

# Exploiting the USDA Castor Bean and Peanut Germplasm Collection as a Potential Crop for Biodiesel Production

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The background of the slide is a solid blue color. In the lower half, there are several decorative elements consisting of concentric white circles, resembling ripples in water. These ripples are scattered across the bottom, with some larger and more prominent than others, creating a subtle, organic pattern.

# Advantages and Current Status

## Ø Environmentally Friendly

Low CO<sub>2</sub> and SO<sub>2</sub> emission (98% less)

Low benzene and particulates

Fast biodegradability

## Ø Energy Renewable

Fats from animals

Oils from oilseed crops

## Ø Long-term independence of fuel-supply

Reduce costly petroleum imports

## Ø Production and Consumption in the US

Less 5% of the world population accounts for 25% of the world's annual demand

Over 90% of the consumed biodiesel in the US is produced from soybean oil



**Biodiesel  
(quality)**

**Fatty Acid  
Composition  
(ratio of fatty acids)**

**Seed Oil Content  
(percentage)**

**Grain Yield of Oilseed Crop  
(bushel/acre)**

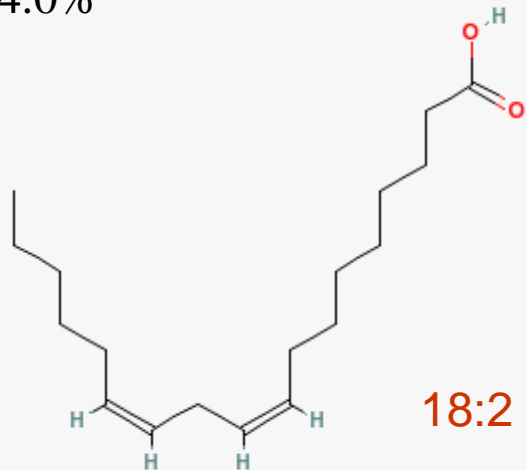
# Major Oilseed Crops and Oil Contents in Seeds

Oilseed Crop	Oil Content (%)
Soybean	18-22
Cotton	20-33
Flax	42-44
Canola	36-50
Sunflower	40-50
Peanut*	40-60
Castor bean	40-60

\* Peanut oil was first used by Rudolph Diesel to power his engine at the Pairs Exhibition in 1900.

# Soybean Oil Composition (Five major fatty acids)

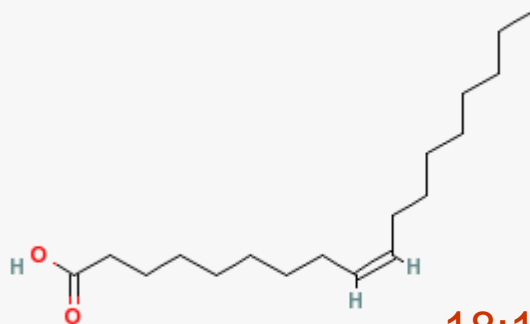
54.0%



18:2

Linoleic acid, MF  $C_{18}H_{32}O_2$ , MW 280.445

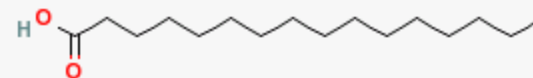
22.0%



18:1

Oleic acid, MF  $C_{18}H_{34}O_2$ , MW 282.461

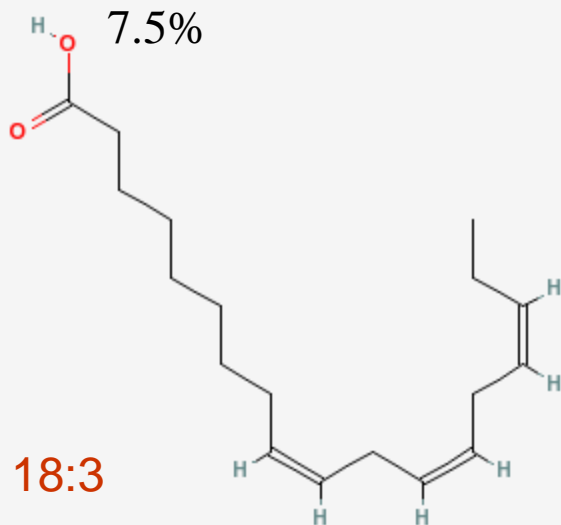
11.0%



16:0

Palmitic acid, MF  $C_{16}H_{32}O_2$ , MW 256.424

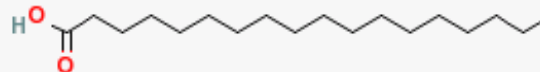
7.5%



18:3

Linolenic acid, MF  $C_{18}H_{30}O_2$ , MW 278.43

4.1%

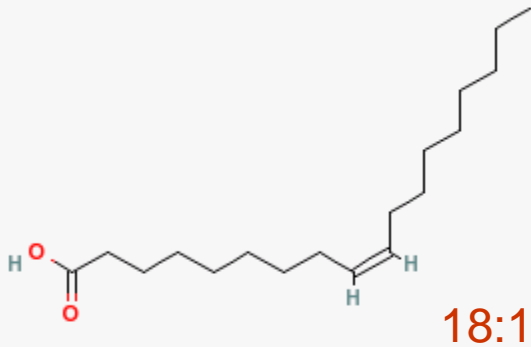


18:0

Stearic acid, MF  $C_{18}H_{36}O_2$ , MW 284.477

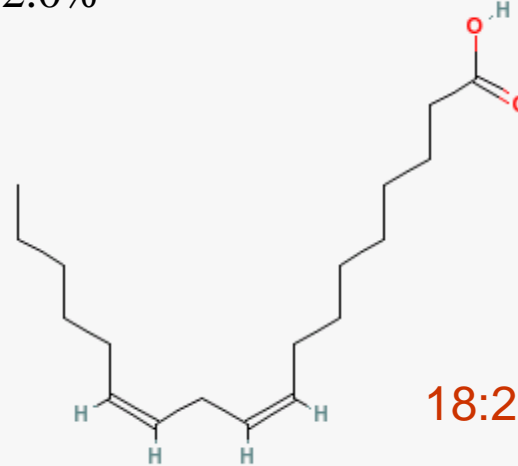
# Peanut Oil Composition (Six major fatty acids)

48.0%



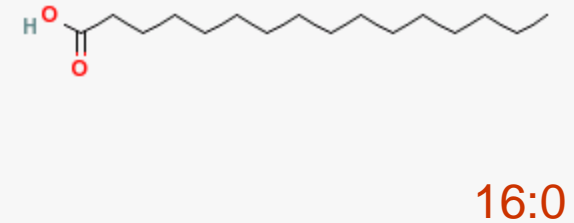
Oleic acid, MF  $C_{18}H_{34}O_2$ , MW 282.461

32.0%



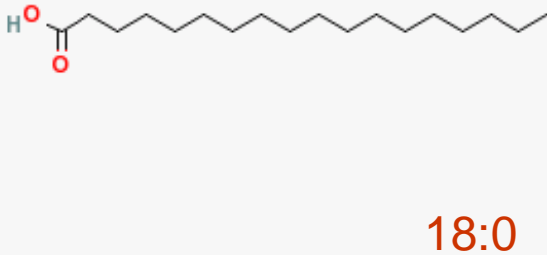
Linoleic acid, MF  $C_{18}H_{32}O_2$ , MW 280.445

11.0%



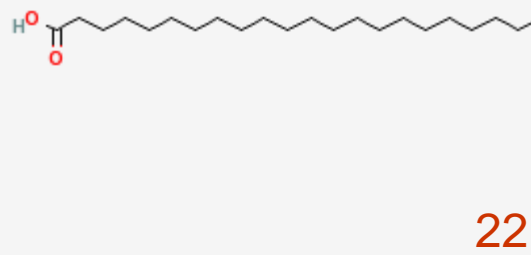
Palmitic acid, MF  $C_{16}H_{32}O_2$ , MW 256.424

3.5%



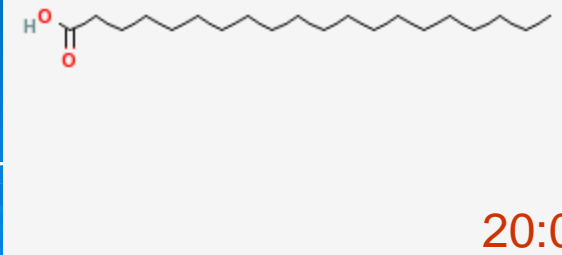
Stearic acid, MF  $C_{18}H_{36}O_2$ , MW 284.477

3.2%



Behenic acid, MF  $C_{22}H_{44}O_2$ , MW 340.584

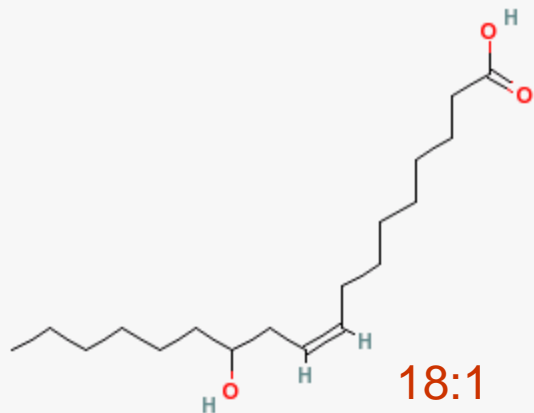
1.6%



Arachidic acid, MF  $C_{20}H_{40}O_2$ , MW 312.530

# Castor Bean Oil Composition (Six major fatty acids)

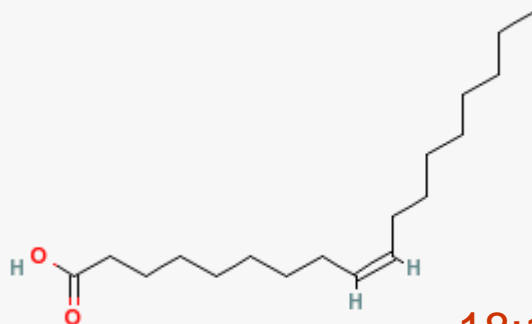
89.5%



18:1

Ricinoleic acid, MF  $C_{18}H_{34}O_3$ , MW 298.461

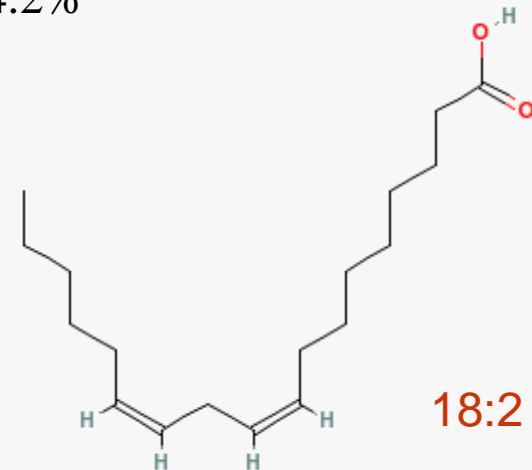
3.0%



18:1

Oleic acid, MF  $C_{18}H_{34}O_2$ , MW 282.461

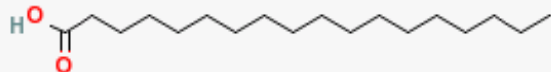
4.2%



18:2

Linoleic acid, MF  $C_{18}H_{32}O_2$ , MW 280.445

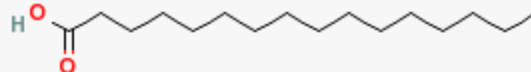
1.0%



18:0

Stearic acid, MF  $C_{18}H_{36}O_2$ , MW 284.477

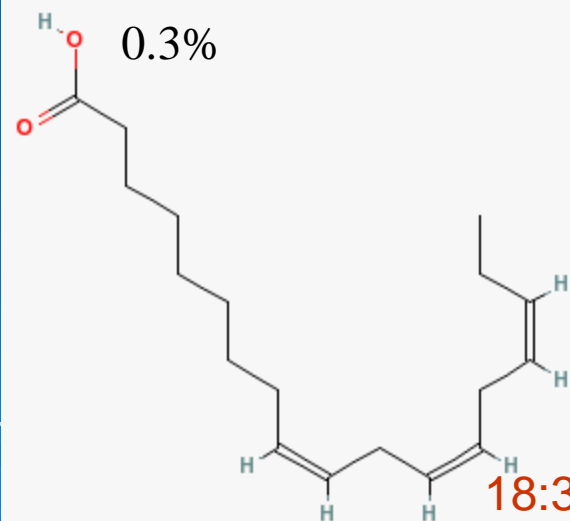
1.0%



16:0

Palmitic acid, MF  $C_{16}H_{32}O_2$ , MW 256.424

0.3%



18:3

Linolenic acid, MF  $C_{18}H_{30}O_2$ , MW 278.43

# Comparison of Oil Contents and Fatty Acid Compositions

Fatty acid	Soybean	Peanut	Castor bean
Oleic acid (18:1)*	22.0%	48.0%	3.0%
Linoleic acid (18:2)	54.0%	32.0%	4.2%
Stearic acid (18:0)	4.1%	3.5%	1.0%
Palmitic acid (16:0)	11.0%	11.0%	1.0%
Linolenic acid (18:3)	7.5%	0.1%	0.3%
Ricinoleic acid (18:1_1OH)	n/a	n/a	89.5%
Arachidic acid (20:0)	n/a	1.6%	n/a
More than one double bonds	61.5%	32.1%	4.5%

\*Oil containing a high percentage of oleic acid lead to biodiesel with a relatively low oxidation rate, low cloud point, and high efficiency of combustion.



Selected Peanut (*A. hypogaea* L.) Accessions

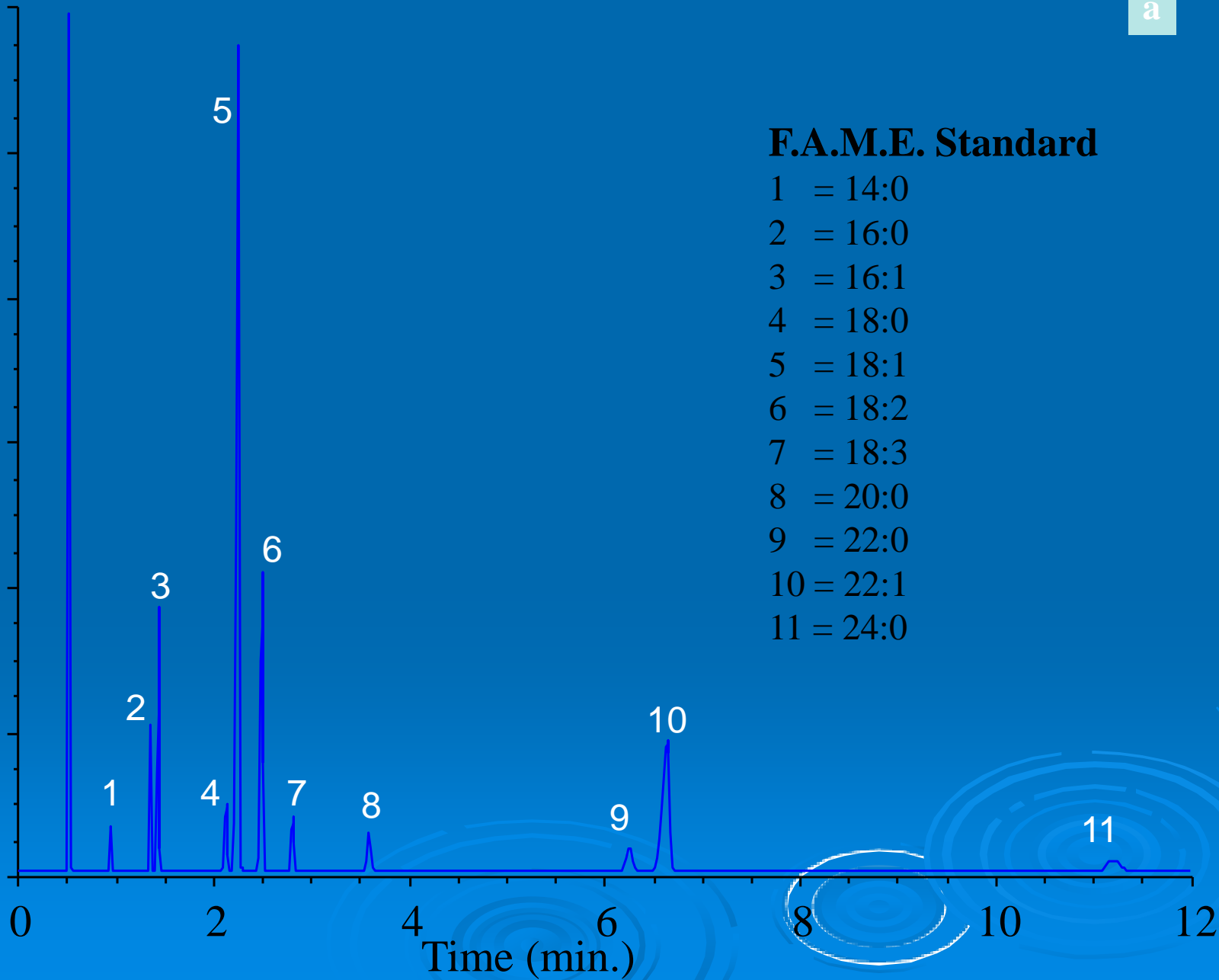
PI #	Identifier	Collection site	PI #	Identifier	Collection site
443033	Te 3	Burkina Faso	313187	1602	Philippines
476079	US 556	Brazil	Grif 14328	TE-006	Ecuador
540498	Chauzulishu	China	590487	US 1397	Brazil
598133	ICGV-SM 86715	India	270983	F1-45	Zambia
540826	Mani 739-1	Bolivia	590351	ICG 4508	Tanzania
540460	NC 10C	US	Grif 14444	DEW 1261	Mexico
540834	Mani 824	Bolivia	Grif 14330	TE-008	Ecuador
505960	Kombong	Togo	306229	No 58670	Senegal
565460	NC 3033	US	502148	SP 509-1	Peru
590473	US 1383	Brazil	565475	PRONTO	US
590461	US 1370	Brazil	Grif 14309	TM-016	Ecuador
476058	US 534	Brazil	Grif 14322	TM-031	Ecuador
512269	n/a	China	275730	153	Brazil
Grif 14305	TM-012	Ecuador	158857	n/a	China
583858	AGGAAT	South Africa	502079	SPZ 485-1	Peru
268996	AR 12	Zambia	600817	K-29	US
628606	TE 20	Ecuador	229660	Valencia 2A7	Madagascar
493463	RC 155	Argentina	Grif 12344	Perzunan	Hungary
269711	Feng Lee You Don	Japan	Grif 14308	TM-015	Ecuador
502116	SPZ 496-1	Peru	493452	RCM 144	Argentina
Grif 15213	CbRbWiPmPz 982	Paraguay	590286	ICG 589	Senegal
565465	GP NC 343	US	372282	M309.96	Nigeria
568164	ICGV 87354	India	635001	Experimental hybrid	US
319767	1066-19	Israel	628599	TE-001	Ecuador
635571	Manduvi ayaca	Paraguay	536636	Ripley	US
Grif 14306	TM-013	Ecuador	597381	Omaha	US

Comparison of oil contents measured by Ankom and NMR

PI #	Oil % from Ankom	Oil from NMR	PI #	Oil % from Ankom	Oil from NMR
628606	51.673 abcdef	55.41 a	Grif 14305	49.451 abcdefghij	51.81 mnopq
565460	53.651 ab	55.13 ab	372282	48.478 efghij	51.795 mnopq
505960	51.224 abcdefghi	54.89 abc	319767	49.885 abcdefghij	51.57 nopqr
Grif 14322	52.496 abcde	54.44 bcd	540834	50.149 abcdefghij	51.545 nopqr
540826	53.211 abc	54.32 bcde	229660	49.188 bcdefghij	51.46 nopqrs
Grif 12344	51.208 abcdefghi	54.29 bcde	476079	49.939 abcdefghij	51.435 nopqrs
Grif 14330	51.295 abcdefgh	54.105 cdef	Grif 14444	49.613 abcdefghij	51.39 opqrs
275730	52.404 abcde	53.89 defg	Grif 15213	47.689 fghij	51.305 pqrst
476058	52.984 abcd	53.69 defgh	565475	47.812 fghij	51.285 pqrst
313187	52.021 abcdef	53.43 efghi	512269	50.583 abcdefghij	51.265 pqrst
583858	51.412 abcdefg	53.14 fghij	268996	48.943 cdefghij	51.015 qrst
Grif 14306	51.038 abcdefghi	53.125 ghij	502116	49.868 abcdefghij	51.01 qrst
306229	52.55 abcde	53.1 ghijk	565465	48.31 efghij	50.815 rst
502148	51.125 abcdefghi	53.015 ghijkl	493452	48.584 defghij	50.51 stu
Grif 14328	52.407 abcde	52.905 hijkl	158857	49.374 abcdefghij	50.43 tu
590461	50.628 abcdefghij	52.83 hijkl	270983	49.337 abcdefghij	49.78 uv
568164	50.71 abcdefghij	52.73 hijklm	Grif 14308	47.091 ghijk	49.765 uv
590473	50.137 abcdefghij	52.71 ijklm	590286	46.896 hijk	49.34 v
540460	50.516 abcdefghij	52.67 ijklm	Grif 14309	46.759 ijk	49.14 v
635571	53.806 a	52.395 jklmn	502079	48.078 efghij	48.02 w
635001	47.154 ghij	52.38 jklmn	540498	46.405 jk	47.665 w
600817	50.163 abcdefghij	52.285 jklmno	590351	42.622 k	45.93 x
598133	51.554 abcdefg	52.225 jklmnop	Average	50.002	51.94
269711	51.35 abcdefgh	52.15 klmnop	MSD	4.4911	0.9672
443033	48.509 defghij	52.08 lmnop	536636 (Soy 1)	n/a	22.385
493463	49.496 abcdefghij	51.83 mnopq	597381 (Soy 2)	n/a	24.168
590487	50.295 abcdefghij	51.82 mnopq	Average	n/a	23.28

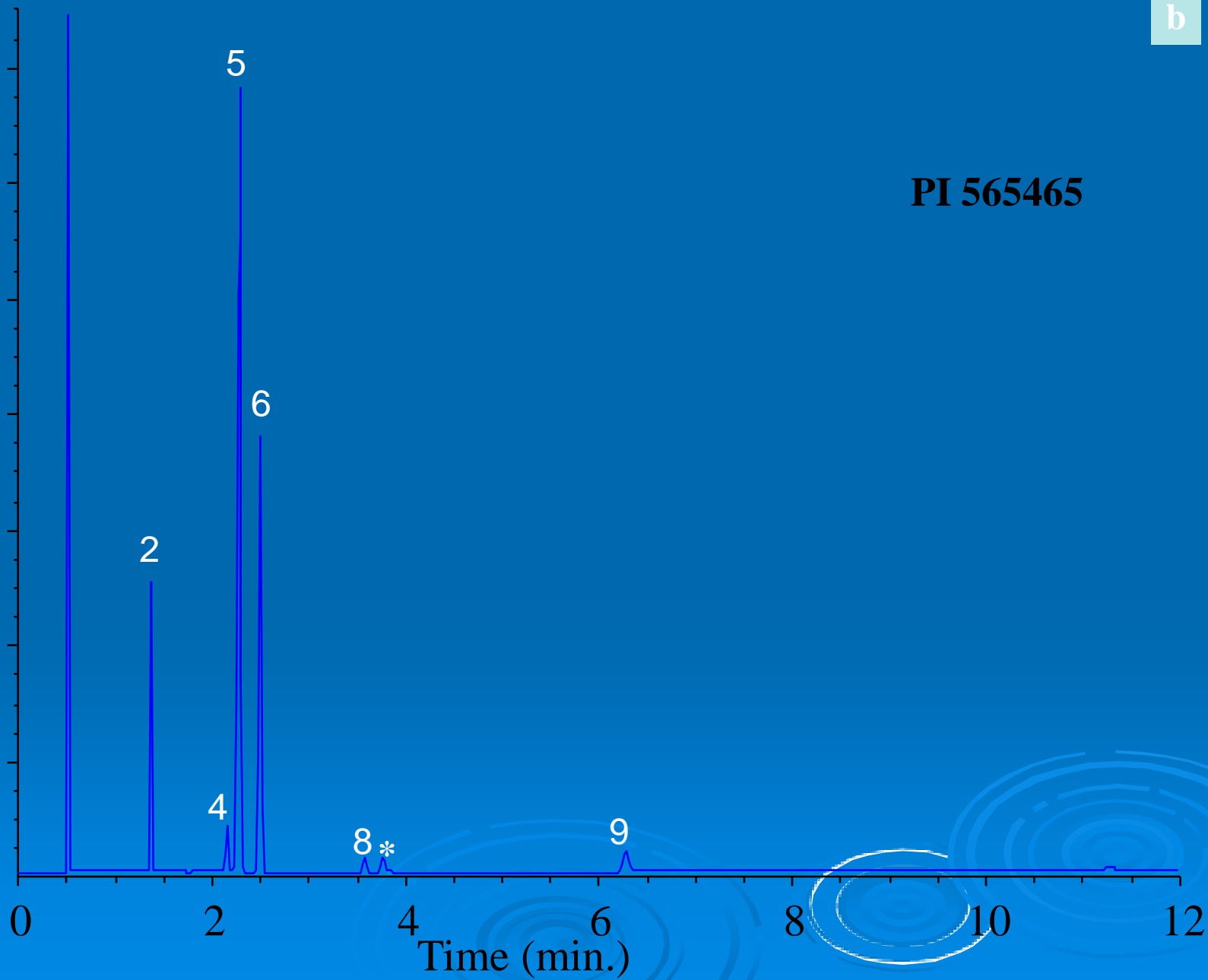
# Peanut Oil Content Measured by Ankom and NMR

- ∅ Variability in oil contents from Ankom  
(42.62 – 53.81%)
- ∅ Variability in oil contents from NMR  
(45.93 – 55.41%)
- ∅ Results from two methods highly correlated  
( $r = 0.84436$ ,  $p < 0.0001$ )
- ∅ Significant variation has been identified  
in the US peanut germplasm



b

PI 565465



Comparison of fatty acid compositions analyzed by GC												
Accession	14:0	16:0	16:1	18:0	18:1	18:2	18:3	20:0	20:1	22:0	22:1	24:0
635001	0.03	8.21	0.05	2.77	55.64	25.18	0.05	1.55	1.47	3.46	0.16	1.44
628606	0.02	9.87	0.1	3.12	53.25	25.84	0.07	1.61	1.13	3.19	0.18	1.62
565465	0.03	9.18	0.05	2.64	51.59	29	0.09	1.33	1.4	3.01	0.13	1.55
590286	0.03	9.26	0.06	1.73	51.33	29.81	0.1	1.04	1.82	2.97	0.2	1.65
565460	0.02	8.9	0.07	2.6	51.43	29.08	0.05	1.45	1.4	3.13	0.18	1.7
158857	0.03	9.07	0.04	2.85	51.35	29.35	0.08	1.45	1.3	2.9	0.12	1.47
268996	0.03	9.83	0.05	2.13	49.96	30.63	0.06	1.22	1.44	2.94	0.15	1.58
590351	0.03	9.86	0.06	2.01	49.87	30.85	0.09	1.14	1.53	2.88	0.15	1.54
540460	0.04	10.49	0.04	3.06	50.06	29.98	0.05	1.47	0.95	2.6	0.08	1.19
635571	0.04	9.55	0.03	3.52	49.25	28.19	0.06	1.87	1.16	4.77	0.08	1.49
600817	0.03	10.68	0.06	3.23	48.89	30.77	0.08	1.48	0.9	2.49	0.12	1.27
598133	0.02	10.29	0.19	2.48	46.97	30.55	0.08	1.46	1.63	3.98	0.27	2.1
270983	0.03	10.23	0.06	3.33	47.02	30.31	0.08	1.67	1.32	4.04	0.14	1.77
372282	0.03	10.14	0.06	1.87	45.63	34.58	0.1	1.17	1.63	3.03	0.18	1.64
540826	0.02	10.05	0.04	4.03	42.96	35.96	0.05	1.79	0.83	2.95	0.13	1.19
313187	0.02	11.2	0.07	3.4	42.55	36.05	0.05	1.62	0.85	2.89	0.1	1.2
Grif 12344	0.03	10.58	0.07	3.9	42.48	35.74	0.05	1.69	0.96	3	0.15	1.35
568164	0.03	12.2	0.09	3.13	42.43	34.81	0.05	1.56	0.95	3.2	0.17	1.36
590473	0.03	11.23	0.05	3.25	42.21	36	0.06	1.56	1.02	2.95	0.24	1.4
502116	0.03	9.51	0.05	2.97	41.95	37.96	0.06	1.42	1.12	3.22	0.13	1.6
590461	0.03	10.67	0.06	3.81	41.75	36.06	0.06	1.79	0.96	3.23	0.15	1.45
Grif 14305	0.03	12.38	0.03	2.25	41.65	37.33	0.07	1.1	1.12	2.7	0.15	1.2
502148	0.03	11.72	0.06	3.69	41.7	35.96	0.06	1.63	0.81	3.13	0.06	1.17
Grif 14309	0.03	12.42	0.02	2.37	41.45	37.06	0.07	1.2	1.17	2.78	0.13	1.32
Grif 14444	0.03	10.7	0.07	3.94	41.4	36.24	0.06	1.78	1.02	3.14	0.11	1.54
590487	0.03	10.87	0.06	3.61	41.18	36.94	0.07	1.57	0.91	3.25	0.14	1.38

Accession	14:0	16:0	16:1	18:0	18:1	18:2	18:3	20:0	20:1	22:0	22:1	24:0
540498	0.04	12.1	0.06	4.37	40.93	35.32	0.07	1.76	0.76	2.98	0.19	1.45
Grif 14322	0.02	12.96	0.04	2.12	40.49	37.41	0.06	1.19	1.16	3.04	0.17	1.36
229660	0.03	10.53	0.08	3.9	40.18	37.34	0.06	1.74	1.09	3.38	0.11	1.56
443033	0.02	11.43	0.06	3.68	40.15	36.94	0.05	1.75	0.97	3.52	0.08	1.34
540834	0.03	11.3	0.06	2.97	40.12	38.38	0.07	1.4	1.02	3.06	0.18	1.43
275730	0.03	11.58	0.07	4.61	40.19	36.15	0.05	1.87	0.79	3.33	0.09	1.27
Grif 14328	0.03	11.96	0.05	3.12	40.11	37.77	0.06	1.45	0.99	2.99	0.12	1.38
476058	0.03	10.42	0.07	6.49	40.21	34.08	0.05	2.61	0.63	3.75	0.17	1.51
476079	0.03	10.52	0.05	3.67	39.95	37.65	0.07	1.73	1.07	3.55	0.13	1.58
493452	0.03	11.26	0.06	3.4	39.84	38.12	0.07	1.55	0.99	3.16	0.08	1.43
319767	0.04	11.17	0.05	3.96	39.47	38.69	0.07	1.66	0.85	2.62	0.1	1.33
583858	0.03	11.56	0.08	4.35	39.32	37.01	0.05	1.87	0.86	3.42	0.12	1.35
Grif 14308	0.03	12.23	0.02	1.96	39.2	39.74	0.07	1.14	1.2	3.03	0.1	1.46
Grif 14306	0.03	10.69	0.07	4.38	38.88	37.33	0.06	1.89	0.97	3.52	0.08	1.49
Grif 14330	0.03	13.06	0.02	2.05	38.7	39.36	0.08	1.16	1.26	2.92	0.07	1.32
Grif 15213	0.03	10.85	0.05	3.23	38.7	38.94	0.06	1.67	1.09	3.68	0.12	1.6
269711	0.03	12.44	0.06	4.44	38.5	37.49	0.05	1.73	0.78	3.14	0.14	1.21
493463	0.05	11.31	0.07	3.76	38.24	38.69	0.08	1.77	0.92	3.27	0.2	1.66
306229	0.03	11.74	0.06	4.89	38.16	37.53	0.05	2.15	0.68	3.41	0.08	1.22
565475	0.03	13.76	0.09	3.66	38.01	37.45	0.05	1.61	0.8	3.23	0.12	1.2
512269	0.04	12.5	0.03	3.47	36.97	39.61	0.06	1.74	0.9	3.15	0.11	1.45
<b>Average</b>	<b>0.028</b>	<b>10.999</b>	<b>0.058</b>	<b>3.31</b>	<b>43.148</b>	<b>35</b>	<b>0.064</b>	<b>1.57</b>	<b>1.07</b>	<b>3.187</b>	<b>0.133</b>	<b>1.431</b>
MSD	0.004	0.131	0.027	0.034	0.235	0.196	0.011	0.03	0.019	0.166	0.163	0.158
Peanut meal	0	15.22	0	3.45	50.84	29.06	0	0.64	0	0.81	0	0
<b>Soy average</b>	<b>0.09</b>	<b>11.23</b>	<b>0.12</b>	<b>3.61</b>	<b>28.82</b>	<b>49.07</b>	<b>6.25</b>	<b>0.32</b>	<b>0.19</b>	<b>0.3</b>	<b>0</b>	<b>0</b>

# Variability in Fatty Acid Composition

Fatty acid	Range (%)	Average (%)	MSD (%)
Myristic acid (14:0)	0.02-0.05	0.028	0.004
Palmitic acid (16:0)	8.21-13.76	10.999	0.131
Palmitoleic acid (16:1)	0.02-0.19	0.058	0.027
Stearic acid (18:0)	1.73-6.49	3.310	0.034
Oleic acid (18:1)	36.97-55.64	43.148	0.235
Linoleic acid (18:2)	25.18-39.74	35.00	0.196
Linolenic acid (18:3)	0.05-0.10	0.064	0.011
Arachidic acid (20:0)	1.04-2.61	1.570	0.030
Gadoleic acid (20:1)	0.63-1.82	1.070	0.019
Behenic acid (22:0)	2.49-4.77	3.187	0.166
Erucic acid (22:1)	0.05-0.27	0.133	0.163
Lignoceric acid (24:0)	1.17-2.10	1.431	0.158



# Correlations among Five Major Fatty Acids in Peanut Seeds

	Palmitic acid	Stearic acid	Oleic acid	Linoleic acid	Behenic acid
Palmitic acid		0.11126 <0.1205	-0.77082 <0.0001	0.72535 <0.0001	-0.50146 <0.0001
Stearic acid			-0.43626 <0.0001	0.24302 <0.0006	-0.21617 <0.0023
Oleic acid				-0.96123 <0.0001	0.32057 <0.0001
Linoleic acid					-0.3378 <0.0001
Oil_ANKOM	0.04258 <0.7714	0.42218 <0.0025	-0.15185 <0.2976	0.02976 <0.8391	0.26353 <0.0673
Oil_NMR	0.02904 <0.843	0.29545 <0.0393	-0.06313 <0.6665	-0.02665 <0.8558	0.12272 <0.4009

# Summary

Species / accession	Soybean	Peanut	PI 628606
Oil content (%)	23.28	51.94	55.41
Oleic acid (18:1)	28.82	43.51	53.25
Linoleic acid (18:2)	49.07	35.00	25.84
Linolenic acid (18:3)	6.25	0.06	0.07
Behenic acid (22:0)	0.30	3.19	1.61
Double bonds	More	Fewer	Fewer
Oxidation	Susceptible	Less susceptible	Less susceptible

- Ø Extensive variability in oil content and fatty acid composition exist in the USDA peanut germplasm collection.
- Ø There are no significant correlations between oil content and fatty acids.
- Ø High oil content and better fatty acid composition make peanut a better oilseed crop for biodiesel production.
- Ø There is potential to increase oil content and alter fatty acid composition through peanut breeding.
- Ø Higher yield of peanut (123 gallon/acre) than soybean (50 gallon/acre)

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