatments until weaning and were then fed a common gestation and lactation diet in the subsequent reproductive cycle.

What did we learn?

As intended, sows provided diets with high EFA consumed greater LA and ALA at levels similar to or exceeding the recommendations provided by Rosero et al. (2016a) for optimal sow reproductive performance (Table 2). Overall, sows consuming high EFA from the SO or Combination diets produced litters with greater litter ADG and heavier piglet weaning weights (Figure 2) when compared to litters from sows fed diets with low EFA provided by CWG at either 0.5% or 3%.

Table 2. Effects of dietary fat source and essential fatty acid intake during lactation on sow performance and litter survivability (Holen et al., 2022)[1]

Trait	Control	CWG	SO	Combination	SEM	*P* =
Sows, n	850	865	874	862	---	---
Parity	4.7	4.7	4.7	4.7	0.11	0.858
Lactation length, d	24.1	24.1	24.0	24.1	0.11	0.733
Lactation EFA intake, g/d						
Linoleic acid[2]	83.0[d]	105.1[c]	173.6[b]	198.4[a]	0.83	< 0.001
α-linolenic acid[2]	6.0[d]	8.2[c]	23.0[b]	26.9[a]	0.10	< 0.001
Litter survivability, %						
Birth to 24 h[3]	89.9	89.1	89.3	89.6	0.33	0.167
24 h to wean[4]	89.7	90.0	90.0	89.6	0.33	0.751

[a-d]Means within row with different superscripts differ ($P < 0.05$).

[1]A total of 3,451 sows and their litters were used over a 28-d experimental period with 850 to 874 sows per treatment. Experimental treatments contained supplemental fat at 0.5% (Control), 3% (CWG or SO), or 5% (Combination; 3% SO and 2% CWG).

[2]Calculated using analyzed dietary LA and ALA and sow overall lactation ADFI.

[3]Survival from birth to 24 h = [(Pigs born alive - count of mortality within 24 h)/Pigs born alive].

[4]Survival from 24 h to wean = count of pigs at weaning/count of pigs alive at 24 h.

Dietary treatment EFA and fat composition did not influence colostrum or milk crude fat or crude protein content in this study. However, LA and ALA content of both colostrum and milk increased in response to high EFA intake among sows provided the SO and Combination treatments (data not shown). Despite the advantages observed in litter growth performance, the elevated dietary LA and ALA and subsequent modifications to colostrum and milk fatty acid profiles did not improve survivability of litters. Furthermore, subsequent reproductive performance of sows was similar among sows, regardless of previous lactation EFA intake.

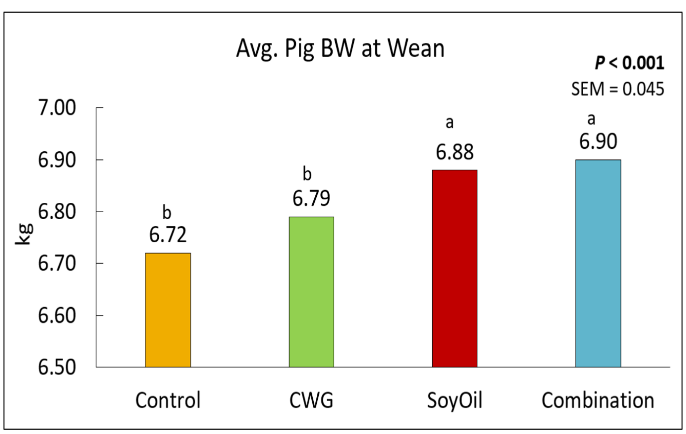

Figure 2. Effects of dietary fat source and essential fatty acid intake during lactation on average bodyweight of pigs at weaning (Holen et al., 2022). A total of 3,451 sows and their litters were used over a 28-d experimental period with 850 to 874 sows per treatment. Experimental treatments contained supplemental fat at 0.5% (Control), 3% (CWG or SO), or 5% (Combination; 3% SO and 2% CWG).

What factors should be considered when evaluating dietary fat sources to increase sow EFA intake during lactation?

The following criteria should be reviewed when evaluating the potential impact of elevated EFA intake for lactating sows within farms: 1) lactation daily feed intake; 2) body condition and bodyweight loss; 3) average parity of the sow herd; 4) lactation length; and 5) litter size. Sows within farms that have lower feed intake during periods of heat stress or commonly undergo significant bodyweight loss during lactation may especially benefit from increased dietary LA and ALA to mitigate scenarios of negative EFA balances and prepare the sow for optimal reproductive performance. Furthermore, the cost of including high EFA fat sources in lactation and the economic value of improved litter growth and the production of heavier piglets at weaning must be assessed for each farm.

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