Research Report

Date:	June 30, 2022
Project title:	**Analysis of 21 Soybean Meal Samples**
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Background:

A study was completed to assess the apparent metabolizable energy and digestible amino acid content of various origins of soybean meal samples collected from the trade in Southeast Asia. This study was paid for by USSEC Southeast Asia and was conducted in the laboratories of University of New England and Bangkok Animal Research Centre (Ajinomoto). Northern Soy Marketing was approached in late 2021 to conduct additional assays on the samples at University of Missouri with logistics coordinated by Prof Seth Naeve at University of Minnesota. Results were subjected to regression and analysis to determine which of the chemical techniques might be useful in predicting amino acid and metabolizable energy.

Findings:

1. The units of trypsin inhibitor reported by University of Missouri were 2 to 2.5 x lower than expected. Averages were US meal: 0.91; Arg meal: 1.00 and Brazil meal 0.84. The individual values ranged between 0.68 and 1.23 TIU per mg compared to the reports of Ravindran et al 2014 with values between 1.66 and 3.12 TIU per mg and Ibanez et al 2019 with values between 1.19 and 5.23 TIU/mg sample. No relationships were found for TIA and lysine digestibility ($R^2 = 0.08$) or TIA and AMEn ($R^2 = 0.0001$)
2. Sucrose was found to be higher in US SBM than the others. The sucrose content of US SBM was 7.3% making it higher than SBM from both Argentina (6.8%) and Brazil (5.6%). A difference of 1.7% (17g/kg) of sucrose between the US and Brazil SBM is equivalent to 68 kcal/kg using a value of 4000 kcal/kg for sucrose. Sucrose content was found to be positively correlated to AMEn (R = 0.47) and negatively correlated to crude protein (R = - 0.71). This suggests an energy advantage for meal with low crude protein and high sucrose.
3. The level of total lysine was correlated to crude protein (R = 0.75). This suggests that crude protein is can estimate total lysine and amino acid content of meal.

4. Lysine availability (or reactivity) was highest for US meal (96.4%) followed by Brazil (96.1%) and then Argentina meal (96.0%). A negative correlation was found between lysine availability and TIA (R = -0.21). A positive correlation was found between lysine availability and lysine digestibility (R = 0.21).

Introduction

Soybean meal (SBM) is the most common protein source in broiler diets. Protein quality and nutrient composition of SBM may vary according to processing and genetics of the soybeans and handling and storage conditions of both beans and meal. The application of heat in the form of steam is necessary to remove traces of hexane remaining from oil extraction and also serves to deactivate protease inhibitors such as trypsin inhibitor that affect amino acid digestibility. Soybeans contain sucrose that remains in SBM after oil extraction. Sucrose is highly digestible and contributes to the metabolizable energy in the meal of the meal. Soybeans grown in cool climates have more sucrose than those growing under warmer tropical climates. Soybeans respire during storage and metabolic changes both protein and carbohydrate are slowed by cold temperature. Because temperate and tropically grown beans have different ratios of the various amino acids to crude protein, laboratory analysis is necessary when comparing different origins of soybean meal. This information should be continually updated to keep feed formulations accurate and avoid deficiencies or excesses in the field. A study was conducted to examine the nutrient profile of 21 samples of SBM from various origins collected from commercial locations in the Asia Pacific region in 2021. Two outlier samples were analyzed but not included in the analysis. Five samples were from US origin, ten from Argentina and four from Brazil.

Materials and methods

Samples of soybean meal from US, Argentina and Brazil were collected from feed mills in Vietnam, Philippines, Thailand, Malaysia and Australia and shipped to the Bangkok Animal Research Centre (BARC) in Bangkok. There were 5 samples of USA, 10 samples of Argentina and 4 samples of Brazil soybean meal. Only Argentina meal was available from Australia. Aliquots of samples collected at BARC were sent to UNE in Australia for laboratory analysis.

Proximate, gross energy, carbohydrates, KOH-PS and amino acids

The nutrient composition including CP, dry matter, crude fiber and ash were analyzed by the standard methods (AOAC, 1994). Aliquots of SBM samples were also scanned in a Bruker MPS near infra-red spectrophotometer. Scans were sent to Adisseo for analysis using the PNE calibrations. Non-starch polysaccharides were analyzed by standard methods (Englyst and Hudson, 1987; Theander and Westerlund, 1993). Sucrose was analyzed by HPLC using a Mass Spec detector (in house method at Eurofins). The protein solubility test used a 0.2% KOH following the procedures of Araba and Dale (1990). Amino acids were tested in SBM, feeds and digesta using AOAC method 982.30 (1994).

In vivo studies

Apparent metabolizable energy (AME) and standardized ileal amino acid digestibility were determined the Bangkok Animal Research Centre in Thailand. Metabolizable energy as AME and AMEn was measured in 756 live Arbor Acres plus broilers with a total collection from 24 to 28 days of age using the substitution method described by Ravindran et al., (2014). Standardized ileal digestible amino acids followed the method of Ravindran et al 2014 with the exception that 0.3% chromic oxide was used instead of titanium dioxide as an indicator of digestibility. A protein free diet was fed to determine endogenous flow of amino acids that were used to calculate standardized ileal digestible amino acids.

Additional assays and regression

In addition to the assays conducted above, the samples were also analyzed for trypsin inhibitor, lysine availability or reactivity, protein dispersibility index, sucrose, sugars and KOH protein solubility. The data were examined for correlations using linear regression.

Formulation exercise

The Ross 308 (Aviagen 2019) nutrient recommendations were used to formulate starter, grower and finisher diets. The metabolizable energy values and SID amino acid values obtained above were applied to the SBM from US, Argentina and Brazil and offered to the Concept 5 least cost formulation program. Formulations were based on corn-SBM, minerals and vitamins and all contained phytase. Formulations were examined for nutritional soundness and then the shadow price of each meal was retained to determine the "breakeven" price for each.

Results and discussion

Table 1 shows the crude protein, crude fat, crude fiber of the SBM samples conducted by wet chemistry and also NIRS using a Bruker MPA instrument and the Adisseo PNE calibrations. The wet chemistry results show all SBM samples were dehulled and of high quality. The Brazilian SBM was highest in crude protein being more than 1 percentage point higher as compared to US and Argentina meal. Residual crude fat content of Argentine SBM was lower than US and Brazilian meal while the crude fiber of Brazilian SBM was higher than Argentina with US being intermediate. The percentage of KOH-PS was higher in US SBM compared to Argentina meal but not significantly different than Brazilian meal. The results of the NIRS determination closely followed the wet chemistry for crude protein and crude fat and although were ranked the same as wet chemistry for crude fiber, the differences were not statistically significant. This highlights the accuracy and cost savings of using Adisseo PNE calibrations for crude protein and crude fat.

The sucrose and non-starch polysaccharide content measured in the SBM samples are shown in Table 2. The sucrose content of US SBM was 7.3% making it higher than SBM from both Argentina (6.8%) and Brazil (5.6%). A difference of 1.7% (17g/kg) of sucrose between the US and Brazil SBM is equivalent to 68 kcal/kg using a value of 4000 kcal/kg for sucrose. Soluble NSP was lower in US SBM as compared to Brazilian SBM with Argentina SBM being intermediate. Insoluble NSP was higher in US SBM as compared to SBM from Brazil with Argentina meal being intermediate. Insoluble NSP correlates to hard fiber that could be expected to have a positive impact on gizzard function. The lower soluble NSP of US meal may reflect the fact that more of the sugars are in the form of sucrose and less are present as oligosaccharides.

The total amino acid content of analyzed SBM samples on an 88% DM basis is shown in Table 3. The content of lysine in US and Argentina meal are the same and higher than Brazil meal. Cystine, arginine and glutamic acid are higher in Brazil meal as compared to US and Argentina meal. There are no differences in valine or methionine content between the meals. These differences confirm previous studies showing higher lysine in meal produced from temperate beans and high non-essential amino acids such as glutamic acid in meals produced from tropical beans. This indicates that amino acids should not be adjusted in the formulation matrix solely based on changes in crude protein content.

The apparent metabolizable energy content of meals is shown in Table 4. The results show the US SBM to have higher AME and AMEn values as compared to Brazil meal and Argentina meal. The average value measured for AME and AMEn across the meals is 2042 kcal/kg and 1873 kcal/kg on an 88% DM basis. While the relative difference between the values is precise the numbers are lower than expected and lower than those reported by Ravindran (2014), the soybean meal meta-analysis conducted by (Ibáñez et al., 2020) and previous BARC studies. For this reason, AME values were used (instead of AMEn values) for the formulation example. Correction to zero nitrogen retention is arbitrary and only done so that using values obtained in adult roosters (who do not retain nitrogen) using the true metabolizable energy technique can be easily used.

The SID amino acid coefficients are presented in Table 5 and the levels of SID amino acids used in formulation on an 88% dry matter basis are presented in Table 6. There is a tendency ($P < 0.08$) for US meal to be more digestible than Brazil meal. Methionine, cystine, threonine and valine are more digestible in US meal as compared to Brazil meal. Digestible lysine is higher in US meal compared to Brazil meal.

Figures 1, 2 and 3 show feed formulations based on corn and soybean meal for starter, grower and finisher using the Ross 308 nutrient specifications for male broilers (Aviagen, 2019). Prices of ingredients are given in the Cost$/Tonne column in USD. All soybean meals were assigned a cost of USD 630/mt. The specifications for SID amino acids and AME were used to formulate the diets offering each of the SBM. For all formulations the US SBM was selected and the Brazil and Argentina SBM were rejected. The opportunity prices of the SBM are given in Table 7. With US SBM at USD 630/mt, Argentine meal would need to be USD 4.60 less expensive in starter and grower diets and 7.80 less expensive in the finisher diet before it could be used. The Brazil meal would need to be 7.70 less expensive in starter and grower and $14.70 less expensive than US meal in finisher feed.

Figure 3 shows the relationship between sucrose concentration and AMEn of meal and Figure 4 show the relationship between sucrose and KOH protein solubility in soybean meal.

Conclusion

A series of SBM samples were collected from the trade in the Asia Pacific region and analysed for nutritional quality by wet chemistry, NIRS and in vivo determination of metabolizable energy and SID amino acids and economic value using least cost feed formulation of broiler diets. The results indicated Brazilian SBM to be highest in crude protein but lowest in total lysine and lowest in sucrose content compared to the US and Argentina meals. The AME and AMEn were highest in US meal followed by Argentina and then Brazil. The AME and AMEn values were lower than expected based on application of the WPSA equation (Jansen, 1989) to predict based on proximate values. The coefficients of lysine digestibility were not different between the meals but the US meal had the highest coefficient of methionine and cystine digestibility. The content of SID amino acids was higher for lysine in US and Argentina meal as compared to Brazilian meal. Formulation of starter, grower and finisher diets showed an economic advantage for US meal being in the range of USD $4.60 to $15.70 over Argentina and Brazilian SBM.

Table 1. Crude protein, crude fat and crude fiber[1] and KOH-PS of soybean meals from different origins measured by wet chemistry and NIRS (%)

Item	United States (n = 5)		Argentina (n = 10)		Brazil (n = 4)	
	Mean	SD	Mean	SD	Mean	SD
Wet chemistry						
Crude protein	46.0[b]	0.56	46.1[b]	0.51	47.3[a]	1.37

Crude fat	1.39[a]	0.20	0.86[b]	0.27	1.27[a]	0.38
Crude fibre	3.86[ab]	0.21	3.38[b]	0.37	4.52[a]	0.88
KOH-PS, %	81.5[a]	1.01	75.1[b]	2.22	78.6[a]	3.32
NIRS						
Crude protein	46.0[b]	0.50	46.1[b]	0.51	47.0[a]	1.14
Crude fat	1.35[a]	0.40	1.12[b]	0.22	1.61[a]	0.24
Crude fibre	4.09	0.33	3.67	0.44	4.26	0.80

[ab] mean values with different superscripts within rows are different ($P < 0.05$);
[1]calculated on an 88 % DM basis
NIRS: Bruker MPA and Adisseo PNE calibrations
KOH-PS = Protein solubility in 0.2% potassium hydroxide

Table 2. Percent sucrose and NSP content of soybean meals from different origins

Carbohydrate	United States (n = 5)		Argentina (n = 10)		Brazil (n = 4)	
	Mean	SD	Mean	SD	Mean	SD
Sucrose	7.3[a]	0.4	6.8[b]	0.2	5.6[c]	0.3
Soluble NSP[2]	0.6[b]	0.11	0.7[ab]	1.24	0.9[a]	1.3
Insoluble NSP[3]	8.0[a]	0.2	7.8[ab]	0.5	7.3[b]	0.4

[ab] mean values with different superscripts within rows are different ($P < 0.05$)
88% DM basis

Table 3. Total amino acid content of SBM from different origins

	United States n = 5		Argentina n = 10		Brazil n = 4	
	Mean	SD	Mean	SD	Mean	SD
Lysine	2.91[a]	0.06	2.91[a]	0.06	2.65[b]	0.37
Methionine	0.63	0.02	0.63	0.01	0.64	0.02
Cystine	0.68[b]	0.03	0.67[b]	0.02	0.72[a]	0.02
Threonine	1.79[b]	0.04	1.84[ab]	0.02	1.88[a]	0.07
Valine	2.22	0.05	2.26	0.05	2.31	0.05
Arginine	3.23[b]	0.08	3.28[ab]	0.07	3.40[a]	0.11
Isoleucine	2.17[b]	0.04	2.23[ab]	0.06	2.27[a]	0.05
Glutamic	8.31[b]	0.22	8.58[ab]	0.23	8.76[a]	0.26

[ab] mean values with different superscripts within rows are different ($P < 0.05$)
88% dry matter basis

Table 4. Apparent metabolizable energy content of SBM from different origins

	United States n = 5		Argentina n = 10		Brazil n = 4	
	Mean	SD	Mean	SD	Mean	SD
AME	2115[a]	91	2042[b]	136	1971[c]	125
AMEn	1901[a]	100	1844[b]	134	1766[c]	122

[abc] mean values with different superscripts within rows are different ($P < 0.05$)
88% dry matter basis

Table 5. Standardised ileal digestibility coefficients of SBM from different origins

	United States n = 5		Argentina n = 10		Brazil n = 4	
	Mean	SD	Mean	SD	Mean	SD
Lysine	0.875	0.017	0.865	0.161	0.846	0.241
Methionine	0.906[a]	0.022	0.875[ab]	0.266	0.853[b]	0.418
Cystine	0.841[a]	0.014	0.799[ab]	0.309	0.772[b]	0.631
Threonine	0.880[a]	0.014	0.853[ab]	0.264	0.826[b]	0.470
Valine	0.891[a]	0.014	0.868[ab]	0.229	0.844[b]	0.398
Arginine	0.920	0.010	0.923	0.124	0.914	0.121
Isoleucine	0.892	0.014	0.874	0.183	0.855	0.351

[ab] mean values with different superscripts within rows are different ($P < 0.05$)

Table 6. Standardised ileal digestibility of soybean meals from different origins

	United States n= 5		Argentina n = 10		Brazil n = 4	
	Mean	SD	Mean	SD	Mean	SD
Lysine	2.55[a]	0.09	2.52[a]	0.08	2.25[b]	0.38
Methionine	0.57	0.03	0.55	0.02	0.55	0.03
Cystine	0.57	0.03	0.53	0.03	0.56	0.05
Threonine	1.57	0.05	1.57	0.05	1.55	0.12
Valine	1.98	0.06	1.95	0.07	1.95	0.08
Arginine	2.97	0.10	3.03	0.06	3.11	0.14
Isoleucine	1.93	0.05	1.95	0.07	1.94	0.08

[ab] mean values with different superscripts within rows are different ($P < 0.05$)
88% dry matter basis
EAA = essential amino acids; NEAA = non-essential amino acids

Figure 1

Product: 270 SBM starter Page: 1

Trial Formula Cost: 486.61/Tne 48.66/Ckg 0.4866/Kg Version: 1

INGREDIENT SOLUTION: (Unrounded)

IngrCode	Ingredient Name	Amount Pct	Minimum Pct	Maximum Pct	Cost $/Tonne	Rest Cost	Low Range	High Range
1	Corn 3300-8.1	53.2652			319.00		19.40	338.20
173	SBM US 2115 46.0	39.5354			630.00		351.00	634.50
439	Veg oil 8900	3.7363			1126.00		1031.50	14289.90
500	Limestone	1.4088			85.00			1610.30
515	MonodicalP 21P/1	0.9355			500.00			1055.20
704	D,L-methionine	0.2963			2528.00		311.80	27683.50
701	L-lysine HCl 78.	0.2048			1630.00		354.20	6354.40
571	Salt	0.1661			150.00			487.60
572	Na bicarb	0.1500	0.1500		250.00	2.316	18.40	
663	Choline Cl 70%	0.0882			1450.00			28442.60
709	L-threonine	0.0784			1678.00		225.30	15790.30
614	UNE Mineral mix	0.0750	0.0750		1500.00			
613	UNE Vitamin mix	0.0500	0.0500		6000.00			
545	Phytase QB 5G (1	0.0100	0.0100	0.0100	15000.00			
							At	Would Use
103	Rice bran 2735 1	Rej		5.0000	268.00	0.380	230.00	
159	SBM Brz 1971 47.	Rej			630.00	0.077	622.30	
92	Wheat Pollard 19	Rej		5.0000	220.00	0.197	200.30	
174	SBM Arg 2042 46.	Rej			630.00	0.046	625.40	

Figure 1. Starter diet

Product: 271 SBM grower Page: 1

Trial Formula Cost: 472.85/Tne 47.28/Ckg 0.4728/Kg Version: 1

INGREDIENT SOLUTION: (Unrounded)

IngrCode	Ingredient Name	Amount Pct	Minimum Pct	Maximum Pct	Cost $/Tonne	Rest Cost	Low Range	High Range
1	Corn 3300-8.1	58.4600			319.00		19.40	510.00
173	SBM US 2115 46.0	34.2262			630.00		230.00	634.50
439	Veg oil 8900	4.2192			1126.00		621.40	14289.90
500	Limestone	1.2774			85.00		-270.50	1610.30
515	MonodicalP 21P/1	0.7596			500.00		-122.60	61147.80
704	D,L-methionine	0.2607			2528.00		311.80	52613.80
701	L-lysine HCl 78.	0.1995			1630.00		354.20	15029.50
571	Salt	0.1665			150.00		-269.30	487.60
572	Na bicarb	0.1500	0.1500		250.00	2.316	18.40	
663	Choline Cl 70%	0.0866			1450.00		-267.60	129721.30
614	UNE Mineral mix	0.0750	0.0750		1500.00	17.69	-268.70	
709	L-threonine	0.0595			1678.00		225.30	32064.00
613	UNE Vitamin mix	0.0500	0.0500		6000.00	62.48	-247.90	
545	Phytase QB 5G (1	0.0100	0.0100	0.0100	15000.00			
							At	Would Use
174	SBM Arg 2042 46.	Rej			630.00	0.046	625.40	335.60
159	SBM Brz 1971 47.	Rej			630.00	0.077	622.30	326.40

Figure 2. SBM grower diet

Product: 272 SBM finisher Page: 1

Trial Formula Cost: 465.52/Tne 46.55/Ckg 0.4655/Kg Version: 1

INGREDIENT SOLUTION: (Unrounded)

IngrCode	Ingredient Name	Amount Pct	Minimum Pct	Maximum Pct	Cost $/Tonne	Rest Cost	Low Range	High Range
1	Corn 3300-8.1	64.6021			319.00			335.60
173	SBM US 2115 46.0	27.7357			630.00		534.30	637.90
439	Veg oil 8900	4.5311			1126.00		994.30	17628.40
500	Limestone	1.1995			85.00			1632.10
515	MonodicalP 21P/1	0.6644			500.00			728.60
701	L-lysine HCl 78.	0.2814			1630.00		341.70	4827.70
704	D,L-methionine	0.2761			2528.00		300.60	14376.30
571	Salt	0.1668			150.00			495.00
572	Na bicarb	0.1500	0.1500		250.00	2.367	13.30	
663	Choline Cl 70%	0.0987			1450.00			24621.00
709	L-threonine	0.0874			1678.00		212.90	8908.00
614	UNE Mineral mix	0.0750	0.0750		1500.00			
727	L-Arginine FB	0.0719			12000.00		9515.80	15693.70
613	UNE Vitamin mix	0.0500	0.0500		6000.00			
545	Phytase QB 5G (1	0.0100	0.0100	0.0100	15000.00			
							At	Would Use
103	Rice bran 2735 1	Rej		5.0000	268.00	0.153	252.70	
92	Wheat Pollard 19	Rej		5.0000	220.00	0.305	189.50	
159	SBM Brz 1971 47.	Rej			630.00	0.147	615.30	
174	SBM Arg 2042 46.	Rej			630.00	0.078	622.20	

Figure 3. Finisher diet

Table 7. Equivalent (shadow) prices USD/mt of SBM from different origins in broiler diets

SBM origin	Starter	Grower	Finisher
United States	630.00	630.00	630.00
Argentina	625.40	625.40	622.20
Brazil	622.30	622.30	615.30

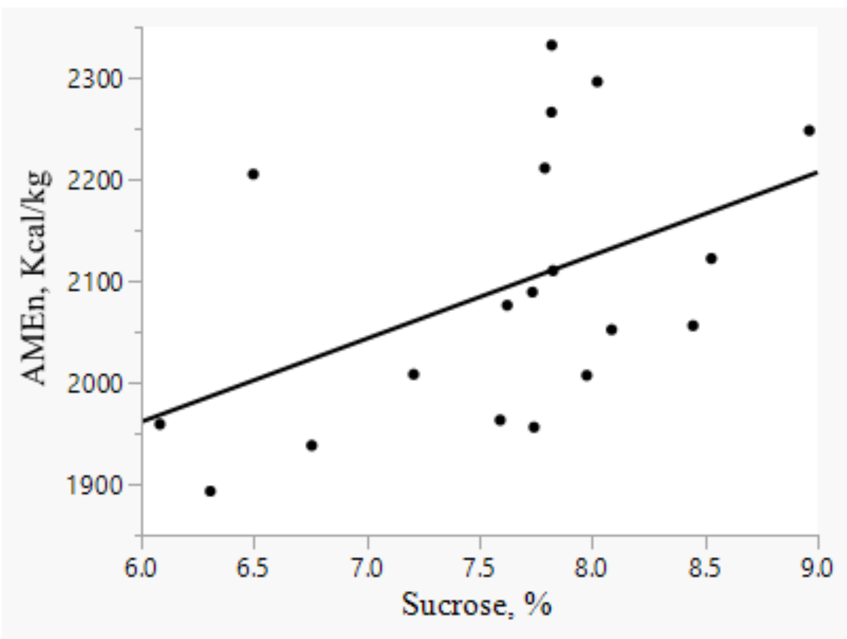

Figure 3. Linear relationship between sucrose concentration and AMEn of soybean meal (r^2 = 0.22, $P < 0.05$)

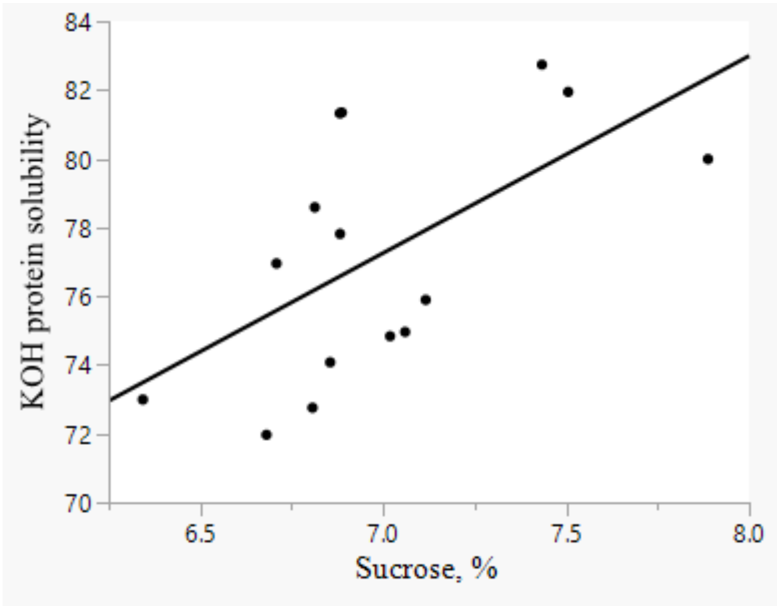

Figure 4. Linear relationship between KOH protein solubility and sucrose concentration of soybean meal ($r^2 = 0.29$, $P < 0.05$; analysis includes only US and Argentina SBM)

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Appendix:

University of Missouri Report with Sample key

Sample Key:

Sample numb	UNE coc	Barc code	origin	shipping description	
1	SBM	T13	Arg	SBM from	No. 11
2	SBM	T2	ARG	Vietnam1	AM212
3	SBM	T3	Arg	Vietnam2	AM212
4	SBM	T4	ARG	Argentina1	AM212
5	SBM	T5	ARG	Argentina2	AM212
6	SBM	T6	BRA	Brazil1	AM212
7	SBM	T7	US	US1 SBM	AM212
8	SBM	T8	US	USA2	AM212
9	SBM	T9	US	USA3	AM212
10	SBM	T10	US	USA4	AM212
11	SBM	T11	US	USA5	AM212
12	SBM	T14	Bra	SBM	No. 12
13	SBM	T15	Bra	SBM	No. 13
14	SBM	T16	Arg	soybean	No. 14
15	SBM	T17	Arg	soybean	No. 15
16	SBM	T18	Arg	Soybean	No. 16
17	SBM	T19	Bra	Soybean -	No. 17
18	SBM	T20	Arg	Soybean	No. 18
19	SBM		Arg		Extra
25	SBM	T21	US	ADM	
26	SBM	T22	AR	ARG-	ARG-

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Phone: 612-625-5772
Purchase Order #: 0002173000 **Date of Report: February 22, 2022**

Description: Soybean Meal **Page 1 of 3**

ESCL #	UM ID	Fructose W/W%	Glucose W/W%	Sucrose W/W%	Lactose W/W%	Maltose W/W%		ESCL #	Sucrose W/W%
16655	T1	0.04	0.24	6.27	0.00	0.68	1.A not used	16673	5.44
16656	T2	0.06	0.28	6.86	0.00	0.70	2.U not used	16674	6.49
16657	T3	0.07	0.29	6.97	0.00	0.65	A	16655	6.27
16658	T4	0.13	0.22	6.31	0.10	0.61	A	16656	6.86
16659	T5	0.07	0.28	6.84	0.00	0.66	A	16657	6.97
16660	T6	0.06	0.21	5.19	0.11	0.42	A	16658	6.31
16661	T7	0.05	0.24	6.69	0.00	0.68	A	16659	6.84
16662	T8	0.05	0.27	7.13	0.10	0.80	A	16668	6.78
16663	T9	0.07	0.31	6.34	0.00	0.81	A	16669	6.12
16664	T10	0.06	0.28	6.97	0.00	0.86	A	16670	6.65
16665	T11	0.08	0.29	6.85	0.00	0.74	A	16672	6.21
16666	T12	0.06	0.22	5.37	0.12	0.51	A	16675	6.55
16667	T13	0.00	0.20	5.38	0.11	0.54	B	16660	5.19
16668	T14	0.04	0.26	6.78	0.09	0.70	B	16666	5.37
16669	T15	0.04	0.24	6.12	0.00	0.61	B	16667	5.38
16670	T16	0.04	0.24	6.65	0.12	0.72	B	16671	4.84
16671	T17	0.06	0.22	4.84	0.07	0.33	U	16661	6.69
16672	T18	0.03	0.25	6.21	0.09	0.69	U	16662	7.13
16673	T20	0.09	0.26	5.44	0.13	0.33	U	16663	6.34
16674	T25	0.03	0.25	6.49	0.08	0.72	U	16664	6.97
16675	T26	0.00	0.27	6.55	0.06	0.68	U	16665	6.85

W/W%= grams per 100 grams of sample.
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	Sucrose	SD
US	6.80	0.30
Arg	6.55	0.31
Brazil	5.19	0.25

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Description: Soybean Meal **Page 2 of 3**

ESCL #	UM ID	Rhamnose W/W%	Fucose W/W%	Ribose W/W%	Arabinose W/W%	Xylose W/W%	Mannose W/W%	Glucose W/W%	Origin
16655	T1	0.23	0.16	0.10	1.19	0.58	0.58	4.46	A
16656	T2	0.19	0.16	0.09	1.04	0.55	0.50	3.92	A
16657	T3	0.22	0.16	0.11	1.28	0.63	0.74	5.12	A
16658	T4	0.22	0.16	0.10	1.14	0.59	0.51	3.59	A
16659	T5	0.27	0.18	0.12	1.40	0.75	0.90	5.50	A
16660	T6	0.26	0.22	0.10	1.64	0.76	0.78	4.25	B
16661	T7	0.15	0.14	0.09	0.88	0.46	0.44	3.53	U
16662	T8	0.20	0.15	0.11	1.21	0.62	0.99	5.84	U
16663	T9	0.19	0.16	0.12	1.34	0.58	0.57	3.82	U
16664	T10	0.26	0.17	0.10	1.25	0.56	0.51	5.06	U
16665	T11	0.26	0.18	0.12	1.30	0.67	0.72	5.31	U
16666	T12	0.27	0.19	0.11	1.40	0.80	0.48	3.74	B
16667	T13	0.29	0.18	0.11	1.42	0.74	0.70	3.95	B
16668	T14	0.33	0.24	0.14	1.73	0.80	0.84	6.23	A
16669	T15	0.22	0.17	0.10	1.11	0.50	0.46	3.57	A
16670	T16	0.24	0.18	0.10	1.20	0.58	0.43	3.78	A
16671	T17	0.27	0.18	0.11	1.38	0.87	0.94	3.67	B
16672	T18	0.36	0.28	0.15	2.09	0.98	0.94	6.49	A
16673	T20	0.27	0.15	0.08	1.06	0.62	0.72	3.44	A not used
16674	T25	0.32	0.20	0.10	1.34	0.73	0.68	5.39	U not used
16675	T26	0.32	0.20	0.10	1.38	0.66	0.69	5.31	A

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Description: Soybean Meal **Page 3 of 3**

ESCL #	UM ID	Xylitol W/W%	Sorbitol W/W%	Mannitol W/W%	Protein Dispersibility W/W%	Trypsin Inhibitor TIU/g	Origin: Argentina, Brazil, USA
16655	T1	*nd*	*nd*	*nd*	14.96	935	A
16656	T2	*nd*	*nd*	*nd*	14.90	715	A
16657	T3	*nd*	*nd*	*nd*	15.97	888	A
16658	T4	*nd*	*nd*	*nd*	14.20	975	A
16659	T5	*nd*	*nd*	*nd*	15.76	1,033	A
16660	T6	*nd*	*nd*	*nd*	15.06	903	B
16661	T7	*nd*	*nd*	*nd*	18.49	884	U
16662	T8	*nd*	*nd*	*nd*	16.16	1,176	U
16663	T9	*nd*	*nd*	*nd*	16.68	681	U
16664	T10	*nd*	*nd*	*nd*	14.01	903	U
16665	T11	*nd*	*nd*	*nd*	17.37	1,08	U
16666	T12	*nd*	*nd*	*nd*	16.41	917	B
16667	T13	*nd*	*nd*	*nd*	20.03	695	B
16668	T14	*nd*	*nd*	*nd*	16.67	863	A
16669	T15	*nd*	*nd*	*nd*	13.48	1,226	A
16670	T16	*nd*	*nd*	*nd*	12.46	1,046	A
16671	T17	*nd*	*nd*	*nd*	14.47	842	B
16672	T18	*nd*	*nd*	*nd*	12.98	1,159	A
16673	T19	*nd*	*nd*	*nd*	13.07	658	A not used
16674	T20	*nd*	*nd*	*nd*	18.85	1,001	U not used
16675	T21	*nd*	*nd*	*nd*	15.20	1,186	A

W/W%= grams per 100 grams of sample. TIU/g = Trypsin Inhibitor units per gram.
Results are expressed on an "as is" basis unless otherwise indicated.

Summary

	ESCL #	Protein Dispersibilit W/W%	Trypsin Inhibitor TIU/g
1.not used	16673	13.07	658
2.not used	16674	18.85	1,001
A	16655	14.96	935
A	16656	14.90	715
A	16657	15.97	888
A	16658	14.20	975
A	16659	15.76	1,033
A	16668	16.67	863
A	16669	13.48	1,226
A	16670	12.46	1,046
A	16672	12.98	1,159
A	16675	15.20	1,186
B	16660	15.06	903
B	16666	16.41	917
B	16667	20.03	695
B	16671	14.47	842
U	16661	18.49	884
U	16662	16.16	1,176
U	16663	16.68	681
U	16664	14.01	903
U	16665	17.37	1,08

	TIU	SD	PDI	SD
US	911	203	16.54	1.66
Arg	1,003	160	14.66	1.36
Brazil	839	102	16.49	2.49

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Description: Soybean Meal

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16655	T1	*nd*	*nd*	*nd*	14.96	935	A
16656	T2	*nd*	*nd*	*nd*	14.90	715	A
16657	T3	*nd*	*nd*	*nd*	15.97	888	A
16658	T4	*nd*	*nd*	*nd*	14.20	975	A
16659	T5	*nd*	*nd*	*nd*	15.76	1,033	A
16660	T6	*nd*	*nd*	*nd*	15.06	903	B
16661	T7	*nd*	*nd*	*nd*	18.49	884	U
16662	T8	*nd*	*nd*	*nd*	16.16	1,176	U
16663	T9	*nd*	*nd*	*nd*	16.68	681	U
16664	T10	*nd*	*nd*	*nd*	14.01	903	U
16665	T11	*nd*	*nd*	*nd*	17.37	1,08	U
16666	T12	*nd*	*nd*	*nd*	16.41	917	B
16667	T13	*nd*	*nd*	*nd*	20.03	695	B
16668	T14	*nd*	*nd*	*nd*	16.67	863	A
16669	T15	*nd*	*nd*	*nd*	13.48	1,226	A
16670	T16	*nd*	*nd*	*nd*	12.46	1,046	A
16671	T17	*nd*	*nd*	*nd*	14.47	842	B
16672	T18	*nd*	*nd*	*nd*	12.98	1,159	A
16673	T19	*nd*	*nd*	*nd*	13.07	658	A not used
16674	T20	*nd*	*nd*	*nd*	18.85	1,001	U not used
16675	T21	*nd*	*nd*	*nd*	15.20	1,186	A

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