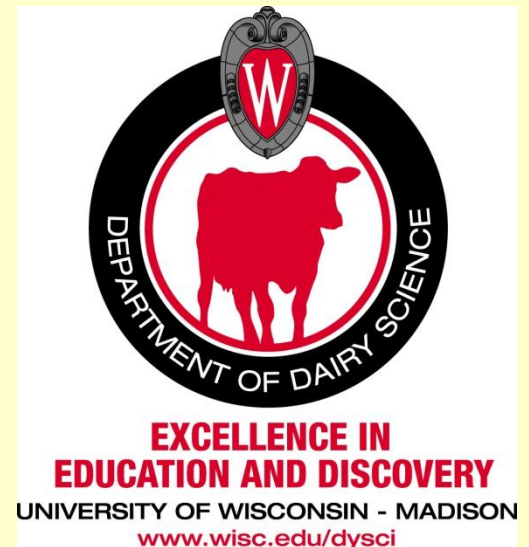


Efficacy of essential oils as dietary supplements for dairy cows

M.D. Tassoul & R.D. Shaver

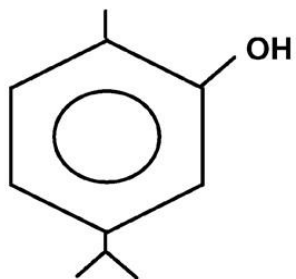
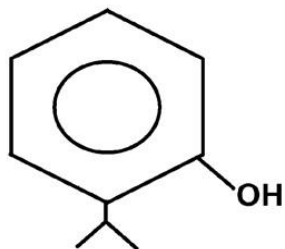
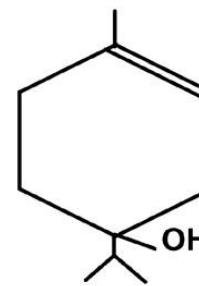
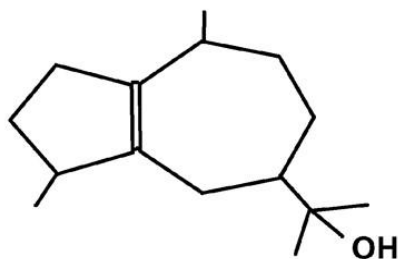
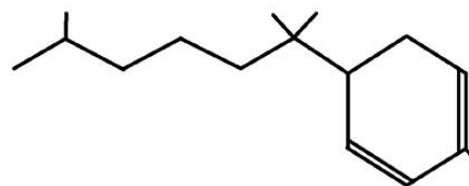
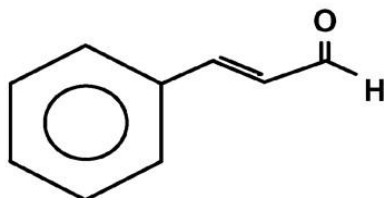
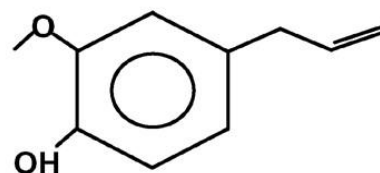
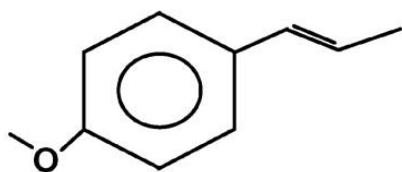
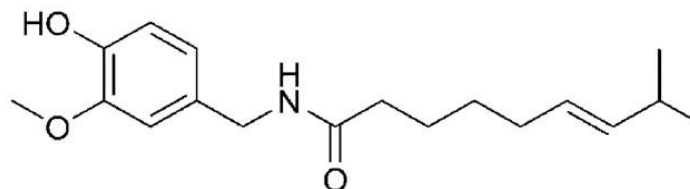
Dairy Science Department
University of Wisconsin - Madison



Essential Oils

- Volatile aromatic compounds with oily appearance extracted from plant materials typically by steam distillation
- Alcohol, ester or aldehyde derivatives of phenylpropanoids and terpenoids
- Anti-microbial activity
- Modify rumen microbial fermentation

Source: Newbold et al., 2006 & Calsamiglia et al., 2007

A**Carvacrol****Thymol****Terpinen-4-ol****B****Guaiol****Zingiberene****C****Cinnamaldehyde****Eugenol****Anethole****Capsaicin**

Some Common Essential Oils

<u>Compound</u>	<u>Source</u>
Thymol	Thyme, Oregano
Eugenol	Clove
Pinene	Juniper
Limonene	Dill
Cinnamaldehyde	Cinnamon
Capsaicin	Hot Peppers
Terpinene	Tea Tree
Allicin	Garlic
Anethol	Anise

Source: Newbold et al., 2006 & Calsamiglia et al., 2007

CRINA RUMINANTS

➤ Mixture of natural & synthesized essential oils including:

❖ Thymol

❖ Eugenol

❖ Vanillin

❖ Guaiacol

❖ Limonene

Essential Oils as Modifiers of Rumen Microbial Fermentation

- Calsamiglia et al. (JDS; 2007) from extensive review of in vitro, in situ & continuous culture based literature concluded the following:
 - ❖ Inhibition of deamination & methanogenesis
 - Lower ammonia-N, methane & acetate concentrations
 - Higher propionate & butyrate concentrations
 - ❖ Effects may vary depending on the specific EO or combination of EO supplemented
 - ❖ Effects of some EO are pH & diet dependent

Dairy Cow Trials

<u>Trial</u>	<u>Essential Oils Product</u>
Yang et al., 2007, JDS	Garlic (5 g/cow/d) Juniper Berry (2 g/cow/d)
Benchaar et al., 2007, JDS	CRINA (0.75 g/cow/d)
Benchaar et al., 2006, JDS	CRINA (2 g/cow/d)
Offer et al., 2005 BSAS abstr.	CRINA (0.5, 1, and 2 g/cow/d)
Schmidt et al., 2004, JDS abstr.	CRINA (1.2 g/cow/d)
Varga et al., 2004, JDS abstr.	CRINA (1.2 g/cow/d)
LaCount, 1997, CRF-520	CRINA (1.5 g/cow/d)

Dairy Cow Trials

<u>Trial</u>	<u>Experimental Design</u>
Yang et al., 2007, JDS	4x4 LS, 21-d periods
Benchaar et al., 2007, JDS	4x4 LS, 28-d periods
Benchaar et al., 2006, JDS	4x4 LS, 28-d periods
Offer et al., 2005, BSAS abstr.	4x4 LS, 28-d periods
Schmidt et al., 2004, JDS abstr.	RCB, 56-d period
Varga et al., 2004, JDS abstr.	Un-replicated pens, 120-d period
LaCount, 1997, CRF-520	CRD, 70-d period

Dairy Cow Trials

<u>Trial</u>	<u>Cows</u>
Yang et al., 2007, JDS	n=4, >113 DIM, Parity>1
Benchaar et al., 2007, JDS	n=4, >61 DIM, Parity>1
Benchaar et al., 2006, JDS	n=4, >98 DIM, Parity>1
Offer et al., 2005, BSAS abstr.	n=16, >50 DIM, Parity>1
Schmidt et al., 2004, JDS abstr.	Parity=1, n=4; Parity>1, n=26; >50 DIM
Varga et al., 2004, JDS abstr.	n=170, High group, Parity 1 & >
LaCount, 1997, CRF-520	n=33, >42 DIM, Parity>1

Dairy Cow Trials

<u>Trial</u>	<u>Diet Ingredient Composition (DM basis)</u>
Yang et al., 2007, JDS	40:60 F:C; Barley silage & grain
Benchaar et al., 2007, JDS	50:50 F:C; AS or CS; Corn & barley grain
Benchaar et al., 2006, JDS	48:52 F:C; 75:25 Grass silage:CS; Corn grain; -/+ 350 mg/d monensin
Offer et al., 2005, BSAS abstr.	Grass silage ad lib; 12 kg/d (as fed) Concentrate
Schmidt et al., 2004, JDS abstr.	50:50 F:C; 50:30:20 CS:AS:AH; Corn grain
Varga et al., 2004, JDS abstr.	42:58 F:C; 70:30 CS:AS; High in byproducts
LaCount, 1997, CRF-520	51:49 F:C; 50:50 CS:AS; Pelleted complete feed

Dairy Cow Trials

<u>Trial</u>	<u>Control DMI</u> <u>kg/d</u>	<u>Control Milk</u> <u>kg/d</u>
Yang et al., 2007	20.7	29.0
Benchaar et al., 2007	17.5	28.9
Benchaar et al., 2006	22.6	34.3
Offer et al., 2005	20.8	31.1
Schmidt et al., 2004	26.4	39.8
Varga et al., 2004	NA	40.1
LaCount, 1997	22.5	44.0

Dairy Cow Trials

Treatment - Control

	DMI <u>kg/d</u>	Milk <u>kg/d</u>	FCM <u>kg/d</u>
Average	+0.4	+0.9	+1.4
Max	+1.9	+2.0	+2.7
Min	-0.3	-1.3	-1.3
P < 0.10	1/9	4/10	7/10

Dairy Cow Trials

Treatment - Control

	Milk/DMI	FCM/DMI
<i>Average</i>	+0.01	+0.04
<i>Max</i>	+0.07	+0.14
<i>Min</i>	-0.07	-0.07

Dairy Cow Trials

Treatment - Control

	Fat <u>%</u>	Fat <u>kg/d</u>
<i>Average</i>	+0.08	+0.07
<i>Max</i>	+0.32	+0.14
<i>Min</i>	-0.05	-0.04
<i>P < 0.10</i>	3/10	7/10

Dairy Cow Trials

Treatment - Control

	Protein <u>%</u>	Protein <u>kg/d</u>
<i>Average</i>	+0.02	+0.03
<i>Max</i>	+0.11	+0.10
<i>Min</i>	-0.08	-0.05
<i>P < 0.10</i>	1/10	4/10

Dairy Cow Trials

<u>Trial</u>	<u>Other P < 0.10 Responses</u>
Yang et al., 2007, JDS Garlic Juniper Berry	ROMD 5.8%; RND +6.5% ROMD 7.1%; RND +5.7%
Benchaar et al., 2007, JDS	Ruminal pH +0.10; Total VFA -9.2 mM for CS
Benchaar et al., 2006, JDS	TTADFD +2.9%; Ruminal pH +0.12
Varga et al., 2004, JDS abstr.	Continuous culture data

UW Madison Trial

Tassoul & Shaver; Abstract submitted for 2008 ADSA Annual Mtg.

- 40 Multiparous Holstein cows
 - ❑ Randomly assigned to either Control or CRINA supplemented TMR
 - ❑ Treatments began 3 wk prepartum & continued thru 15 wk postpartum
- CRINA supplementation
 - ❑ 0 & 1.2 g/cow/d
 - Placebo or CRINA premixes
 - 62 g/d added to TMR

Pre-Fresh TMR

<u>Ingredients</u>	<u>% of DM</u>
Alfalfa silage	11.0
Corn silage	48.0
Wheat straw	11.0
Ground shelled corn	18.2
Soybean meal-48%	9.2
Minerals & Vitamins	2.6

Pre-Fresh TMR

Nutrients

DM, % as fed

46.1 ± 2.9

-----DM basis-----

CP %

12.5 ± 0.7

NDF%

38.1 ± 4.6

Starch%

29.9 ± 4.6

Fat%

3.5 ± 0.4

TDN_{1x}%

68.9 ± 1.9

Pre-Fresh Measurements

	Control	CRINA	SE	P<
DMI, kg/d	13.8	13.1	0.4	NS
BW, kg	762	745	16	NS
BCS	3.9	3.8	0.1	NS

Pre-Fresh Measurements

<u>Blood Data</u> ¹	Control	CRINA	SE	P<
NEFA, mEq/L	280	299	46	NS
BHBA, mg/dL	4.8	5.5	0.9	NS
Glucose, mg/dL	56.6	57.8	1.5	NS
Urea-N, mg/dL	10.4	10.1	0.4	NS

¹Samples taken d -21, -7 & -1 relative to calving

Lactation TMR

<u>Ingredients</u>	<u>% of DM</u>
Alfalfa silage	17.0
Corn silage	30.0
Mixed Alfalfa/Grass Hay	3.7
Ground shelled corn	22.0
Soybean meal-48%	9.2
Distillers dried grains	9.2
Whole cottonseed-linted	5.6
Tallow	0.9
Minerals & Vitamins	2.4

Lactation TMR

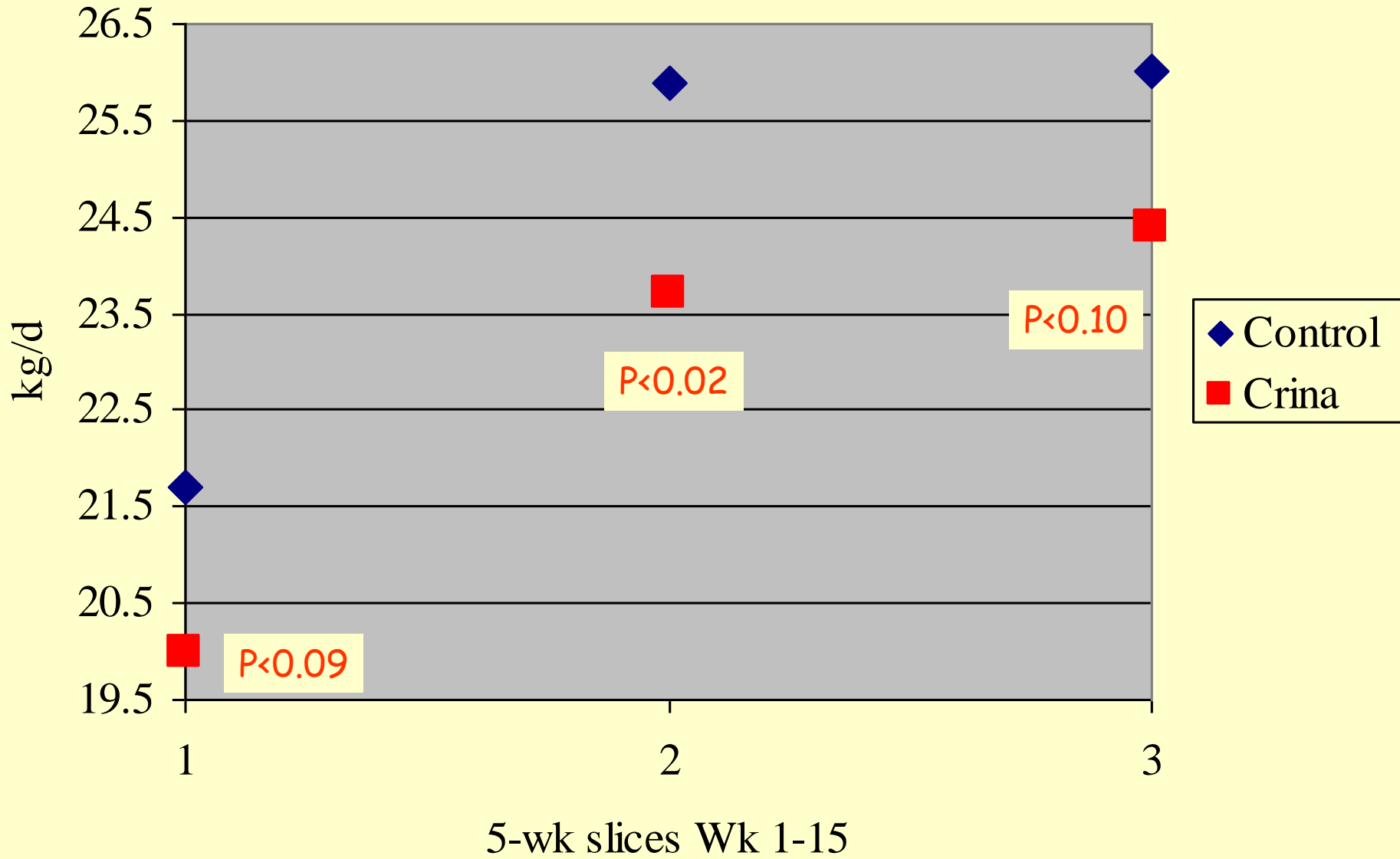
Nutrients

DM, % as fed	53.6 ± 3.0
	-----DM basis-----
CP %	17.1 ± 0.8
NDF%	35.3 ± 1.9
Starch%	24.7 ± 2.1
Fat%	6.3 ± 0.6
NEL _{3x} , Mcal/kg	1.71 ± 0.03

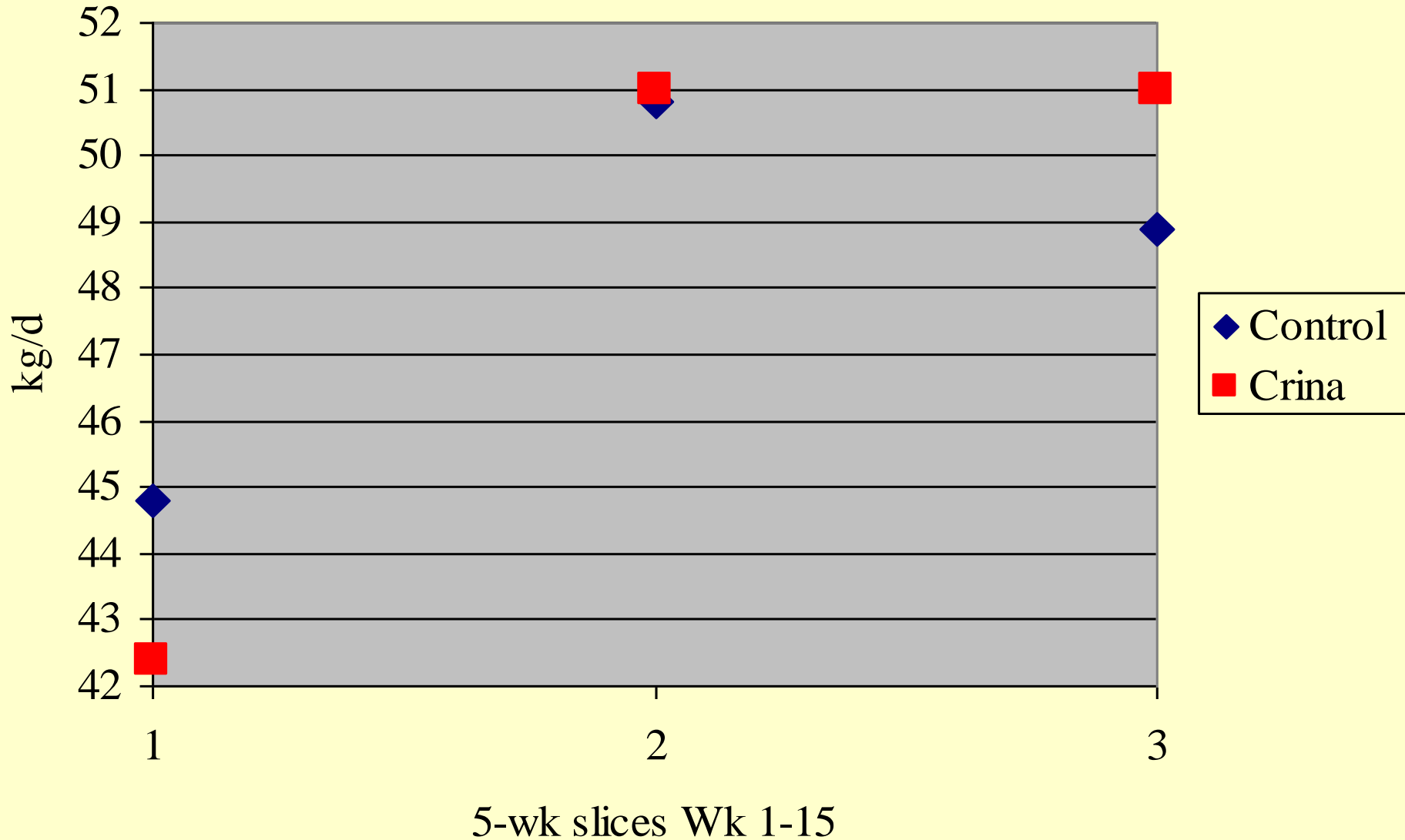
Lactation Performance

	Control	CRINA	SE	P<
DMI, kg/d	24.5	22.7	0.6	0.04
Milk, kg/d	48.2	48.1	1.1	NS
FCM, kg/d	43.9	44.0	1.2	NS

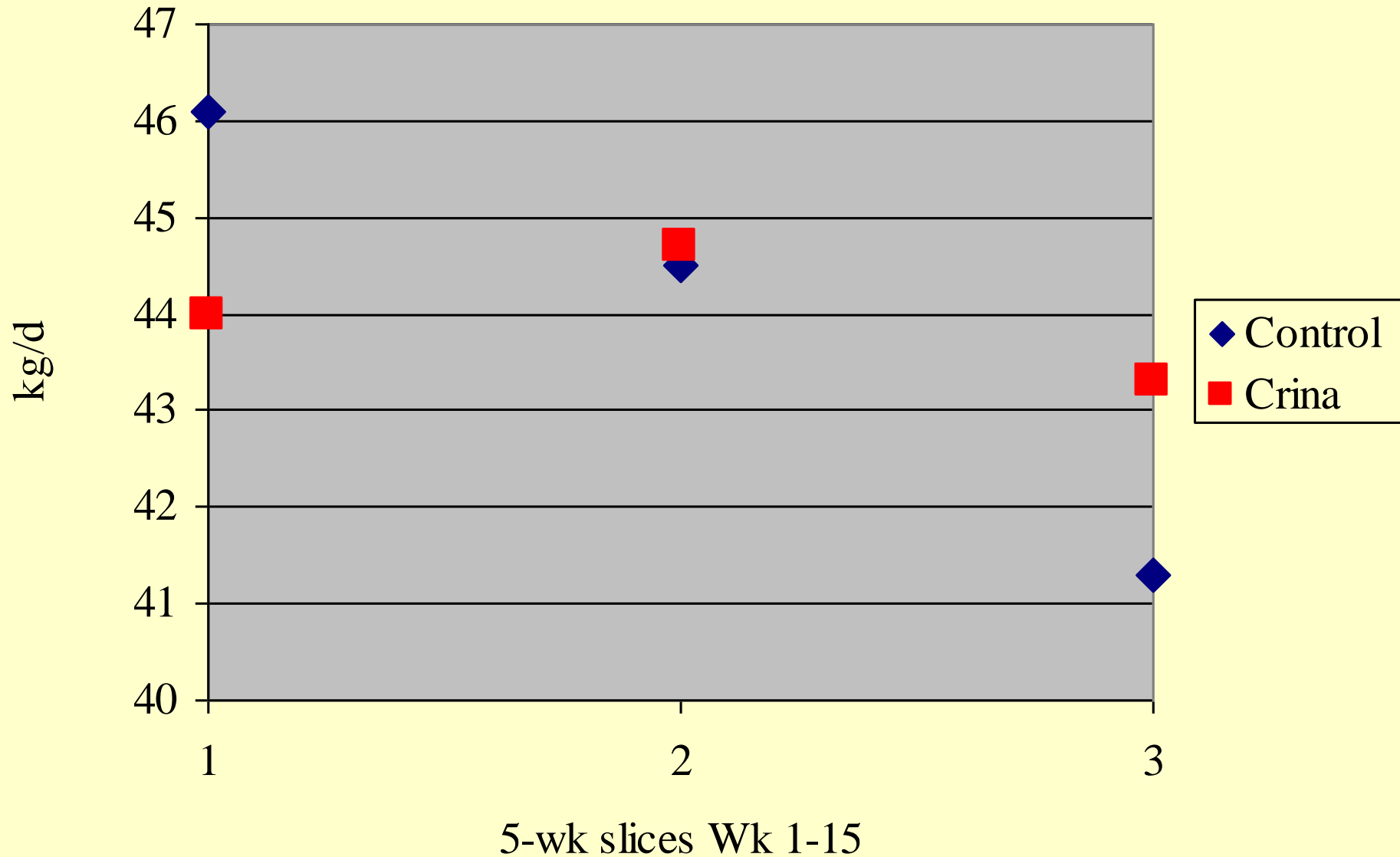
DMI



Milk Yield



FCM Yield

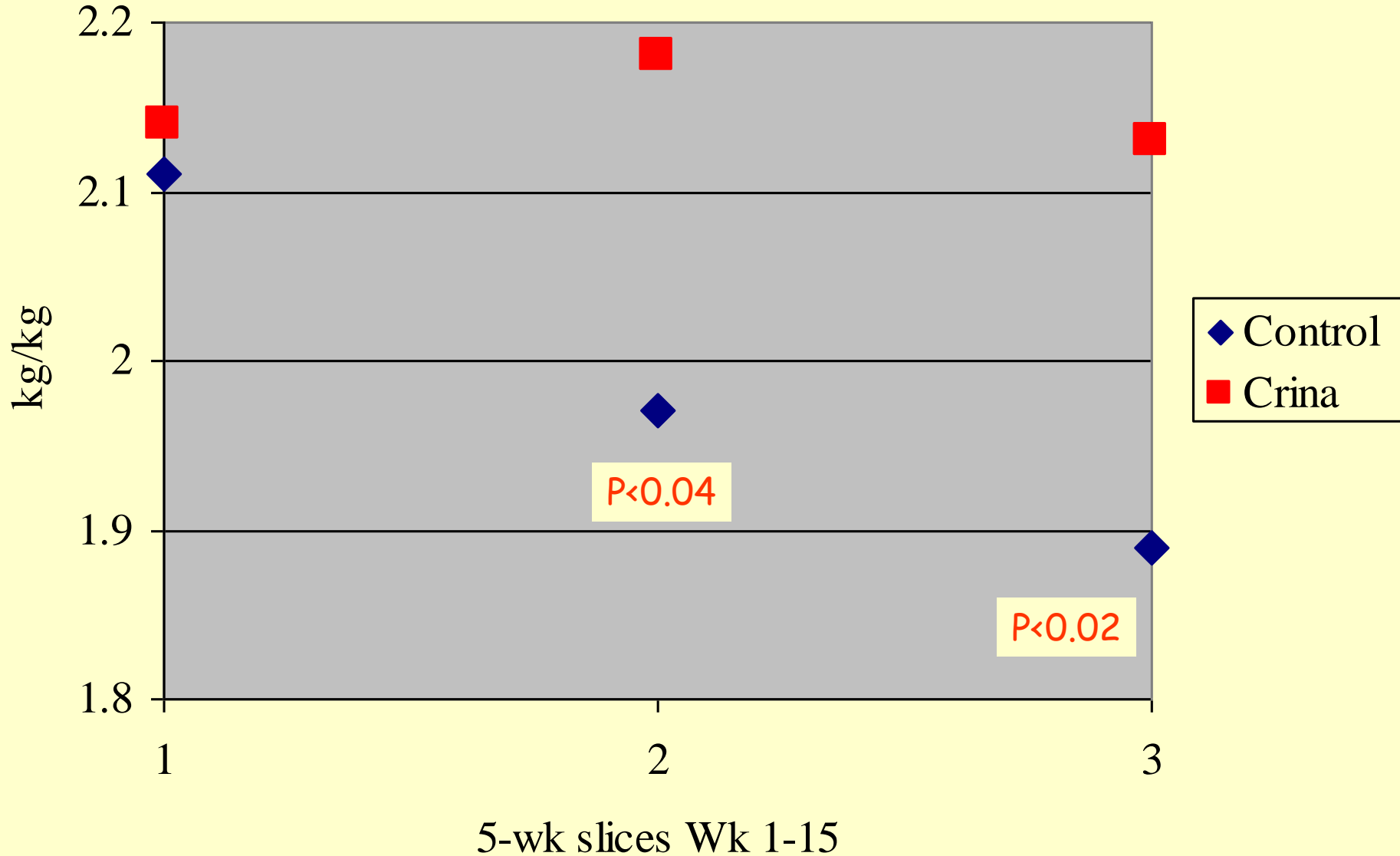


Lactation Performance

	Control	CRINA	SE	P<
Milk/DMI	1.99	2.15	0.06	0.08
FCM/DMI	1.83	1.98	0.06	0.07

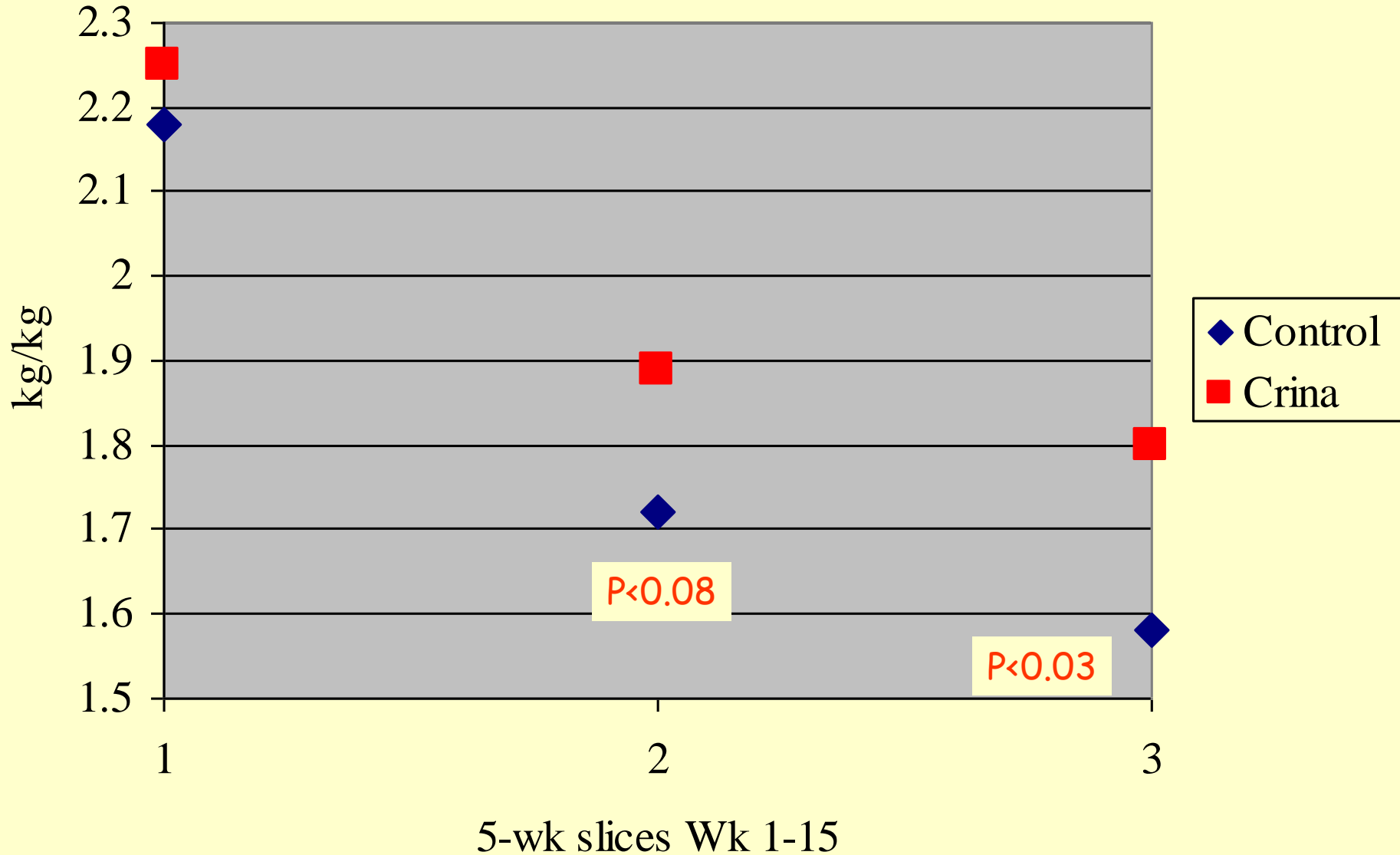
Feed Efficiency

Milk/DMI



Feed Efficiency

FCM/DMI



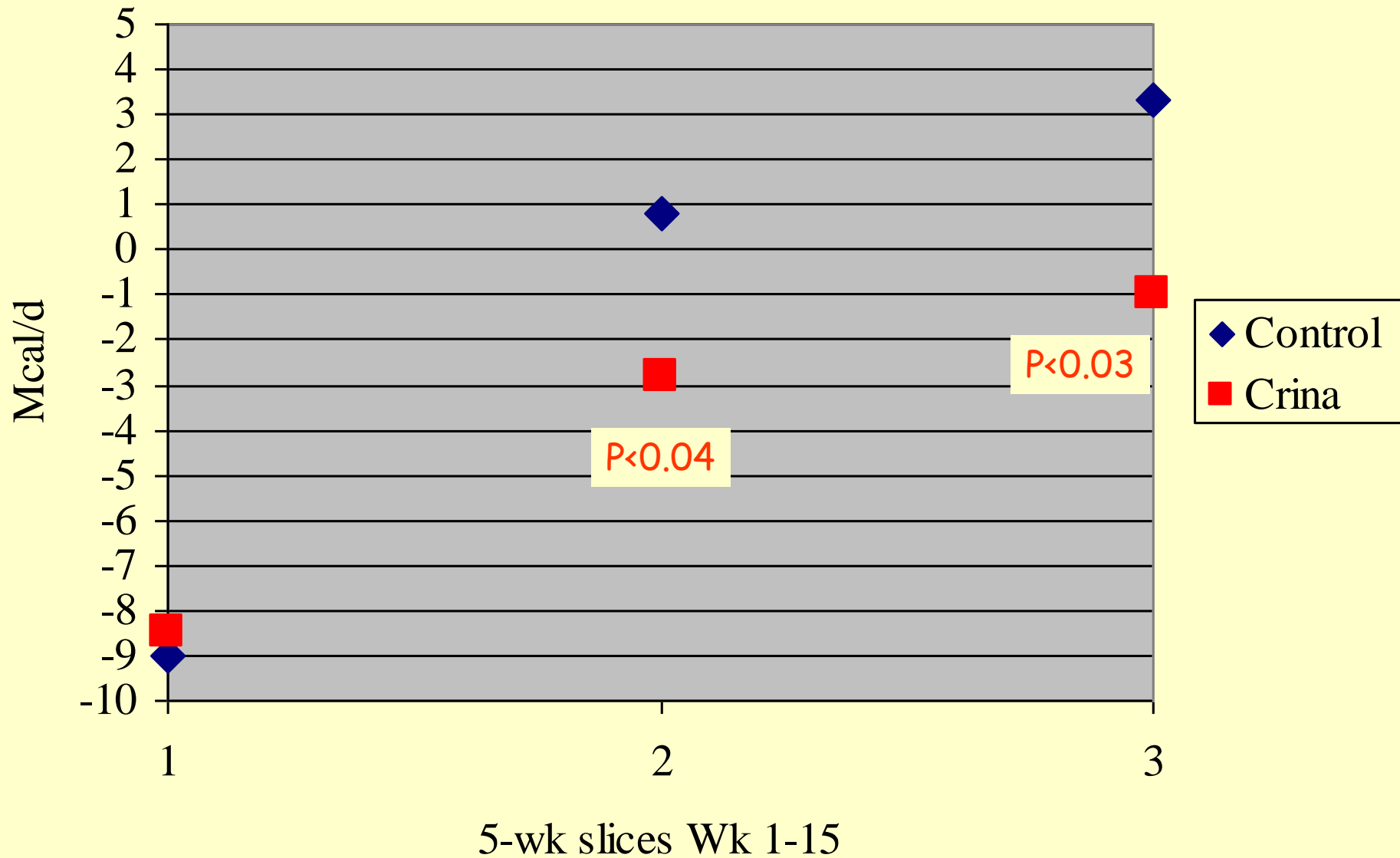
Lactation Performance

	Control	CRINA	SE	P<
Fat, %	3.48	3.46	0.10	NS
kg/d	1.65	1.64	0.09	NS
Protein, %	3.10	2.95	0.05	0.03
kg/d	1.46	1.41	0.06	NS
MUN, mg%	12.9	13.4	0.3	NS

Lactation Performance

	Control	CRINA	SE	P<
EB, Mcal/d	-1.6	-4.1	0.9	0.06
BW, kg	672	658	16	NS
BCS	2.9	2.8	0.1	NS

Calculated Energy Balance



Post-Fresh Measurements

<u>Blood Data</u> ¹	Control	CRINA	SE	P<
NEFA, mEq/L	671	670	45	NS
BHBA, mg/dL	7.9	9.2	0.9	NS
Glucose, mg/dL	52.1	53.3	1.5	NS
Urea-N, mg/dL	12.9	13.1	0.4	NS

¹Samples taken at 1, 8, 15, 22 & 29 DIM

Meta Analysis

- Data from 8 trials
- MIXED procedure of SAS
 - ❖ Fixed effect of EO & Random effect of Trial
 - ❖ Each response weighted according to number of cows used to test for it using the WEIGHT statement
 - ❖ St. Pierre, 2001, JDS

Meta Analysis

LS Means	Control	EOB	P<
DMI, kg/d	22.3	22.4	NS
Milk, kg/d	36.7	37.9	0.01
Milk/DMI	1.64	1.67	NS

Meta Analysis

LS Means	Control	EOB	P<
Fat, %	3.68	3.71	NS
kg/d	1.35	1.41	0.01
Protein, %	3.00	3.02	NS
kg/d	1.10	1.15	0.04

Calculated Income Minus Feed Cost Using Meta Analysis Average Responses

Milk Fat	+0.06 kg/d @ \$3.00/kg	\$0.18
Milk TP	+0.05 kg/d @ \$4.50-\$9.00/kg	\$0.23-\$0.45
Milk OS	+0.06 kg/d @ \$0.45/kg	\$0.03
Milk Premiums	1.2 kg/d @ \$0.03/kg	\$0.04
DMI & EO	0.1 kg/d @ \$0.20/kg	-\$0.08
Income Minus Feed Cost/cow/day		\$0.40-\$0.62

Conclusions

- EO supplementation influenced lactation performance by dairy cows
- Cost of EO & magnitude of lactation responses shows potential for positive economic returns
- Benefits as an additive for transition cows were not observed
- Research to determine the mode of action for improved feed efficiency is needed
- Research regarding potential interactions between basal diet, stage of lactation & EO supplementation is warranted