FORMULATING DIETS TO IODINE PRODUCT SPECIFICATIONS

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Concerns with diet affecting fat quality in swine are not a recent phenomenon. In 1926, Ellis indicated price discriminations against soft and oily carcasses. He mentioned that for many years the issue was confined to peanut growing areas, with his concern that soybeans and peanuts were being grown in an increasing geographic area and their recognition as a valuable protein source for swine. He also mentions that, "The fat derived from feed fat is not materially changed during the process of absorption and deposition." Please remember this quote as we go through today's discussion.

The fat on a pig comes from two primary dietary sources: fats and carbohydrates. Carbohydrates are converted to fat through de novo synthesis. Mayes tells us that de novo synthesis creates predominately saturated fatty acids. Thus, the fat the pig creates from carbohydrates is hard. Azain documented that that dietary fats inhibit de novo synthesis resulting in the pig taking on, for the most part, the characteristics of the fat he is fed.

The pork industry's most common measure of fat firmness is iodine value (IV), which does not measure the physical firmness of fat but is an estimation of the firmness based on a measure of unsaturated fats. IV is a determination of unsaturation based on the number of double bonds. IV is commonly measured by fatty acid analysis, the Hanus method (direct chemical means), and Near Infra-Red (NIR) methods. The vast majority of vegetable oils have a higher degree of unsaturation, higher IV and are liquid at room temperature, while animal fats are more saturated with a lower IV and are solid at room temperature.

Unsaturated fats = high iodine value= softer fat   Saturated fats = low iodine value = firmer fat.
In 1992, Madsen proposed by measuring the amount of fat/oil and IV of the fat/oil in ingredients used in a swine diet you could estimate what the IV of the carcass fat would be. This concept was furthered in 1997 by Boyd of PIC. The equation brought forth is predicted carcass back fat IV=.32 IVP +52.4 where IVP = 0.1 x (iodine value of the ingredient's fat x % of fat in that ingredient). I have found this iodine value product (IVP) concept to be a useful tool in managing the IV of carcass fat.

Monitoring fat levels in your ingredients is an important part of formulating for IVP. Whether your corn is 3.3% fat or 3.8% fat will have significant effect on your formulation. It also important to confirm the iodine values of the fat in ingredients. I have found substantial differences in sources of bakery products, feed fat, meat and bone, and distillers dried grains with soluble (DDGS) when compared to reference material. To formulate with IVP I have 3 nutrients set up in my formulation package Fat, IV, and IVP. I put values in for Fat and IV and have an equation that calculates the IVP. This equation saves from having to hand calculate your IVP each time you change an ingredient's fat level. DDGS is not the only ingredient that will cause soft fat. When you start formulating for IVP you will discover that 3% yellow grease, 3.7 pork fat or 30% DDGS will produce similar IVP.

Table 1. A Few of My Loadings

Ingredient	ME kcal/lb	Fat %	Iodine Value (IV)	Iodine Value Product (IVP)
Corn	1520	3.6	130	46.8
Milo	1483	2.9	120	34.8
Barley	1300	1.9	120	22.8
Wheat	1485	1.9	120	22.8
Midds	1170	4.95	119.5	59.2
SBM	1428	1.3	135	17.6
DDGS	1465	11.1	112	124.3
DDGS	1529	10.0	112	112
Pork fat	3630	98.5	68.5	675.7
Beef fat	3630	99	47	465.3
Soy oil	3810	100	135	1350
Yellow grease	3630	98.5	80	788
Bakery product	1500	7	115	80

Non-nutritional factors also can have substantial effects on carcass IV. Nurnberg indentified several non-nutritional factors that impact carcass IV. Genotype, in most cases a leaner pig will have softer fat. Gender, typically barrows will be harder than gilts. Age and weight, heavier and older pigs will be harder. Fat sampling location, Benz found jowl fat softer than loin fat. Apple reported differences in IV between layers of back fat with inner being harder than middle, which in turn was harder than outer. Rate of gain, Correa reported faster growing animals having firmer fat. White indicated that pigs housed above their thermoneutral zone had harder belly fat when given additional space, which also improved their daily gain.

IVP is not absolute; it is confounded by the non-nutritive factors discussed in the previous paragraph. Nutritional control is important in controlling carcass IV but IVP can be overwhelmed by the non-nutritive factors. If we know what our carcass IV is, where the sample was taken and we know the IVP of the diets those pigs consumed, we can make diet adjustments to get closer to our carcass IV target. Using IVP to formulate for carcass IV is like a map. If you know where you are (carcass IV), which direction you came from (past diet IVP), and which way you need to go (carcass IV target), then IVP can be used to move you in the right direction.
In 1926 peanut and soybeans were cost effective sources of nutrients for swine that were high in vegetable oil, which created soft fat concerns. In 2010 the Renewable Fuels Association reports 33,000,000 tons of Dried Distillers Grains will be produced this year. Seven fold year 2000 production, fourteen times as much as was produced in 1990. In 2010 DDGS are an economical source of nutrients with 8.8-12.4 % corn oil. Our 33rd president said, "There is nothing new in the world except the history you do not know."

Formulating swine diets with distillers dried grains with solubles (DDGS) has challenges above and beyond soft carcass fat. They are highly variable in their nutrient content (Table 2) and present a mycotoxin risk (Shurson 2009).

Table 2. Averages and Ranges of Selected Nutrients Among 32 U.S. DDGS Sources (100% Dry Matter Basis)

	Average	Range
Dry matter, %	89.3	87.3-92.4
Crude protein, %	30.9	28.7-32.9
Fat, %	10.7	8.8-12.4
Crude fiber, %	7.2	5.4-10.4
Ash, %	6.0	3.0-9.8
Swine ME, kcal/kg	3810	3504-4048
Lysine, %	0.90	0.61-1.06
Phosphorus, %	0.75	0.42-0.99

DDGS have been shown to reduce carcass yield (Stein 2009).They do not flow well (Ileleji 2009). DDGS offers such economically significant savings, that dealing with these issues offer the opportunity of substantial feed cost savings.

There are substantial differences in nutritional value between DDGS sources and much less difference in selling price. This creates an opportunity for the producer to substantially lower diet cost by identifying superior sources of DDGS. Having accurate nutrient loading for the DDGS source used can give the nutritionist confidence to use higher levels of DDGS, which can and will lower feed cost. I am going to make a comparison of diets formulated with two sources of DDGS and also indicate the expected consequences on carcass IV. In table 3 find the prices used in the comparison. Notice that DDGS is priced at 90% the price of corn, I have seen this as low as 70% at times which amplifies the savings.

Table 3. Prices Used in Analysis, $/ton

August 2010
Corn $3.30 bu $118/ton
SBM $290
DDGS $106
Lysine $2020
21% Phos $545
Threonine $2700
Methionine $4300
Pork fat $520

There are 2 sources of DDGS being used. The mid value plant is ranked by the Vast Illuminate program as being in the top 40% of the 100 DDGS sources that we routinely monitor. The high value source would be in the top 20% of those same 100 DDGS plants. You can see a comparison of the two DDGS sources in table 4.

Table 4. Two sources of DDGS

	Mid Value DDGS	High Value DDGS
Moisture	10.5	8.6
Fat	10.0	11.9
ADF	11.0	10.9
Crude Prot.	26.2	26.6
ME, kcal/kg	3225	3365
Lysine	.79	.86
Dig. Lysine	.51	.58
Avail. Phos	.58	.55

In Table 5 there are diets formulated to an IVP of 46.72. This IVP with good gain should achieve a jowl fat IV of 72 when fed these diets. Using the PIC equation Loin IV equals 0.32 IVP + 52.4. I calculate Jowl IV as .32 IVP + 52.4 + 4.65. The feeding programs and diets in Tables 5 thru 10 are based on feeding a constant IVP from 50 lbs to market. Another approach to lower carcass IV is the complete withdrawal of distillers for a length of time before slaughter. Xu saw a .5 to 1 IV point reduction in belly fat IV for each week withdrawal of DDGS before slaughter. Realize a 9 week withdrawal did not take belly IV down to the level of the control pigs that received no DDGS.

Table 5. Diets 46.7 IVP, DDGS: Mid Value

Ingredients	F1 46.7 IVP	F2 46.72 IVP	F3 46.72 IVP	F4 46.72 IVP	F5 46.72 IVP	F6 46.72 IVP	Paylean 46.72 IVP
Corn	1330.82	1453.87	1496.47	1572.42	1619.6	1692.65	1491.12
SBM 46%	435	350	325	272	239	187	328
DDGS	189	155	142	121	108	88	144
Limestone	21.5	20	19	18.5	19	18	19
Lysine 98.5	8.3	7.3	6.9	6.3	5.3	4.7	6.8
Salt	6	6	6	6	6	6	6
21% Phos	4	3.5	0.5			0.5	
Finish VTM	2	2	2	2	2	2	2
Threonine	1.7	1.35	1.2	0.9	0.5	0.55	1.7
Phytase	0.93	0.93	0.93	0.88	0.6	0.6	0.88
Methionine	0.75	0.05					
Paylean							0.5
$/ton	169.18	159.16	$155.80	$150.27	$145.70	$140.98	$172.91

Table 6 indicates the allocation of the 7 feeds used in this feeding program. Please notice 106 lbs of F6. The amount of F6 will be adjusted in our economic comparison in order to achieve an equal carcass weight across feeding programs utilizing varying amounts of DDGS.

Table 6. Allocation 46.7 IVP, DDGS: Mid Value

Mixed Sex Diet Number	Initial (lb)	Final (lb)	Feed/Pig (lb)	Feed/Gain	ADG	Days	Cost per head
F1	50	80	60	2.00	1.70	18	5.08
F2	80	110	69	2.30	1.80	17	5.49
F3	110	140	75	2.50	1.84	16	5.84
F4	140	170	81	2.70	1.82	16	6.09
F5	170	210	118	2.95	1.88	21	8.60
F6	210	240	106	3.45	1.73	17	7.47
Paylean	240	280	118	2.95	2.00	20	10.20
		Overall	627	2.73	1.83	126	48.76

In Table 7 diets formulated to an IVP of 56.09, which would give you an expected jowl fat IV of 75, are shown below. Loin IV is calculated

Table 7. Diets 56.09 IVP DDGS: Mid Value

Ingredients	F1 56.09 IVP	F2 56.09 IVP	F3 56.09 IVP	F4 56.09 IVP	F5 56.09 IVP	F6 56.09 IVP	Paylean 56.09 IVP
Corn	1163.94	1286.43	1335.68	1412.25	1457.75	1524	1333.7
SBM 46%	391	307	286	233	200	155	285
DDGS	403	367	337	315	304	284	339
Limestone	22	21	20.5	20	20	19.5	20.5
Lysine 98.5	8.9	7.8	7.4	6.8	5.8	5	7.4
Salt	6	6	6	6	6	6	6
21% Phos							
Finish VTM	2	2	2	2	2	2	2
Threonine	1.3	0.95	0.8	0.55	0.1	0.1	1.35
Phytase	0.86	0.82	0.62	0.4	0.35	0.4	0.55
Methionine							
Pork Fat	1	1	1	4	4	4	4
Paylean							0.5
	2000	2000	2000	2000	2000	2000	2000
$/ton	$ 161.87	$153.35	$151.54	$145.99	$141.63	$137.19	$ 168.55

In Table 8 find the feed allocation for pigs fed the diets in the table above. Notice the amount of F6 has changed. The assumptions going onto this increase in F6 are a yield drag of .322% for each 10% of DDGS fed the last 42 days of the feed program and a feed conversion of 3.55 for that time period. To make a fair economic comparison the amount of F6 is adjusted to achieve the same carcass weight on the diets in Table 7 fed using the allocation in Table 8 as you would feeding the diets in table 5 using the allocation in Table 6.

Table 8. Allocation 56.09 IVP DDGS- Mid Value

Mixed Sex Diet Number	Initial (lbs)	Final (lb)	Feed/Pig (lb)	Feed/Gain	ADG	Days	Cost per head
F1	50	80	60	2.00	1.70	18	4.86
F2	80	110	69	2.30	1.80	17	5.29
F3	110	140	75	2.50	1.84	16	5.68
F4	140	170	81	2.70	1.82	16	5.91
F5	170	210	118	2.95	1.88	21	8.36
F6	210	240	110	3.45	1.73	17	7.55
Paylean	240	280	118	2.95	2.00	20	9.94
		Overall	631	2.74	1.83	126	47.59

The cost to achieve IVP levels from 41.2 to 65.47 can be viewed in table 9 as well as the expected loin and jowl IV. The % DDGS refers to a weighted average of the level fed the last 42 days of the finishing period. This % was used to calculate the diminished yield and adjust the feed required. Higher levels of DDGS were fed prior to those 42 days to meet the appropriate IVP maximum. Notice the cost to control IV is more at the lower boundary. Another way to perceive it, is that going from 0 to 5% DDGS reduces diet cost more than going from 20 to 25% DDGS.

Table 9. DDGS: Mid Value

IVP	41.2	46.72	56.09	59.22	62.34	65.47
Loin IV	65.58	67.35	70.35	71.35	72.35	73.35
Jowl IV	70.23	72	75	76	77	78
% DDGS	0	5.817	15.594	18.74	21.923	25.073
Feed cost/hd	49.97	48.76	47.59	47.31	47.04	46.78
Savings/hd	NA	1.21	2.42	2.65	2.93	3.19
Cost/1 IV		.68	.51	.46	.43	.41

Indentifying and feeding a higher value DDGS source creates more saving as seen it Table 10. These High Value DDGS are a better buy, which makes the cost of controlling IV even higher. The pattern of the first inclusion of DDGS reducing feed cost more is continued.

Table 10. DDGS: High Value Source

IVP	41.2	46.72	56.09	59.22	62.34	65.47
Loin IV	65.58	67.35	70.35	71.35	72.35	73.35
Jowl IV	70.23	72	75	76	77	78
% DDGS	0	6.212	19.99	24.55	29.02	33.52
Feed cost/hd	50.41	48.83	46.67	46.07	45.49	45.12
Savings	NA	1.58	3.73	4.33	4.91	5.28
Cost/1IV		.89	.78	.75	.73	.68

TAKE HOME MESSAGES

- In the pig the fat derived from feed fat is not materially changed during the process of absorption and deposition
- The IVP concept is a useful tool in formulating diets to meet carcass IV goals.
- Iodine Value of the fat of the pork carcass is influenced by the diet fed, however it is not the only influencer.
- DDGS offers challenges as a feed ingredient, however the feed cost saving offered are so substantial it is worth addressing those challenges.
- Constraints on carcass IV level add substantial costs with today's ingredient prices.
- There is nothing new in the world except the history you do not know.

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