Nutritional Value of Soybean Products

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Summary

Soybean meal, fermented soybean meal, and enzyme-treated soybean meal are excellent sources of protein, and their amino acid profiles complement that of most cereal grains. The crude protein and amino acids in soybean meal are more digestible compared with the digestibility of crude protein and amino acids in other protein sources, such as corn distillers dried grains with solubles, canola meal, or sunflower meal. However, soybean meal can cause decreased growth performance when fed to weanling pigs, but processing of soybean meal to produce fermented soybean meal or enzyme-treated soybean meal removes antinutritional factors and antigenic proteins, which may mitigate transient hypersensitivity in weanling pigs. Soybean meal contains a large percentage of phytate-bound phosphorus; however, addition of microbial phytase or further processing to produce fermented soybean meal, hydrolyzes the phytate bonds and increase the concentration of free phosphorus in soybean meal. Soybean meal can be included in diets fed to all phases of swine production to supply adequate levels of amino acids; however, conventional soybean meal levels usually are restricted to less than 20% in diets fed to weanling pigs. In contrast, fermented soybean meal and enzyme-treated soybean meal are well tolerated by young pigs and may replace fishmeal or animal proteins in weanling pig diets.

Introduction

In 2012, the U.S. produced 31% (82.0 million tons) of the world's soybeans, making it the second largest soybean producer after Brazil (Soyatech, 2014). However, the U.S. is predicted to produce 88.6 million tons of soybeans during the 2013-2014 harvest season, which would once again make the U.S. the world's top soybean producer. The majority of soybeans are dehulled, defatted, and crushed to produce soybean meal (**SBM**) that is then fed to livestock. Due to its favorable nutrient and digestible amino acid (**AA**) composition, SBM is the primary protein source fed to livestock (Shelton et al., 2001), with pigs consuming approximately 26% of total SBM produced (Stein et al., 2008; ASA, 2013).

Raw soybeans contain antinutritional factors, such as trypsin inhibitors, oligosaccharides, antigenic proteins, and lectins. To remove trypsin inhibitors and lectins, SBM is toasted. Trypsin inhibitors are known for binding to trypsin, chymotrypsin, and other enzymes, which ultimately decrease AA digestibility and growth performance in pigs (Yen et al., 1977; Goebel and Stein, 2011). However, because of the other antinutritional factors in SBM, weanling pigs have a difficult time digesting SBM, and as a consequence, they will experience a temporary decrease in nutrient digestibility and reduced growth performance if fed diets containing high levels of SBM (Li et al., 1990, 1991; Friesen et al., 1993; Qin et al., 1996). The temporary decrease in nutrient digestibility is the result of transient hypersensitivity to the soy protein, which causes villus atrophy in the small intestine of weanling pigs (Li et al., 1990). Therefore, SBM inclusion in weanling pig diets is usually restricted to less than 20%.

Fermentation or enzyme treatment of SBM removes the antigenic proteins (Sissons, 1982), and these products can be fed as replacements for animal proteins such as fish meal without negatively affecting growth (Jones et al., 2010; Kim et al., 2010). As a consequence, in the last decade, interest has increased in feeding fermented soybean meal (**FSBM**) or enzyme-treated soybean meal (**ESBM**) to potentially mitigate the effects of transient hypersensitivity by deactivating these antigenic proteins and removing oligosaccharides.

Energy and Nutrient Composition

Energy

Soybean meal is primarily classified as a protein source, but it also contributes energy to the diet. Soybean meals from different growing regions of the U.S. contain similar concentrations of nutrients and antinutritional factors (Table 1; Sotak and Stein, 2014). However, SBM from the western growing region of the United States has decreased energy and crude protein (**CP**) concentrations compared with the northern and eastern growing regions of the U.S. The energy values for SBM observed in research conducted at the University of Illinois between 2010 and 2013 (Goebel and Stein, 2011b; Rodriguez et al., 2013; Rojas and Stein, 2013a; Sulabo et al., 2013; Yoon and Stein, 2013; Baker et al., 2014; Sotak and Stein, 2014) are greater than energy values reported by NRC (1998; 2012). It is, therefore, possible that the NRC (1998; 2012) underestimates the energy concentrations of SBM.

Fermented SBM and ESBM have greater concentrations of CP, acid detergent fiber (**ADF**), and neutral detergent fiber (**NDF**) because fermentation removes sucrose and oligosaccharides from the SBM (Cervantes-Pahm and Stein, 2010; Rojas and Stein, 2013b). Energy values for FSBM and ESBM are greater compared with energy values of SBM (Table 2). The increase in energy for FSBM and ESBM is due to increased concentrations of CP and decreased concentrations of antinutritional factors and antigenic proteins.

Carbohydrates

Soybeans are a major contributor of carbohydrates to the diet and contain 30 to 35% carbohydrates. These carbohydrates are classified as either structural (e.g., cellulose, hemicellulose, or lignin) or non-structural (e.g., sugars, oligosaccharides, or starch; Table 3; Grieshop et al., 2003). All non-structural carbohydrates are soluble and easily fermented by the pig, but only some structural carbohydrates are soluble and fermentable. The remaining structural carbohydrates are not easily fermented by the pig, which decreases the energy the pig can obtain from the ingredient.

On average, SBM contains 5 to 7% oligosaccharides (Karr-Lilienthal et al., 2005). When 2% stachyose was added to weanling pig diets, a greater decrease in growth performance was observed compared with weanling pigs fed diets containing 20% SBM (Liying et al., 2003). Pigs fed 1% stachyose had similar growth performance and decreased incidence of diarrhea compared with pigs fed SBM (Liying et al., 2003); therefore, other antinutritional factors, such as glycinin, may be a factor in the transient hypersensitivity observed in weanling pigs (Li et al., 1991). Pre-exposure to SBM prior to weaning did not affect growth performance in weanling pigs (Friesen et al., 1993). However, FSBM and ESBM contain almost no oligosaccharides due to hydrolysis of oligosaccharides during the fermentation process (Cervantes-Pahm and Stein, 2010), which may make them more digestible to weanling pigs and mitigate transient hypersensitivity. Jones et al. (2010) observed similar daily gains and daily feed intakes, but improved gain:feed ratios, in pigs fed increasing levels of FSBM.

Dietary fiber components include ADF, NDF, and lignin, and are not easily fermentable by the pig, which causes a decrease in dry matter digestibility. Ingredients containing higher fiber concentrations have a decreased dry matter digestibility because dietary fiber increases the rate of passage in the intestine, which decreases time for absorption. However, whereas SBM, FSBM, and ESBM have similar concentrations of dietary fiber, these concentrations are low compared with other protein sources, such as canola meal, distillers dried grains with solubles (**DDGS**), and sunflower meal (Table 4).

Phosphorus and Calcium

Phosphorus aides in skeletal support, and is also important in lipid metabolism and transport, and cell membrane structure (Pond et al., 2005). Total phosphorus (**P**) is the sum of phytate bound P, inorganic P, and other P found in SBM (Table 5). Phytate-bound P is unavailable to pigs because they lack the phytase enzyme (Paulsen, 2008). When microbial phytase is added to the diet, apparent total tract digestibility (**ATTD**) of P and standardized total tract digestibility (**STTD**) of P increase (Almeida and Stein, 2010), which ultimately decreases fecal P by 35% (Simons et al., 1990). Fermented SBM has increased ATTD and STTD of P compared with SBM, but FSBM and SBM had similar ATTD and STTD of P when microbial phytase was added to the diet (Rojas and Stein, 2012). During the fermentation process, the phytate bonds may have been hydrolyzed, which increased the concentration of free P available to the pig (Ilyas et al., 1995). Enzyme-treated SBM had similar ATTD and STTD of P compared with SBM; however, an increase was observed when the enzyme mixture contained phytase. When microbial phytase was added to diets, pigs fed ESBM had similar ATTD and STTD of P compared with pigs fed SBM (Goebel and Stein, 2011b).

Not only does phytate bind P, but it also binds calcium (**Ca**), which ultimately decreases its absorption (Paulsen, 2008). The ATTD and STTD of Ca increased for FSBM, ESBM, and SBM when microbial phytase was added to the diet (Goebel and Stein, 2011b; Rojas and Stein, 2012).

Protein and Amino Acids

Soybean meal is the premiere source of protein for pigs because the **AA** profile is complementary to several cereal grains, such as corn, sorghum, barley, and wheat. Soybean protein is rich in lysine, threonine, and tryptophan, but deficient in sulfur AA. Cereal grains tend to be deficient in lysine, threonine, and tryptophan, but rich in sulfur AA. Proteins in SBM are highly digestible, and have a greater standardized ileal digestibility (**SID**) compared with canola meal and corn DDGS

(Gonzalez-Vega et al., 2012; NRC, 2012). Soybean meal not only has increased SID of CP compared with canola meal and corn DDGS, but also contains more AAA and less dietary fiber. Therefore, SBM supplies more energy to pigs compared with canola meal.

The concentration of CP in SBM is greater than in soybeans because of the removal of fat and the hulls. With the removal of oligosaccharides and antigenic proteins during fermentation, FSBM and ESBM have greater concentrations of CP compared with SBM (Table 2; Cervantes-Pahm and Stein, 2010). Fermented SBM and ESBM have similar SID of AA compared with SBM, but adding fat to diets increases SID of AA because it decreases the rate of intestinal passage, allowing for increased absorption (Table 6; Cervantes-Pahm and Stein, 2008).

Another advantage of using SBM as the protein source instead of other protein sources (e.g., canola meal, corn DDGS, or sunflower meal) is decreased variability among batches of product (Table 7). Variability among batches is challenging when formulating diets due to a decrease in confidence in digestibility values; therefore, swine nutritionists have more confidence in digestibility values in SBM compared with other protein sources.

Fat

Soybean oil contains approximately 79% unsaturated fatty acids and 14.5% saturated fatty acids (Table 8). The major fatty acid in soybean oil is linoleic acid (C18:2; 50% of total). Soybean oil also contains approximately 6% linolenic acid (C18:3), which may have anti-inflammatory properties in diets fed to pigs (NRC, 2012). Because soybean oil contains a large portion of unsaturated fatty acids, issues with processing pork bellies and loins and decreased shelf life can occur if large quantities of soybean oil are used during the finishing phase.

Literature Cited

Almeida, F. N., and H. H. Stein. 2010. Performance and phosphorus balance of pigs fed diets formulated on the basis of values for standardized total tract digestibility of phosphorus. J. Anim. Sci. 88:2968-2977.

Baker, K. M., Y. Liu, H. H. Stein. 2014. Nutritional value of soybean meal produced from high protein, low oligosaccharide, or conventional varieties of soybeans and fed to weanling pigs. Anim. Feed Sci. Technol. 188:64-73.

Cervantes-Pahm, S. K., and H. H. Stein. 2008. Effect of dietary soybean oil and soybean protein concentration on the concentration of digestible amino acids in soybean products fed to growing pigs. J. Anim. Sci. 86:1841-1849.

Cervantes-Pahm, S. K., and H. H. Stein. 2010. Ileal digestibility of amino acids in conventional, fermented, and enzyme treated soybean meal and in soy protein isolate, fish meal, and casein fed to weanling pigs. J. Anim. Sci. 88:2674-2683.

Friesen, K. G., R. D. Goodband, J. L. Nelssen, F. Blecha, D. N. Reddy, P. G. Reddy, and L. J. Kats. 1993. The effect of pre- and postweaning exposure to soybean meal on growth performance and on the immune response in the early-weaned pig. J. Anim. Sci. 71:2089-2098.

Goebel, K. P., and H. H. Stein. 2011a. Ileal digestibility of amino acids in conventional and low-Kunitz soybean products fed to weanling pigs. Asian-australas. J. Anim. Sci. 24:88-95.

Goebel, K. P., and H. H. Stein. 2011b. Phosphorus digestibility and energy concentration of enzyme-treated and conventional soybean meal fed to weanling pigs. J. Anim. Sci. 89:764-772.

González-Vega, J. C., and H. H. Stein. 2012. Amino acid digestibility in canola, cottonseed, and sunflower products fed to finishing pigs. J. Anim. Sci. 90:4391-4400.

Grieshop, C. M., C. T. Kadzere, G. M. Clapper, E. A. Flickinger, L. L. Bauer, R. L. Frazier, and G. C. Fahey. 2003. Chemical and nutritional characteristics of United States soybeans and soybean meals. J. Agric. Food Chem. 51:7684-7691.

Ilyas, A., M. Hirabayashi, T. Matsui, H. Yano, F. Yano, T. Kikushima, M. Takebe, and K. Hakayaka. 1995. A note on the removal of phytate in soybean meal using *Aspergillus usami*. Asian-australas. J. Anim. Sci. 8:135-138.

Jones, C. K., J. M. DeRouchey, J. L. Nelssen, M. D. Tokach, S. S. Dritz, and R. D. Goodband. 2010. Effects of fermented soybean meal and specialty animal protein sources on nursery pig performance. J. Anim. Sci. 88:1725-1732.

Karr-Lilienthal, L. K., C. T. Kadzere, C. M. Grieshop, and G. C. Fahey. 2005. Chemical and nutritional properties of soybean carbohydrates as related to nonruminants: A review. Livest. Prod. Sci. 97:1-12.

Kim, S. W., E. van Heugten, F. Ji, C. H. Lee, and R. D. Mateo. 2010. Fermented soybean meal as a vegetable protein source for nursery pigs: I. Effects on growth performance of nursery pigs. J. Anim. Sci. 88:214-224.

Li, D. F., J. L. Nelssen, P. G. Reddy, F. Blecha, J. D. Hancock, G. L. Allee, R. D. Goodband, and R. D. Klemm. 1990. Transient hypersensitivity to soybean meal in the early-weaned pig. J. Anim. Sci. 68:1790.

Li, D. F., J. L. Nelssen, P. G. Reddy, F. Blecha, R. Klemm, and R. D. Goodband, 1991. Interrelationship between hypersensitivity to soybean proteins and growth performance in early-weaned pigs. J. Anim. Sci. 69:4062-4069.

Liying, Z., L. Defa, S. Qiao, E. W. Johnson, B. Li, P. A. Thacker, and I.N.K. Han. 2003. Effects of stachyose on performance, diarrhea incidence and intestinal bacteria in weanling pigs. Arch. Anim. Nutr. 57:1-10.

NRC. 1998. Nutrient requirements of swine 10th Ed. National Academy Press, Washington, DC.

NRC. 2012. Nutrient requirements of swine 11th Ed. National Academy Press, Washington, DC.

Paulsen, M. R. 2008. Measurement and Maintenance of Soybean Quality. Pages 151-192 in Soybeans Chemistry, Production Processing, and Utilization. L. A. Johnson, P. J. White, and R. Galloway, eds. AOCS Press, Urbana, IL.

Pond, W. G., D. C. Church, K. R. Pond, and P. A. Schoknecht. 2005. Macromineral Elements. Pages 163-183 in Basic Animal Nutrition and Feeding 5th Edition. R. Hope, C. Raphael, and S. Wolfman-Robichaud, eds. John Wiley & Sons, Inc., Hoboken, NJ.

Qin, G. X., M.W.A. Verstegen, and A.F.B. Van der Poel. 1998. Effect of temperature and time during steam treatment on the protein quality of full-fat soybeans from different origins. J. Sci. Food Agric. 77:393-398.

Rodriguez, D. A., R. C. Sulabo, J. C. Gonzalez-Vega, and H. H. Stein. 2013. Energy concentration and phosphorus digestibility in canola, cottonseed, and sunflower products fed to growing pigs. J. Anim. Sci. 93:493-503.

Rojas, O. J., and H. H. Stein. 2012. Digestibility of phosphorus by growing pigs of fermented and conventional soybean meal without and with microbial phytase. J. Anim. Sci. 90:1506-1512.

Rojas, O. J., and H. H. Stein. 2013a. Concentration of digestible and metabolizable energy and digestibility of amino acids in chicken meal, poultry byproduct meal, hydrolyzed porcine intestines, a spent hen-soybean meal mixture, and conventional soybean meal fed to weanling pigs. J. Anim. Sci. 91:3220-3230.

Rojas, O. J., and H. H. Stein. 2013b. Concentrations of digestible, metabolizable, and net energy and digestibility of energy and nutrients in fermented soybean meal, conventional soybean meal, and fish meal fed to weanling pigs. J. Anim. Sci. 91:4397-4405.

Shelton, J. L., M. D. Hemann, R. M. Strode, G. L. Brashear, M. Ellis, F. K. McKeith, T. D. Bidner, and L. L. Southern. 2001. Effect of different protein sources on growth and carcass traits in growing-finishing pigs. J. Anim. Sci. 79:2428-2435.

Simons, P.C.M, H.A.J. Versteegh, A. W. Jongbloed, P. A. Kemme, P. Slump, K. D. Bos, M.G.E. Wolters, R. F. Beudeker, and G. J. Verschoor. 1990. Improvement of phosphorus availability by microbial phytase in broilers and pigs. Br. J. Nutr. 64:525-540.

Sissons, J. W. 1982. Effects of soyabean products on digestive processes in the gastrointestinal tract of preruminants calves. Proc. Nutr. Soc. 41:53-61.

Sotak, K. M., and H. H. Stein. 2014. Concentrations of digestible and metabolizable and net energy in soybean meal produced throughout the United States and fed to pigs. J. Anim. Sci. 92(Suppl. 2):68-69 (Abstr.)

Stein, H. H., L. L. Berger, J. K. Drackley, G. F. Fahey, Jr., D. C. Hernot, and C. M. Parsons. 2008. Nutritional properties and feeding values of soybeans and their coproducts. Pages 613-660 in Soybeans Chemistry, Production, Processing, and Utilization. L. A. Johnson, P. J. White, and R. Galloway, ed. AOCS Press, Urbana, IL.

Sulabo, R. C., L. I. Chiba, F. N. Almeida, S. D. Brotzge, R. L. Payne, and H. H. Stein. 2013. Amino acid and phosphorus digestibility and concentration of digestible and metabolizable energy in hydrolyzed feather meal fed to growing pigs. J. Anim. Sci. 91:5829-5837.

Yoon, J., and H. H. Stein. 2013. Energy concentration of high-protein, low-oligosaccharide, and conventional full fat de-hulled soybeans fed to growing pigs. Anim. Feed Sci. Technol. 184:105-109.

Table 1. Energy and nutrient composition of soybean meal (SBM) from different regions of the U.S.

Item	Zone[1]				Average[2]	*P*-value[3]
	1	2	3	4		
GE, kcal/kg	4,165	4,209	4,162	4,198	4,184	0.08
DE, kcal/kg DM	3,882[a]	3,875[a]	3,835[b]	3,858[ab]	3,863	0.02
ME, kcal/kg DM	3,732[ab]	3,736[a]	3,694[b]	3,718[ab]	3,720	0.02
DM, %	88.60	88.71	88.30	89.03	88.66	0.18
CP, %	46.64[ab]	48.44[a]	46.50[b]	48.06[a]	47.41	0.03
AEE, %[4]	1.11[ab]	0.86[b]	1.37[a]	0.69[b]	1.01	0.04
ADF, %	4.81	5.20	4.89	4.76	4.91	0.34
NDF, %	7.78	7.53	8.21	8.94	8.11	0.13
Lignin, %	0.60	0.59	0.58	0.63	0.58	0.13
Ca, %	0.34	0.30	0.47	0.42	0.38	0.06
P, %	0.63	0.65	0.67	0.64	0.65	0.07

a-d Means within a row lacking a common superscript letter are different ($P < 0.05$).

1 Zone 1 = northern growing area (MI, MN, and SD); Zone 2 = eastern growing area (GA, IN, and OH); Zone 3 = western growing area (IA, MO, and NE); Zone 4 = IL.

2 Average is for the 22 sources of SBM.

3 *P*-values compare SBM within the 4 zones and are considered significant at $P \leq 0.05$.

4 AEE = acid hydrolyzed ether extract.

Table 2. Energy and nutrient composition of soybean meal (SBM), fermented soybean meal (FSBM), and enzyme-treated soybean meal (ESBM; as fed basis).[1]

Item	SBM	FSBM	ESBM
GE, kcal/kg	4,256	4,533	4,451
DE, kcal/kg	3,619	3,975	3,914
ME, kcal/kg	3,294	3,607	3,536
DM, %	89.98	92.88	92.70
CP, %	47.73	54.07	55.62
EE, %	1.52	2.30	1.82
Ca, %	0.33	0.29	0.31
P, %	0.49	0.80	0.75

1 Values obtained from NRC (2012); Goebel and Stein, 2011; Rojas and Stein, 2013b.

Table 3. Carbohydrates in soybean meal (SBM), fermented soybean meal (FSBM), and enzyme-treated soybean meal (ESBM).[1]

Item, %	SBM	FSBM	ESBM
Sucrose	4.30	ND[2]	0.20
Stachyose	7.33	0.06	0.24
Raffinose	3.78	ND	0.35
Verbascose	ND	-	-
ADF	5.28	4.53	5.37
NDF	8.21	8.82	11.43
Lignin	1.10	-	-
Starch	1.89	0.90	-

1 Values obtained from Goebel and Stein, 2011b; NRC, 2012; Rojas and Stein, 2013.

2 ND = Not detected.

Table 4. Dietary fiber content of protein sources, %.[1]

Item, %	Soybean meal	Corn DDGS	Canola meal	Sunflower meal
ADF	5.28	12.02	15.42	23.00
NDF	8.21	30.46	22.64	30.24
Lignin	1.10	5.05	3.36	8.6
Crude fiber	3.89	8.92	10.50	18.44

[1] Values obtained from NRC, 2012.

Table 5. Concentrations and apparent total tract digestibility (ATTD) and standardized total tract digestibility (STTD) of phosphorus (P) and calcium (Ca) in soybean meal (SBM), fermented soybean meal (FSBM), and enzyme-treated soybean meal (ESBM).[1]

Item, %	SBM	FSBM	ESBM
Total P	0.71	0.80	0.75
ATTD of P	39.00	60.90	60.00
STTD of P	48.00	65.50	66.00
Phytate-bound P	0.38	0.40	-
Phytate-bound of total P	53.5	50.00	-
Non-phytate P	0.33	0.40	-
Non-phytate bound P of total P	46.50	50.00	-
Total Ca	0.33	0.29	0.31

[1] Values obtained from Goebel and Stein, 2011; NRC, 2012; Rojas and Stein, 2012.

Table 6. Standardized ileal digestibility (SID, %) of crude protein (CP) and amino acids (AA) in soybean meal (SBM), fermented soybean meal (FSBM), and enzyme-treated soybean meal (ESBM).[1]

Item, %	SBM	FSBM	ESBM
CP	87	79	88
Indispensable AA			
Arginine	94	90	96
Histidine	90	81	90
Isoleucine	89	82	89
Leucine	88	82	89
Lysine	89	75	86
Methionine	90	88	91
Phenylalanine	88	80	86
Threonine	85	73	83
Tryptophan	91	78	83
Valine	87	80	89
Dispensable AA			
Alanine	85	79	86
Aspartic acid	87	78	86
Cysteine	84	64	73
Glutamic acid	89	78	88
Glycine	84	75	89
Serine	89	80	87
Tyrosine	88	88	92

[1] Values obtained from NRC, 2012.

Table 7. Variability in standardized ileal digestibility (SID) of amino acids (AA) expressed as standard deviation (SD) in soybean meal (SBM), corn distiller's dried grains with solubles (DDGS), canola meal, and sunflower meal.[1]

	SBM		DDGS		Canola meal		Sunflower meal	
AA	**SID**	**SD**	**SID**	**SD**	**SID**	**SD**	**SID**	**SD**
Arginine	94	3.12	81	5.25	85	5.56	93	3.35
Histidine	90	4.15	78	4.75	78	10.24	85	6.28
Isoleucine	89	3.79	76	4.87	76	8.34	80	6.15
Leucine	88	3.45	84	4.00	78	6.44	80	5.27
Lysine	89	3.44	61	8.75	74	9.65	78	5.13
Methionine	90	4.70	82	4.13	85	4.06	89	-
Phenylalanine	88	3.65	81	3.96	77	8.42	81	7.11
Threonine	85	4.47	71	5.73	70	9.64	77	8.54
Trypeophan	91	3.32	71	8.16	71	-	80	-
Valine	87	4.16	75	4.95	74	9.78	79	8.06

[1] Values obtained from NRC, 2012.

Table 8. Fatty acid profile (% of ether extract) and iodine value of full-fat soybeans.[1]

Fatty acid	Abbreviation	%
Myristoleic acid	C-14:0	0.28
Palmitic acid	C-16:0	10.62
Palmitoleic acid	C-16:1	0.28
Stearic acid	C-18:0	3.57
Oleic acid	C-18:1	21.81
Linoleic acid	C-18:2	49.79
Linolenic acid	C-18:3	6.67
Saturated fatty acids	-	14.46
Monounsaturated fatty acids	-	22.09
Polyunsaturated fatty acids	-	56.46
Iodine value	-	128.24

[1] Values obtained from NRC, 2012.