Wheat for swine: Nutritional properties for diets

Wheat is a major cereal grain utilized in swine diets across the world. Wheat typically serves as a main cereal grain in Canadian, European, and Australian swine diets. Although wheat is not as prevalent in United States swine diets, it can still be incorporated depending on availability and cost. This fact sheet discusses important nutritional properties associated with wheat and its application in swine diets.

Utilizing wheat in swine diets

Wheat contains higher levels of crude protein (CP) and amino acids (AA) compared to most other cereal grains. This allows for less soybean meal inclusion in the diet to meet the pigs AA requirement. Wheat's standardized ileal digestibility (SID) of CP and AA is similar to corn, but greater than barley and sorghum. Wheat has a particularly high Trp content which results in less feed grade Trp needed to be supplemented to meet the pig's requirements.

Wheat has a lower energy density than corn but is higher in energy than many other cereal grains. Wheat has both a higher total P and digestibility of P compared to corn, therefore less supplemental P is needed in wheat-based diets compared to diets based on other cereal grains.

Nutrient and amino acid profile and standardized ileal digestibility

Wheat contains on average 12.6% CP with a range of 8.5 to 17.6%. Variation in protein content is due to different classes and growing regions of wheat. Hard and spring classes of wheat will generally have higher protein than soft and winter classes of wheat. The mean SID of CP is 87.2%. On average, wheat contains 0.38% Lys with an SID of 76.8%. As CP content in wheat increases, so will the total Lys and digestibility. A 1% increase in CP content will result in a 0.019 and 0.026% increase in total Lys and the content of SID Lys in wheat, respectively.

Table 1. Nutrient and AA composition and SID of wheat[1]

Item, %	N	Content	SID
DM	36	88.9	---
CP	55	12.6	87.2
EE	52	1.7	---
Ash	49	1.6	---
ADF	49	2.8	---
NDF	49	11.7	---
Starch	39	57.7	---
AA, %			
Lys	45	0.38	76.8
Ile	45	0.43	87.1
Met	45	0.19	88.3
Thr	45	0.35	80.9
Trp	43	0.15	86.5
Val	45	0.56	85.0

[1] Stas et al., 2024

Wheat's average starch content is 57.7% with a range of 30.3 to 64.4%. In general, higher protein wheat will typically have a lower starch content. This is due to the protein to starch ratio within the endosperm of the wheat kernel (Saleem et al., 2022). Wheat has higher acid-detergent fiber (ADF) and neutral detergent fiber (NDF) compared to other cereal grains such as corn and sorghum. However, wheat is still considered a high starch, low fiber cereal grain (McGhee and Stein, 2020). Wheat is similar to other cereal grains for dry matter (DM), ether extract (EE), and ash.

Phosphorus and phytase activity

Mean P of wheat is 0.27% with a range of 0.07 to 0.45%. In addition to high P, wheat also has very high digestible P because it contains intrinsic phytase. The standardized total tract digestible P in wheat is 0.218%, whereas corn is only 0.088% (NRC, 2012). Intrinsic

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phytase allows for increased release of phytate-bound P that is largely unavailable to pigs (Poulsen et al., 2010). Wheat's intrinsic phytase is more of an advantage when microbial phytase is not added to the diet. However, even though wheat contains high levels of intrinsic phytase, supplementation of microbial phytase in wheat-based diets will still improve P digestibility in pigs.

Energy

When summarizing all published values, mean gross energy, digestible energy (DE), and metabolizable energy (ME) values of wheat are 4,401, 3,900, and 3,785 kcal/kg of DM, respectively. Previous literature suggested wheat contains 91 to 97% of the energy of corn for pigs (Stein et al., 2010). However, more recent literature with direct comparisons of wheat and corn suggest wheat's mean energy content is 99 and 98% of the energy of corn for DE and ME, respectively (Table 2; Cervantes-Pahm et al., 2014; Park et al., 2016; Jeon et al. 2019; McGhee and Stein, 2020; Rodriguez et al., 2020). Therefore, wheat can be utilized at a similar rate as corn without a major decrease in the energy density of the diet. Energy content of wheat can vary depending on the class of wheat and growing conditions (Rosenfelder et al., 2013).

Net energy (NE) was calculated using Eq. 1-8 from NRC (2012) using DE, EE, starch, CP, and ADF values. Mean NE of wheat agrees with previously published values. The NRC (2012) reports an NE of 2,788 and 3,004 kcal/kg DM for hard red and soft red wheat, respectively.

Table 2. Energy content of wheat vs. corn (kcal/kg DM)[1]

Item	N	Wheat	Corn	Ratio
GE	6	4,404	4,418	1.00
DE	6	3,824	3,882	0.99
ME	6	3,690	3,780	0.98
NE[2]	15	2,786	---	---

[1] Stas et al., 2024. Only includes publications with direct comparisons to corn.

[2] Net energy value of wheat is calculated using Eq. 1-8 from NRC (2012).

Processing and Pelleting

Processing wheat by grinding to a finer particle size leads to linear improvements in feed efficiency (De Jong et al., 2016). However, wheat particle size is generally recommended to not fall below 500 µm for swine diets (Stein et al., 2010). Wheat tends to flour when ground too finely resulting in reduced feed intake, stomach lesions, and dust accumulation (Mavromichalis et al., 2000).

Gluten and hemi-cellulose in wheat is beneficial to improve quality of pelleted feed diets (Behnke, 1990). Pelleted wheat diets have been found to have significantly greater pellet durability index by 33.1% units compared to corn-based diets (Stevens, 1987). Even if wheat is not utilized as the main cereal grain, it can be incorporated into diets as a pelleting aid. Increasing wheat in the diet from 5, 10, and 20% of the diet has been shown to progressively increase PDI regardless of die thickness (Behnke, 1990).

More information about nutritional characteristics associated with wheat is described by Stas et al. (2024).

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