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21st International Oil Palm Conference

APPLICATION OF PALM OIL IN POULTRY NUTRITION

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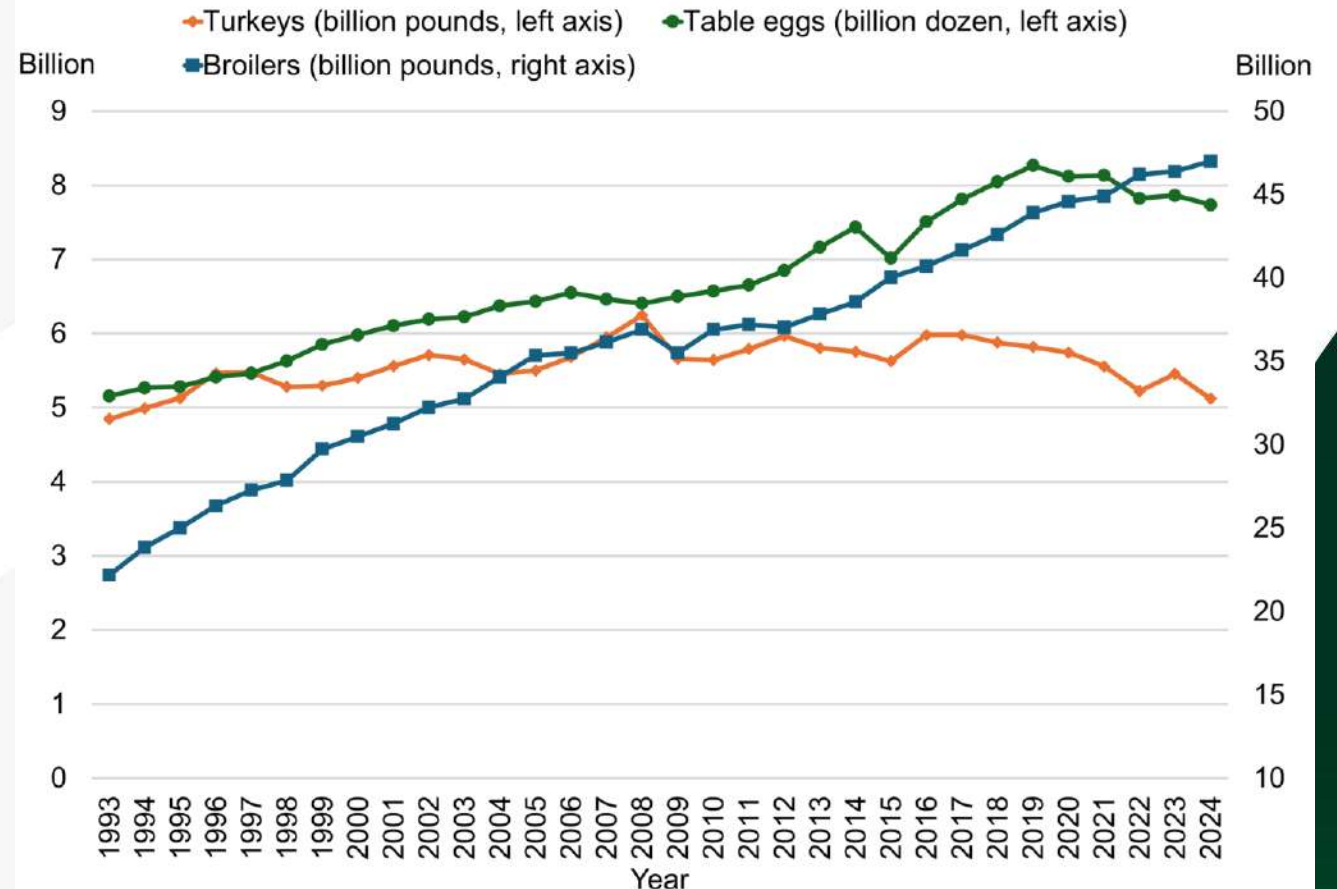
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Georgia, Athens, GA 30602, USA

2025

U.S. Poultry sector

- U.S. poultry products hold leading positions in both international and U.S. meat commodity markets.
- In the U.S. (annually):
 - ~220 million turkeys
 - ~9.4 billion broiler chickens
 - ~375 million laying hens

Annual U.S. production of broilers, turkeys, and table eggs, 1993–2024



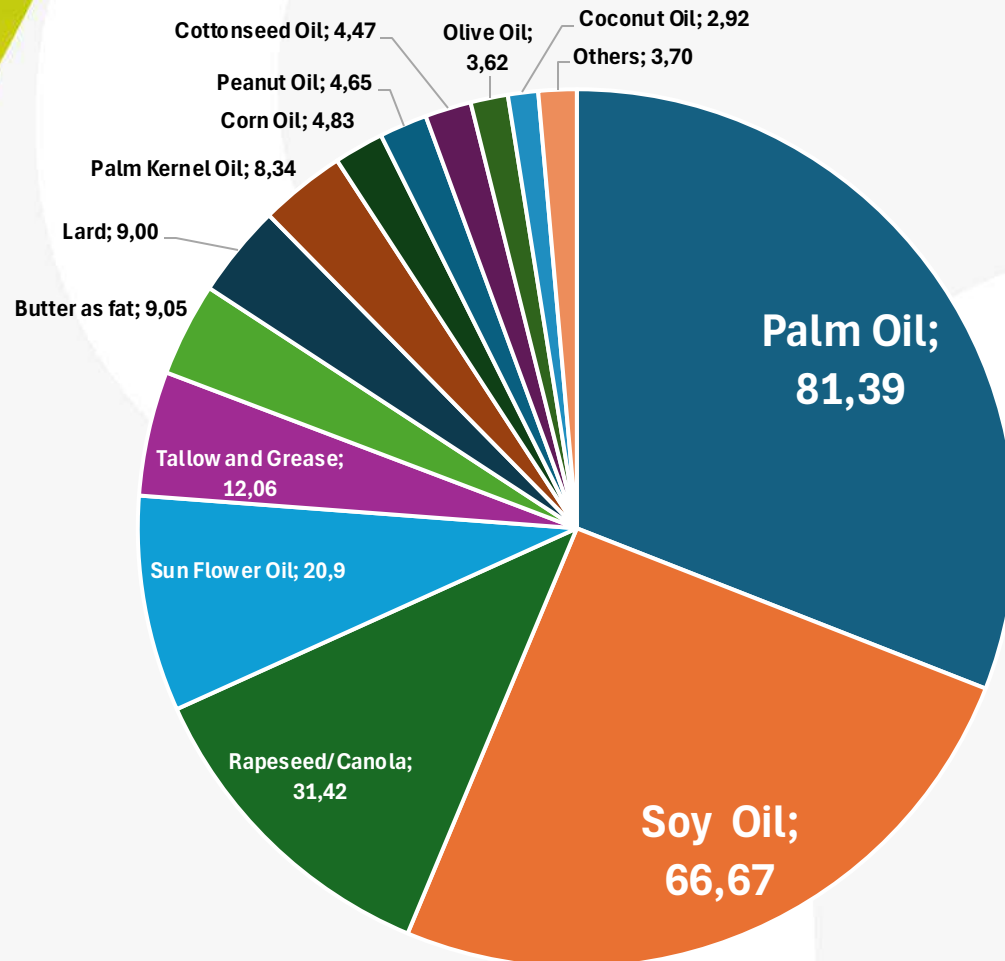
Source: USDA, Economic Research Service calculations using USDA, National Agricultural Statistics Service data.

Oil production (World vs USA)

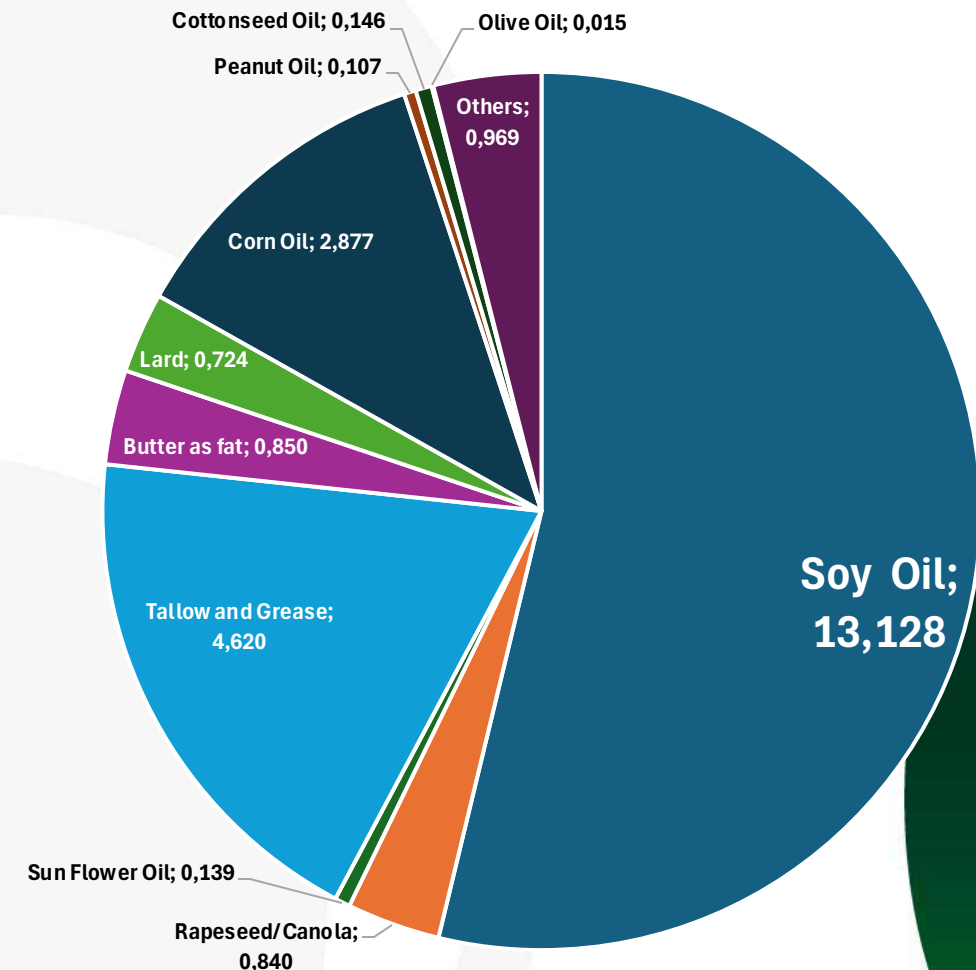


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World Production (million MT)



USA Production (million MT)



Why is there interest from the U.S. poultry industry to have additional fat sources?



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Consistent nutritional values

Quality

Availability

Price



- Handling
- Feed pellet quality
- Palatability
- Final product quality
 - Fatty acid composition
 - Shelf life
 - Organoleptic properties

Blend of fat sources

Palm oil products

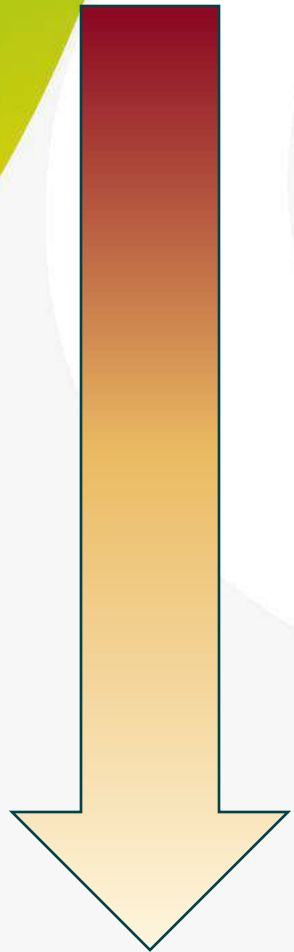


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Palm oil flowchart

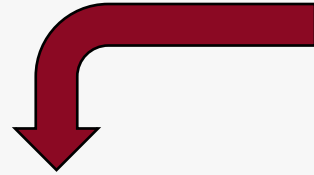
Less refined



More refined



Elaeis guineensis



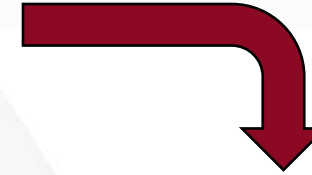
CRUDE PALM OIL
(**CPO**)



PALM FRUIT
(PULP)



OxG Hybrid



HIGH OLEIC CRUDE
PALM OIL
(**HOPO**)



REFINED, BLEACHED AND
DEODORIZED PALM OIL

(**RBDPO**)



RBD PALM OLEIN
(**PALMOL**)





Objective

- Explore energy value of different palm oil products though isocaloric replacement of soybean oil in poultry diet formulation.
 - Nitrogen-adjusted true metabolizable energy (TMEn)
 - Fatty acid profile
 - Growth performance
 - Production
 - Carcass characteristics
 - Meat and egg quality
- Broilers, Laying hens, and Turkeys

Oil energy values



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Oil treatment description		Gross Energy (Kcal/kg)	TME _n (Kcal/kg)
Soybean oil	SOY OIL	9758	8800
High oleic palm oil	HOPO	9784	9008
Refined bleached and deodorized palm oil	RBDPO	9757	9190
Crude palm oil	CPO	9727	8906
Refined bleached and deodorized palm olein	PALMOL	9764	8549

Precision-fed cecectomized rooster essay to determine metabolizable energy content.

Experimental diets



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	TME _n (Kcal/kg)
SOY OIL	8800
HOPO	9008
RBDPO	9190
CPO	8906
PALMOL	8549

- Similar corn-soybean meal basal diet for all the treatments
- Isocaloric replacement of soybean oil with palm oil
- Feed and water: *Ad libitum*
- Table: Oil inclusion in % of diet

- **Broilers:** 0-14 d (starter), 15-28 d (grower), 29-42 d (finisher)

Feed phase	SOY OIL	HOPO	RBDPO	CPO	PALMOL
Starter	0.5%	0.49%	0.48%	0.49%	0.52%
Grower	1.0%	0.98%	0.96%	0.99%	1.03%
Finisher	1.5%	1.47%	1.44%	1.48%	1.54%

- **Turkeys:** 0-28 d (starter), 29-42d (grower I), 43-55 d (grower II)

Feed phase	SOY OIL	HOPO	RBDPO	CPO	PALMOL
Starter	5.0%	4.9%	4.8%	4.9%	5.1%
Grower I	5.5%	5.4%	5.3%	5.4%	5.7%
Grower II	6.0%	5.9%	5.7%	5.9%	6.2%

- **Laying hens:** 29-38 weeks-old (Peak), 38-45 weeks-old (Layer II) (16 weeks trial)

Feed phase	SOY OIL	HOPO	RBDPO	CPO	PALMOL
Peak	4.36%	4.26%	4.17%	4.31%	4.49%
Layer II	1.27%	1.24%	1.22%	1.25%	1.31%



Statistical analysis

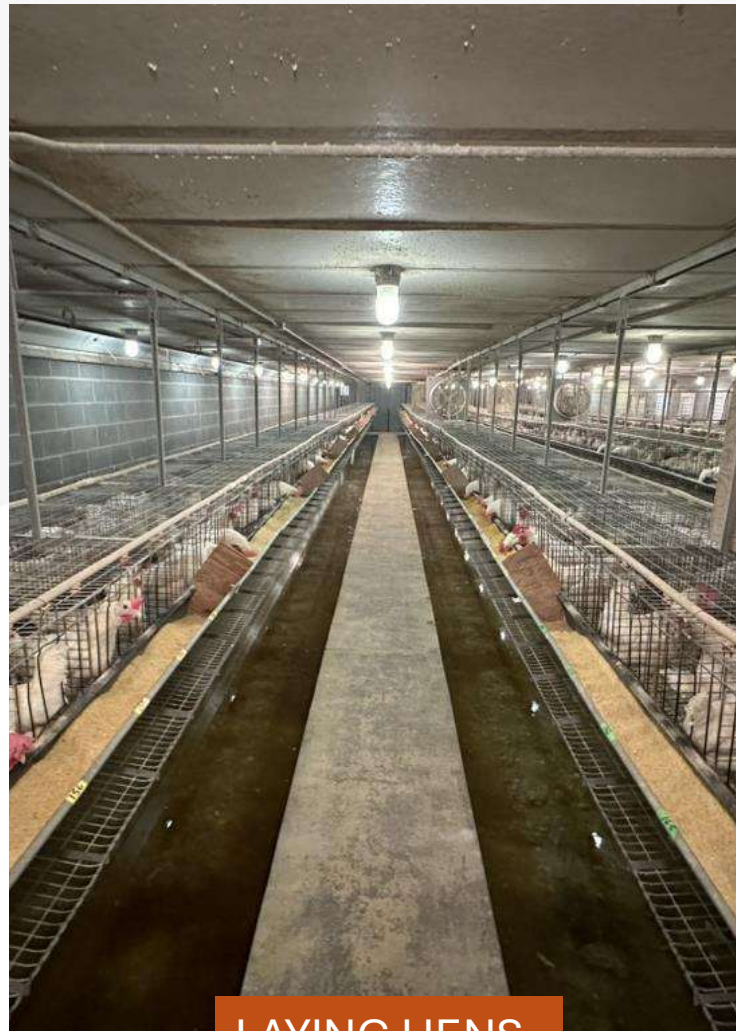
- One-way **ANOVA**
- Mean separation by **Tukey's HSD**
- Significance level set at **P<0.05** and P< 0.1 as a trend
- JMP Pro 17.0.0 (SAS Inst. INC., Cary, NC)

Experimental facilities

Poultry Research Center (PRC), Department of Poultry Science, the University of Georgia, U.S.



BROILERS



LAYING HENS



TURKEY



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- Results

Broilers
0-42 days

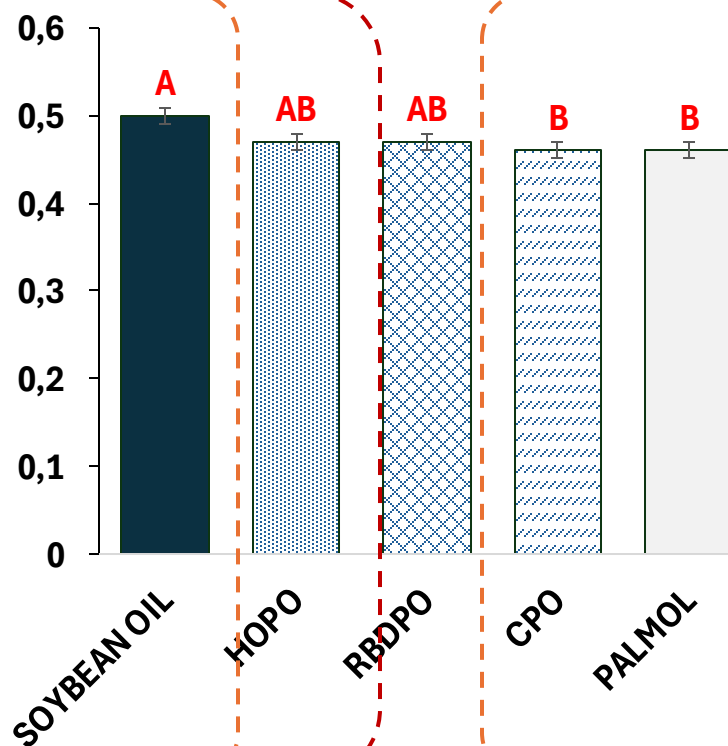
Growth performance 0 to 14 days (starter phase)



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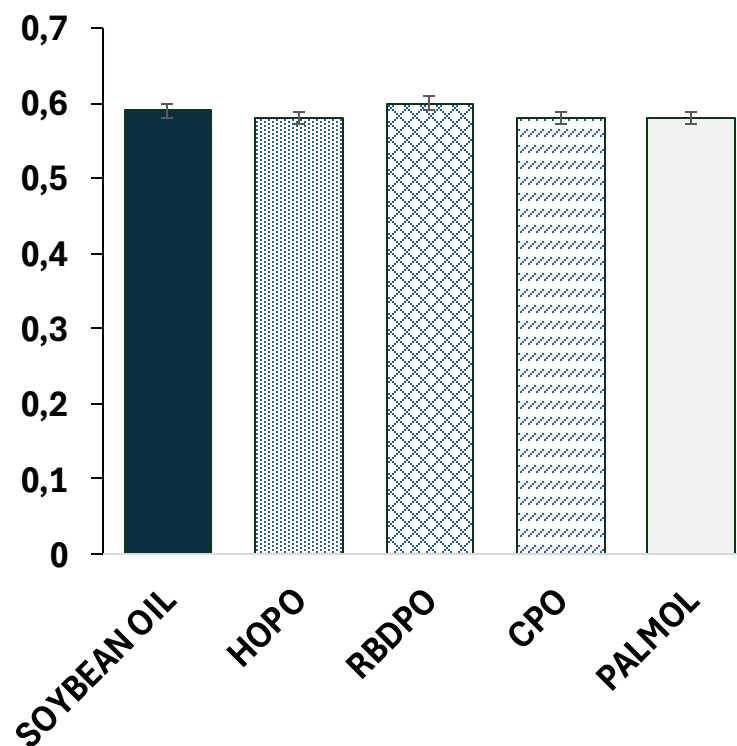
Body weight gain (Kg)

P=0.0139



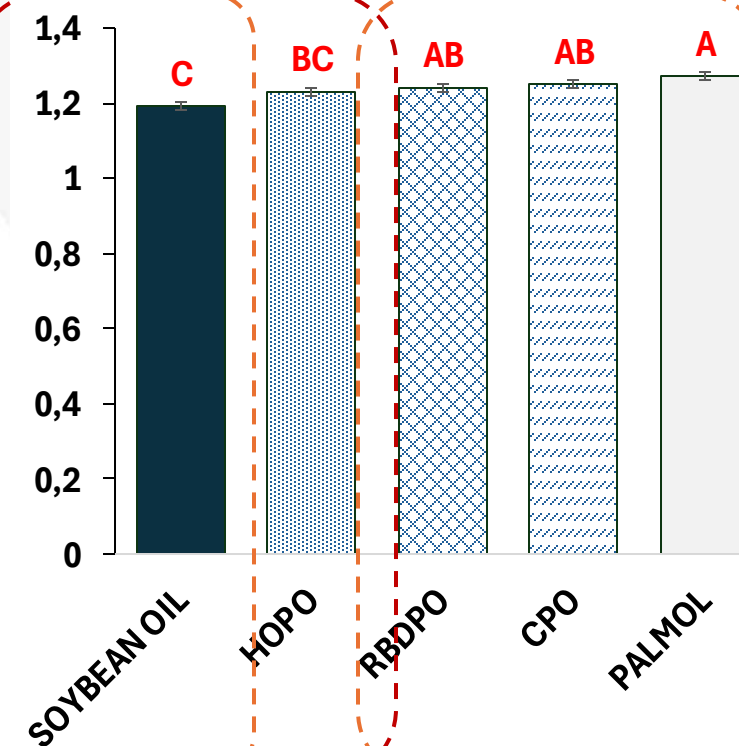
Feed intake/bird (Kg)

P=0.4301



Feed conversion ratio (Kg:Kg)

P=0.0001



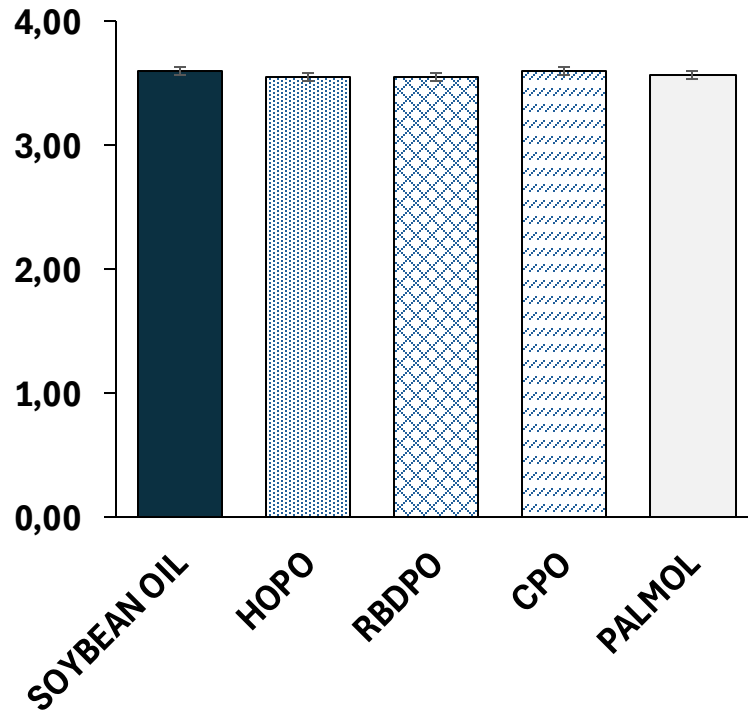
Growth performance 0-42 days (Overall data)



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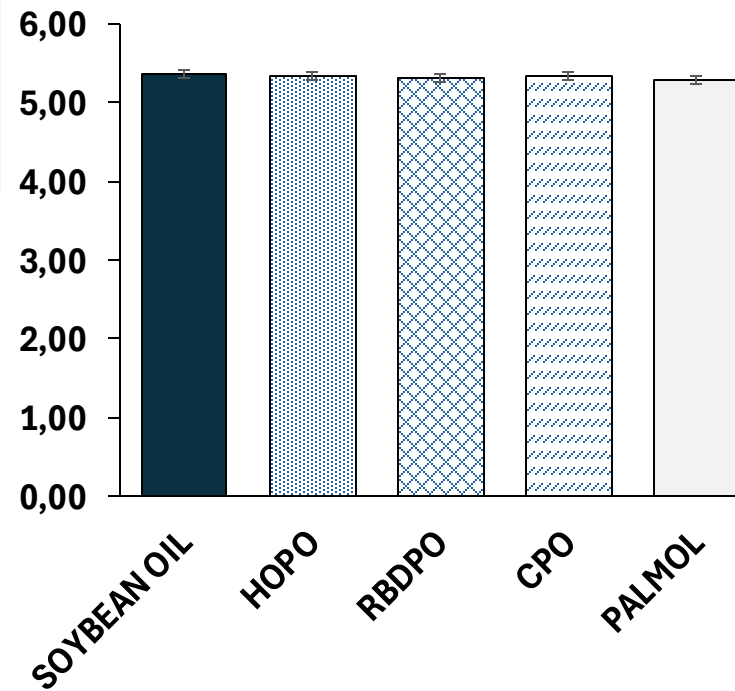
Body weight gain (Kg)

P=0.0574



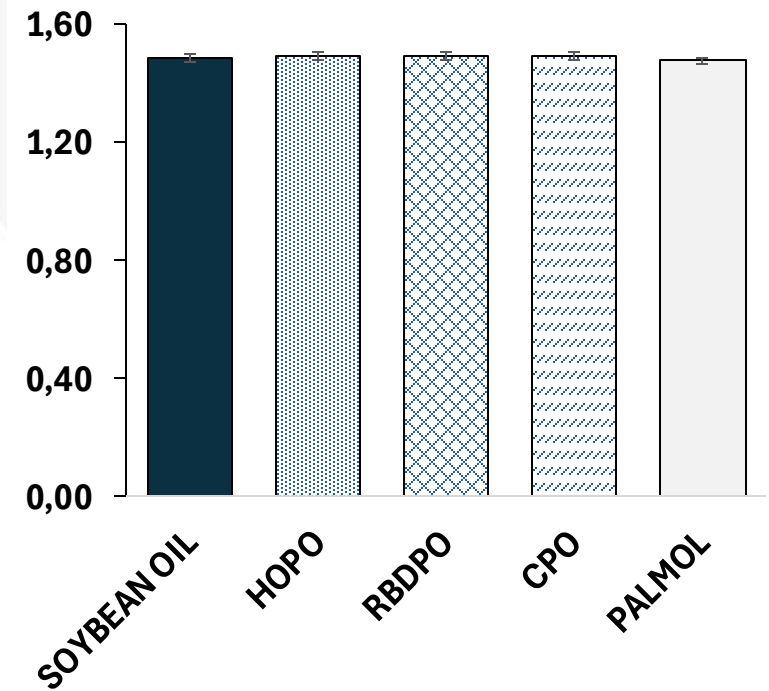
Feed intake/bird (Kg)

P=0.8669



Feed conversion ratio (Kg:Kg)

P=0.8932



Carcass characteristics

No statistical difference observed

Treatment description	Live body weight (kg)	Hot carcass weight (kg)	Cold carcass weight (kg)
SOYBEAN OIL	3.680	2.761	2.813
HOPO	3.609	2.714	2.771
RBDPO	3.615	2.701	2.751
CPO	3.638	2.727	2.785
PALMOL	3.693	2.790	2.848
CV%	2.720	3.046	3.000
SEM ±	0.033	0.028	0.028
P-value	0.288	0.170	0.143

Carcass characteristics



	Dressing (%)	Wings (kg)	Legs (kg)	Major (kg)	Minor (kg)
SOYBEAN OIL	76.41 ^{AB}	0.289 ^A	0.803	0.853 ^{ab}	0.146
HOPO	76.78 ^{AB}	0.282 ^{AB}	0.800	0.842 ^{ab}	0.146
RBDPO	76.09 ^B	0.276 ^B	0.790	0.844 ^{ab}	0.147
CPO	76.57 ^{AB}	0.283 ^{AB}	0.805	0.839 ^b	0.150
PALMOL	77.112 ^A	0.289 ^A	0.804	0.885 ^a	0.146
SEM ±	0.22	0.003	0.010	0.013	0.002
P-value	0.0255*	0.0128*	0.784	0.073	0.680

Dressing (%)= cold carcass weight/live BW x 100



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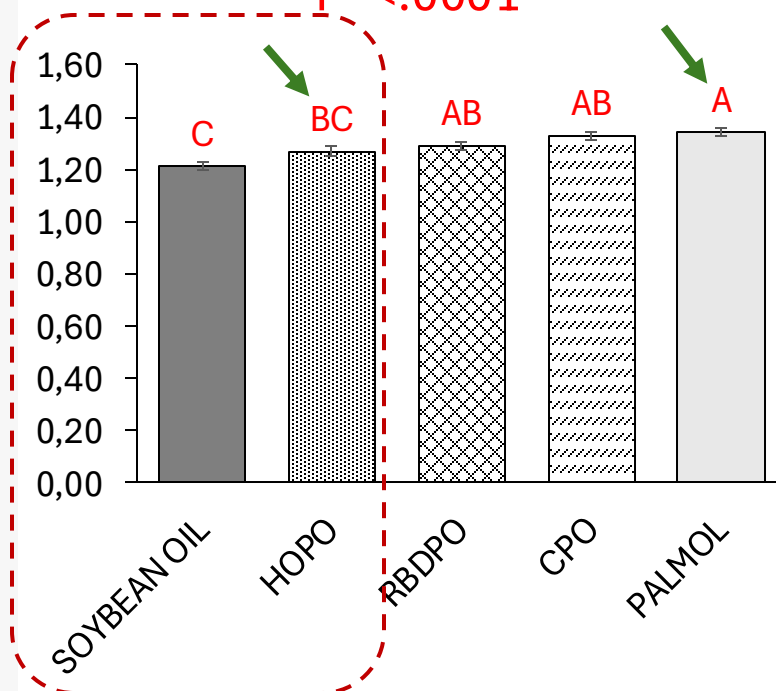
Turkeys
0-55 days

Feed conversion ratio

Body weight gain (Kg):Feed intake (Kg)

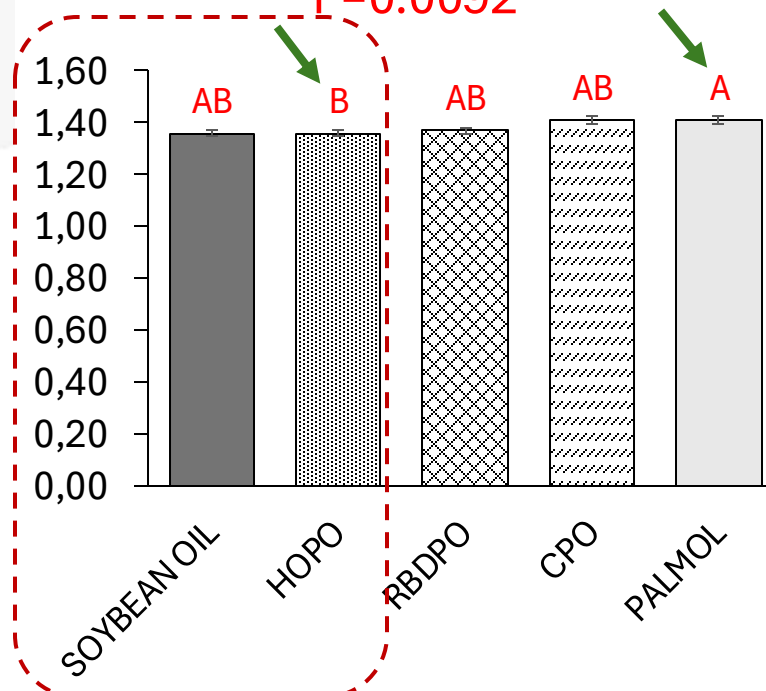
**Starter phase
0-28 days**

$P < .0001$



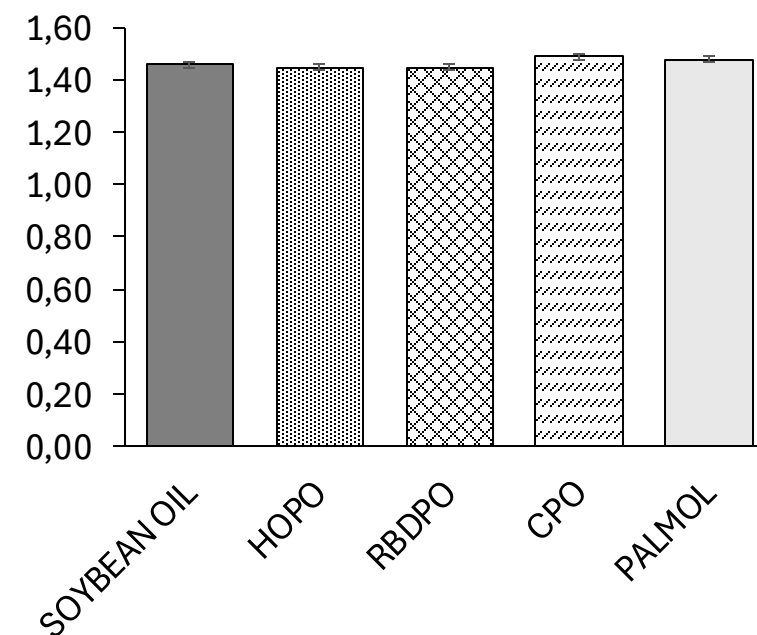
**Overall period
0-42 days**

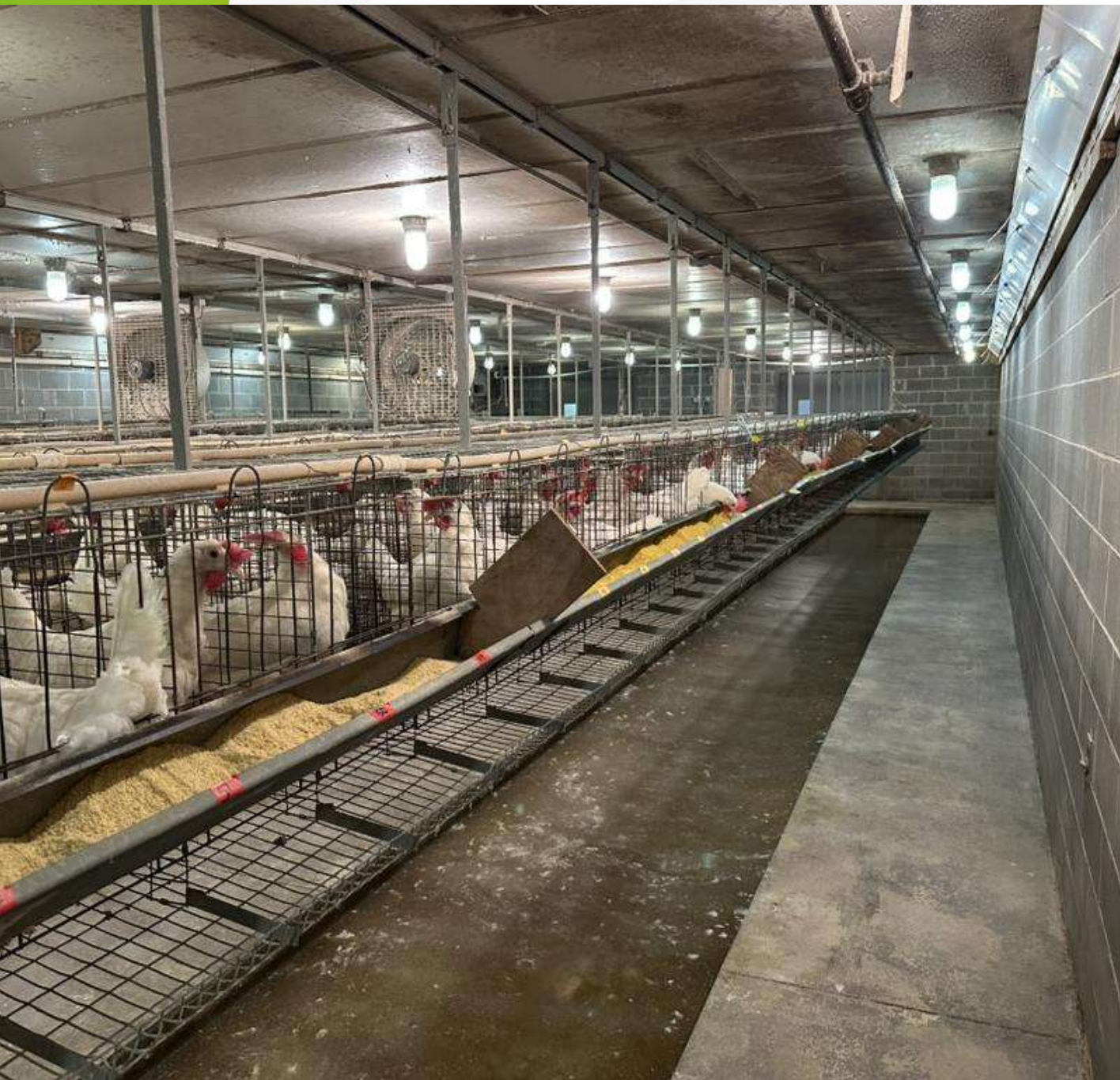
$P = 0.0092$



**Overall trial period
0-55 days**

$P = 0.0582$





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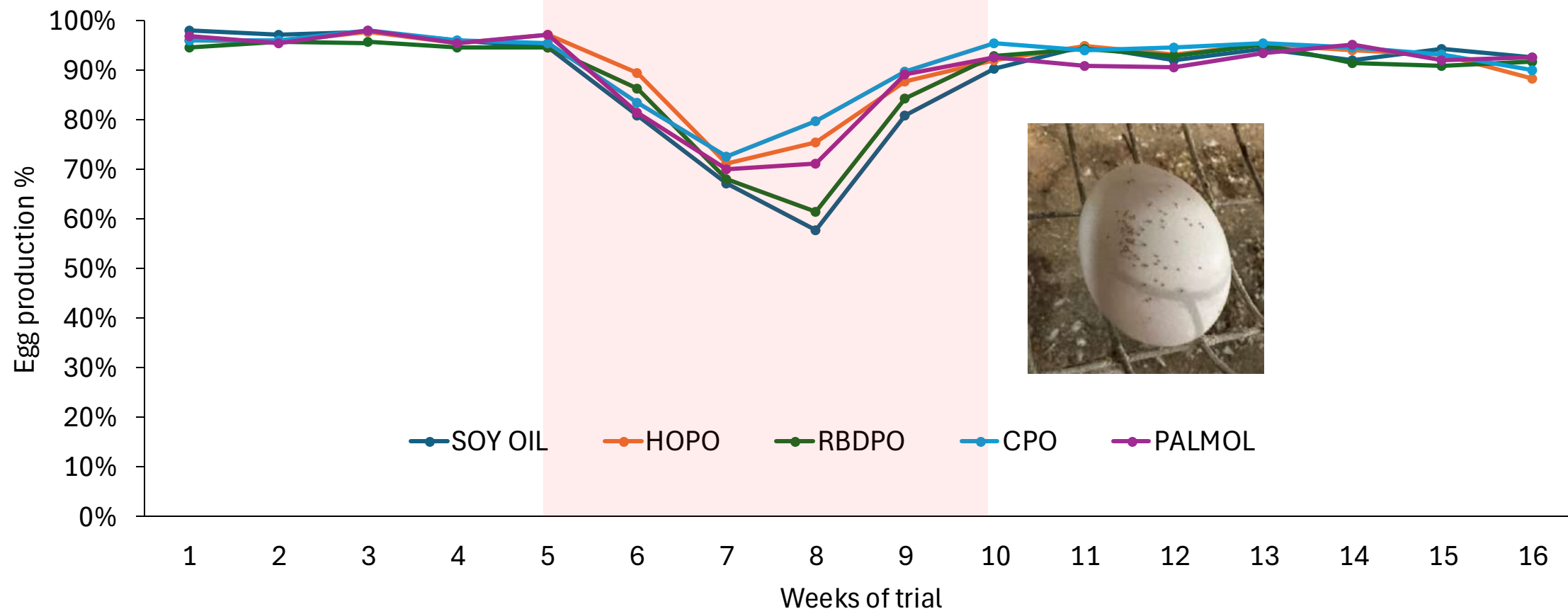
- Results

Laying hens
29-45 weeks old

Weekly Egg production (%)



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Week of the trial	SOY OIL	HOPO	RBDPO	CPO	PALMOL	SEM	P-VALUE
8	57.9% ^B	75.4% ^{AB}	61.4% ^{AB}	79.9% ^A	71.2% ^{AB}	0.0529	0.0277*

Egg weight



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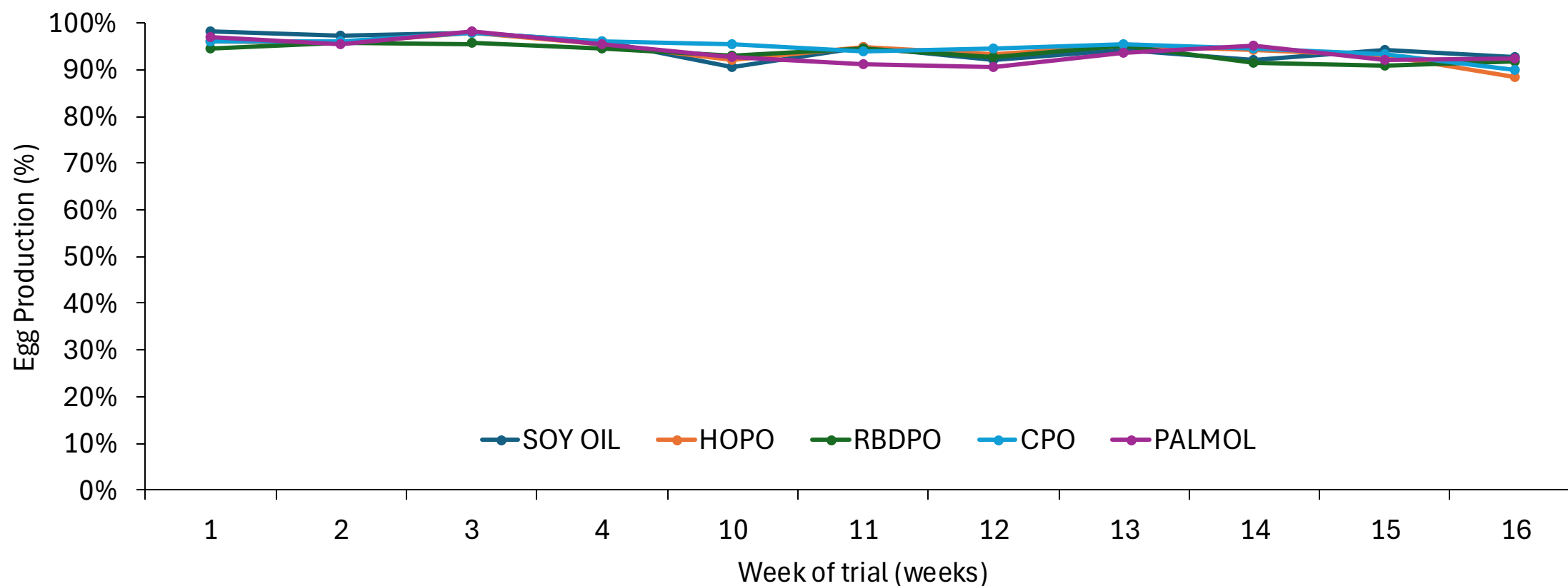
Weeks of trial	Age (weeks)	SOY OIL	HOPO	RBDPO	CPO	PALMOL	SEM	P-value
0	29	60.72	61.06	61.11	60.23	60.71	0.436	0.6331
4	33	62.04	62.63	61.98	62.52	62.32	0.498	0.4977
9	38	63.80	64.72	64.22	64.28	64.57	0.539	0.7821
12	41	63.42	64.81	64.24	64.25	64.18	0.514	0.4557
16	45	64.14	63.95	65.28	64.07	64.50	0.643	0.5972

Weekly Egg production (%)

Excluding mites control period

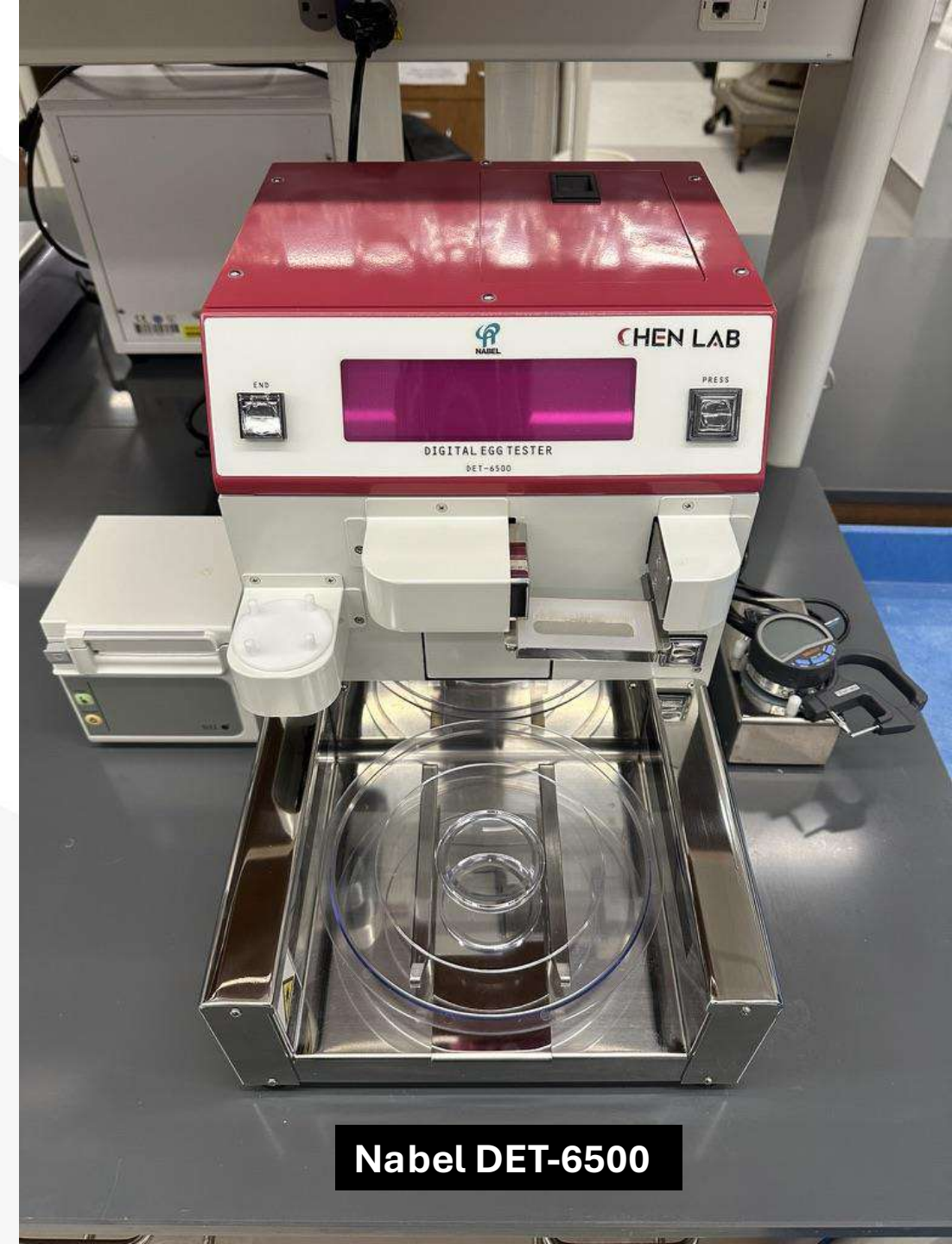


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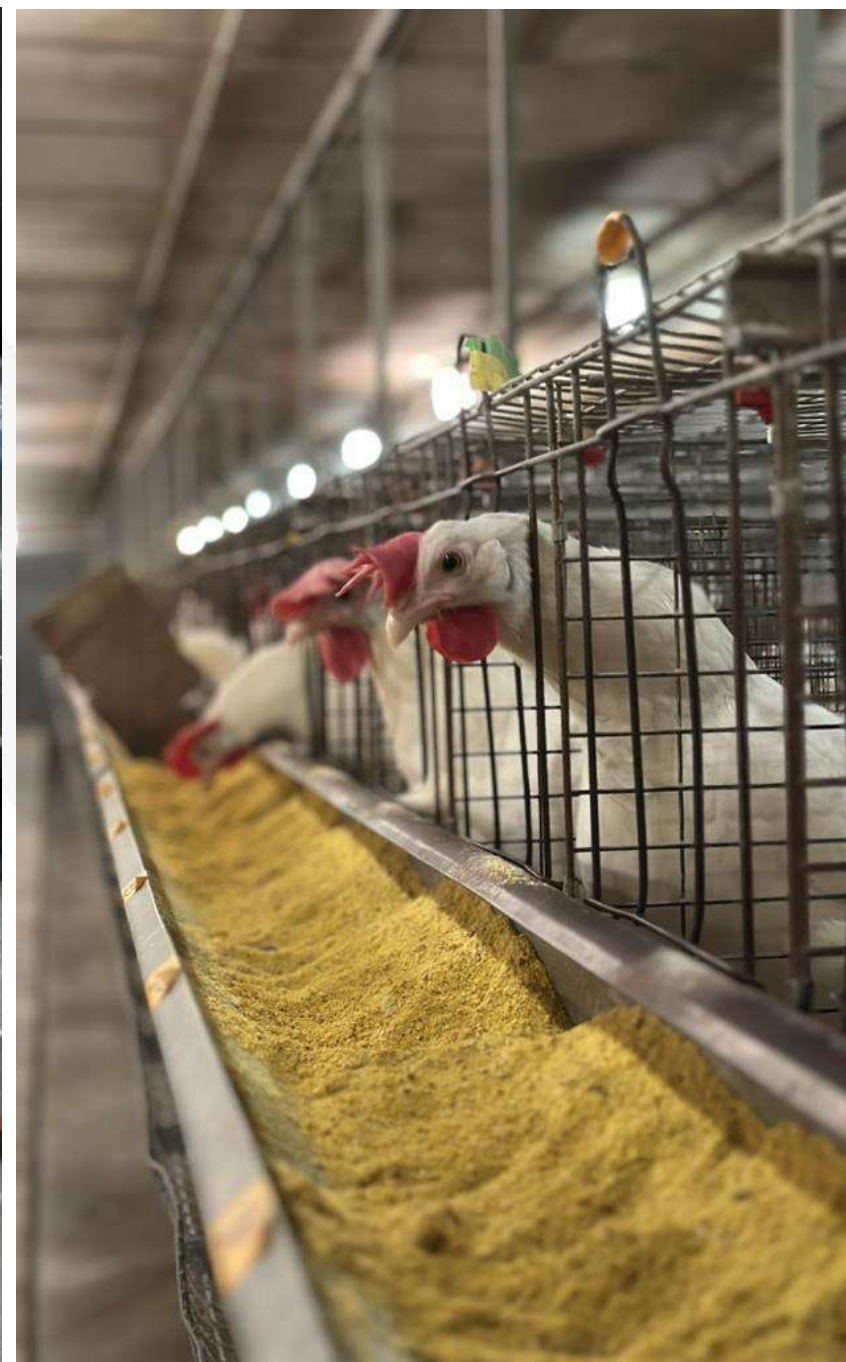


Egg quality

- Albumen height
- Albumen weight
- Yolk Height
- Yolk weight
- Yolk diameter
- Yolk Index
 - Yolk Index (YI) = Yolk Height / Yolk Diameter
- Haught Unit
 - $HU = 100 * \log(H + 7.57 - 1.7 * W^{0.37})$
- Shell Breaking strength
- Shell thickness
- Shell weight

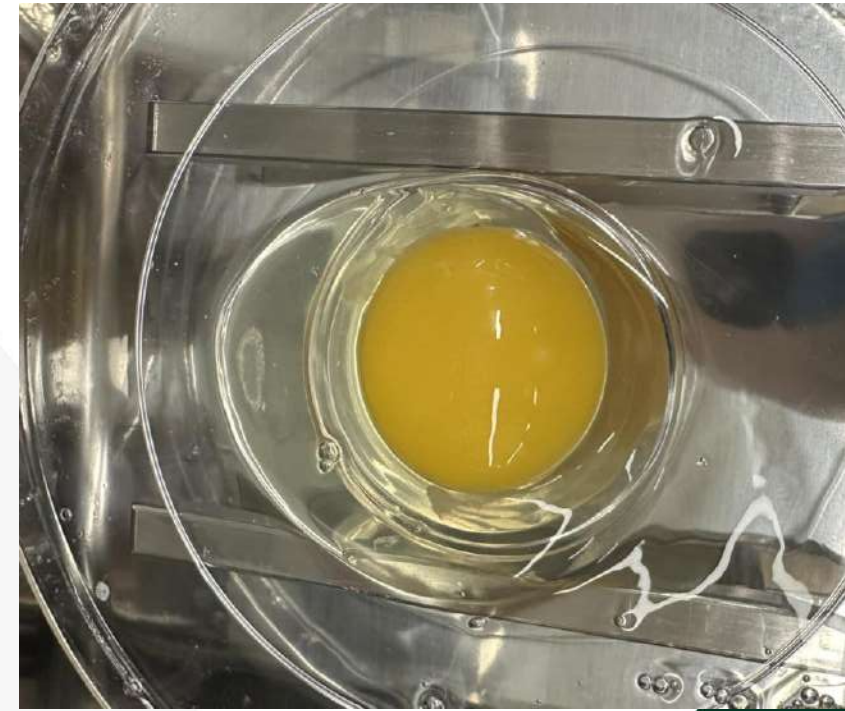


Nabel DET-6500





Egg yolk color



week of the trial	SOY OIL	HOPO	RBDPO	CPO	PALMOL	SEM	P-VALUE
0	5.8	5.9	6.1	5.9	5.9	0.1336	0.3957
4	5.5 ^C	6.6 ^A	6.0 ^{ABC}	6.5 ^{AB}	5.9 ^{BC}	0.1553	<.0001*
9	6.0 ^C	7.3 ^A	6.5 ^{BC}	7.0 ^{AB}	6.4 ^{BC}	0.1623	<.0001*
12	6.0 ^B	6.9 ^A	6.4 ^{AB}	6.6 ^A	6.4 ^{AB}	0.1524	0.0044*
16	6.0 ^B	6.8 ^A	6.1 ^B	6.5 ^{AB}	6.0 ^B	0.125	0.0002*

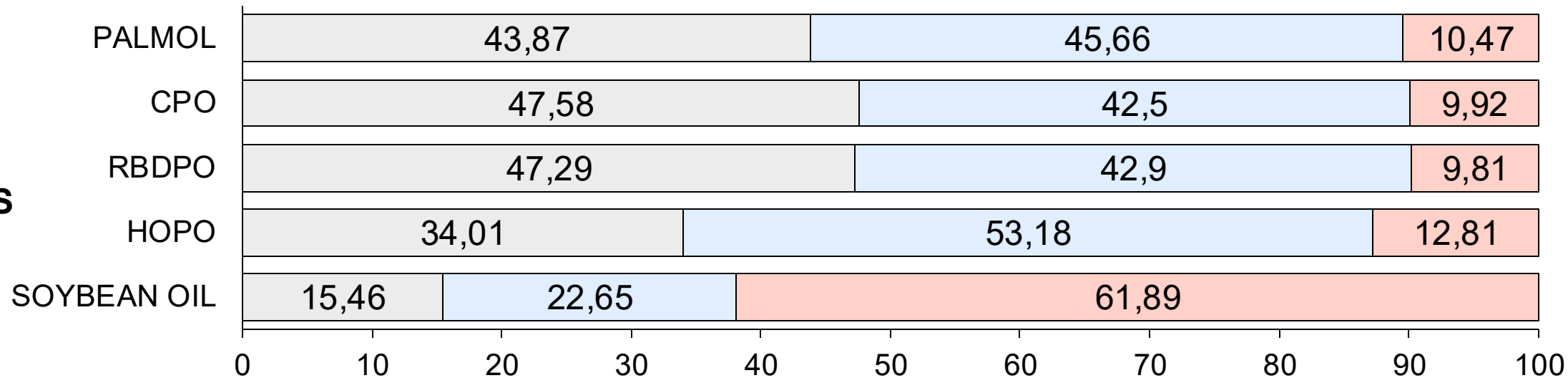


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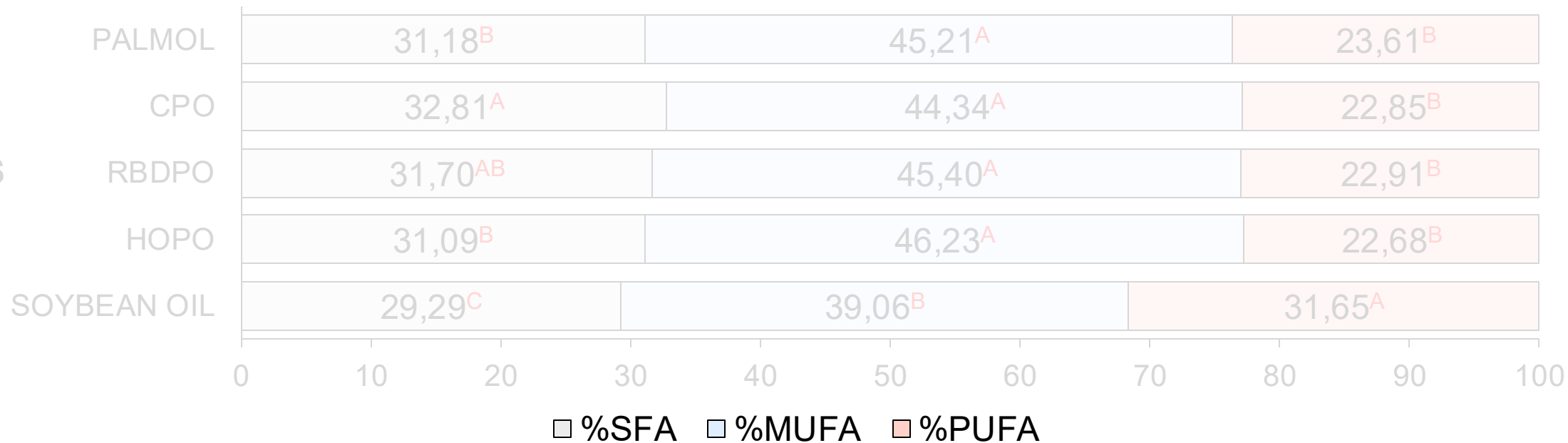
Fatty acid
composition of oils
and breast muscle

OILS SAMPLES



BREAST MUSCLE SAMPLES

P<.0001*



Breast muscle Fatty acid composition – SFA (%w/w)



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Saturated fatty acids

Fatty acid	C:B	SOY OIL	HOPO	RBDPO	CPO	PALMOL	SEM	P-value
Myristic	C14:0	0.574 ^C	0.614 ^{BC}	0.712 ^A	0.682 ^{AB}	0.660 ^{AB}	0.017	<.0001
Pentadecanoic	C15:0	0.138	0.138	0.14	0.137	0.131	0.004	0.6335
Palmitic	C16:0	21.274 ^C	23.314 ^B	23.989 ^{AB}	24.567 ^A	23.681 ^{AB}	0.263	<.0001
Stearic	C18:0	7.143	6.749	6.564	7.112	6.509	0.182	0.0439
Behenic	C22:0	0.111 ^B	0.230 ^A	0.250 ^A	0.247 ^A	0.159 ^B	0.013	<.0001

Breast muscle Fatty acid composition

– MUFA (%w/w)



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Monounsaturated fatty acids

Fatty acid	C:B	SOY OIL	HOPO	RBDPO	CPO	PALMOL	SEM	P-value
Myristoleic	C14:1	0.129	0.143	0.163	0.13	0.136	0.011	0.2113
Trans-palmitoleic acid (TPA)	transC16:1	0.583 ^B	0.666 ^A	0.682 ^A	0.637 ^{AB}	0.648 ^{AB}	0.017	0.0029
Palmitoleic	C16:1	3.47	4.209	4.53	3.789	4.094	0.267	0.0741
Heptadecenoic	C17:1	0.522	0.57	0.581	0.563	0.477	0.026	0.0472
Elaidic acid	transC18:1	0.201	0.211	0.207	0.223	0.2	0.006	0.0756
Oleic	C18:1	33.737 ^B	39.960 ^A	38.774 ^A	38.547 ^A	39.230 ^A	0.411	<.0001
Gadoleic	C20:1	0.447	0.471	0.46	0.457	0.428	0.019	0.5816

Breast muscle Fatty acid composition

– PUFA (%w/w)



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Polyunsaturated fatty acids

Fatty acid	C:B	SOY OIL	HOPO	RBDPO	CPO	PALMOL	SEM	P-value
ω-6								
Linoleic	C18:2	25.417 ^A	17.867 ^B	17.969 ^B	18.141 ^B	19.250 ^B	0.422	<.0001
Gamma-Linolenic acid (GLA)	C18:3, n-6	0.356 ^A	0.270 ^B	0.254 ^B	0.260 ^B	0.290 ^B	0.0144	<.0001
Eicosadienoic	C20:2	0.402 ^A	0.306 ^B	0.293 ^B	0.291 ^B	0.279 ^B	0.0198	0.0004
Dihomo-gamma-linolenic acid (DGLA)	C20:3	0.601	0.663	0.661	0.646	0.564	0.0395	0.3303
Arachidonic (AA)	C20:4	2.469	2.341	2.523	2.33	2.111	0.1659	0.46
ω-3								
Alpha-Linolenic (ALA)	C18:3, n-3	1.681 ^A	0.729 ^B	0.697 ^B	0.672 ^B	0.710 ^B	0.0232	<.0001
Docosapentaenoic (DPA)	C22:5	0.358 ^A	0.252 ^B	0.260 ^B	0.248 ^B	0.219 ^B	0.0187	<.0001
Docosahexaenoic (DHA)	C22:6	0.279 ^A	0.186 ^B	0.194 ^B	0.193 ^B	0.144 ^B	0.0194	0.0005

Summary

- Tested Palm oils have higher metabolizable energy than soybean oil except palm olein.
- Palm oil groups provided comparable results to soybean oil for performance during the later stages and carcass yield in broilers and turkeys.
- In laying hens, evidence shows that under stress condition (mites challenge) palm oil (CPO) recovers better in production.
- Egg quality and production in laying hens were not affected (from 29 to 45 weeks-old). HOPO and CPO increased egg yolk color.
- The Fatty acid profile (FA) of oil can influence the FA composition in breast muscle.



Key Take-aways

- Energy is the most expensive component in poultry diet.
 - Reliable alternative energy sources are needed!
- Due to its consistent energy value and balanced fatty acid profile, high oleic palm oil (HOPO) may benefit the U.S. poultry industry's dietary fat blend strategy.
- These results agree with previous research suggesting Palm oil as an strategic fat source for the poultry diet with no negative implications on growth performance and product quality.

Muchas gracias

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