Utilization of degossypolled cottonseed protein in aquatic feed

脱酚棉籽蛋白在水产饲料中的应用

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Why research on degossypolled cottonseed protein (DCP)

研究脱酚棉籽蛋白在水产饲料中的应用的目的

- **Fish meal is deficient and expensive resources，phosphorus excretion**
- 鱼粉是很好的水产饲料蛋白源，但资源短缺，价格昂贵，磷污染严重
- **The market price of the fish has been decreased rapidly**
- 由于养殖规模的扩大和产量的大幅提高，水产品价格降幅较大
- **The importance of vegetable alternative proteins**
- 植物性替代蛋白源成为研究热点

-Continue

研究脱酚棉籽蛋白在水产饲料中的应用的目的

- **The annual product of cottonseed is about 5 million ton in China, but normal use of cottonseed meal in feed is less than 15% because of its low lysine, methionine, cystine availability and toxicity of gossypol.**
- 我国年产棉籽500万吨，但由于传统榨油工艺导致棉籽粕中的某些氨基酸利用率低以及游离棉酚的毒性，使得棉籽粕在饲料中的正常使用量不足15%。

-Continue

研究脱酚棉籽蛋白在水产饲料中的应用的目的

- **DCP: the meal left after oil and gossypol have been extracted from the cottonseed with special treatment process**
- 脱酚棉籽蛋白是采用液-液-固工艺将棉籽去油、脱酚处理后得到的金黄色粉末

	含量 Content(%)	国标 National standard
Crude protein 粗蛋白	≥ 50	
gossypol 游离棉酚	≤400mg/kg	1200mg/kg

脱酚棉籽蛋白氨基酸组成及与相关产品比较

Amino acids composition of DCP (% of crude protein)

	一般棉籽粕 Cottonseed meal	脱酚棉籽蛋白 DCP	豆粕 Soybean meal
精氨酸Arg	11.05	12.21	7.52
组氨酸His	2.82	3.22	2.76
异亮氨酸Iie	3.09	3.61	4.42
亮氨酸Leu	5.89	6.28	7.41
赖氨酸Lys	4.13	4.79	5.98
蛋氨酸+胱氨酸 Met+ Cys	3.27	3.88	2.93
苯丙氨酸Phe	5.31	5.62	4.99
苏氨酸Thr	3.23	3.29	3.96
缬氨酸Val	4.24	5.03	4.90
总必需氨基酸TEAA	42.55	47.95	44.51
粗蛋白含量 CP(%dw)	44.90	56.25	53.80

Objectives of the study
研究对象

To determine the effect of DCP on

- 虹鳟**Rainbow trout**(***Oncorhynchus mykiss***)
- 花鲈**Japanese sea bass *(Lateolabrax Japonicus)***
- 南美白对虾***Penaeus. vannamei***

虹 鳟(冷水，淡水肉食性)

(Rainbow trout，*Oncorhynchus mykiss*，cold water, fresh water carnivorous fish)

I. Materials and Methods
材料与方法

1. Experimental Diets

实验饲料

Table 1 实验饲料配方
Formulation of the experimental diets(%)

ingredients	FM	DCP25	DCP50	DCP75	DCP75A	DCPT
豆粕Soybean meal	8	8	8	8	8	8
脱酚棉籽蛋白DCP	0	15.2	30.5	46.5	46	61
鱼粉Fishmeal	45	33.75	22.5	11.25	11.25	0
大豆磷脂Lecithin	2	2	2	2	2	2
鱼油Fish oil	4.6	5.6	6.5	7	7	8.6
面粉Flour	31.3	26.05	20.8	15.65	15.9	9.8
谷朊粉Wheat gluten	5	5.3	5.6	5.5	4.5	6.5
预混料Vitamins/Minerals premix	4	4	4	4	4	4
赖氨酸Lysine					0.93	
蛋氨酸Methionine					0.32	
指示剂Y_2O_3	0.1	0.1	0.1	0.1	0.1	0.1

Table 2 实验饲料营养成分组成
Chemical composition of the experimental diets(%)

Diets	FM	DCP25	DCP50	DCP75	DCP75A	DCPT
干物质 Dry matter	90.45	90.47	91.05	90.53	91.16	91.16
粗蛋白 Crude protein	45.93	45.22	44.82	44.12	44.10	44.50
粗脂肪 Crude fat	12.33	13.43	14.80	14.92	14.84	16.52
灰分Ash	11.82	11.04	9.93	9.04	8.88	8.09
能量 Energy(MJ/kg)	19.01	19.35	19.75	20.08	20.09	20.59

Table 3 实验饲料的必需氨基酸组成
Essential amino acids composition of experimental diets

Diets	FM	DCP25	DCP50	DCP75	DCP75A	DCPT	Req.[1]
Essential amino acids (% of dry matter)							
Threonine	1.78	1.68	1.71	1.56	1.45	1.48	0.8
Methionine	1.33	1.16	1.05	0.91	1.29	0.80	
Cysteine	0.73	0.72	0.84	0.91	0.84	1.10	
Met.+Cysteine	2.06	1.88	1.89	1.82	2.13	1.90	1.0
Valine	2.06	1.99	2.00	1.78	1.64	1.76	1.2
Isoleucine	1.80	1.75	1.68	1.51	1.41	1.44	0.9
Leucine	2.90	2.95	2.83	2.64	2.61	2.57	1.4
Phe.+Tyrosine	3.01	3.39	3.48	3.51	3.24	3.46	1.8
Lysine	2.99	2.62	2.50	2.11	2.75	1.81	1.8
Histidine	1.36	1.46	1.46	1.47	1.57	1.44	0.7
Arginine	2.47	3.17	1.71	3.73	3.57	4.19	0.8

[1]Requirement is for rainbow trout based on cruder protein 38% (NRC, 1993)

2. Fish, holding conditions and procedures

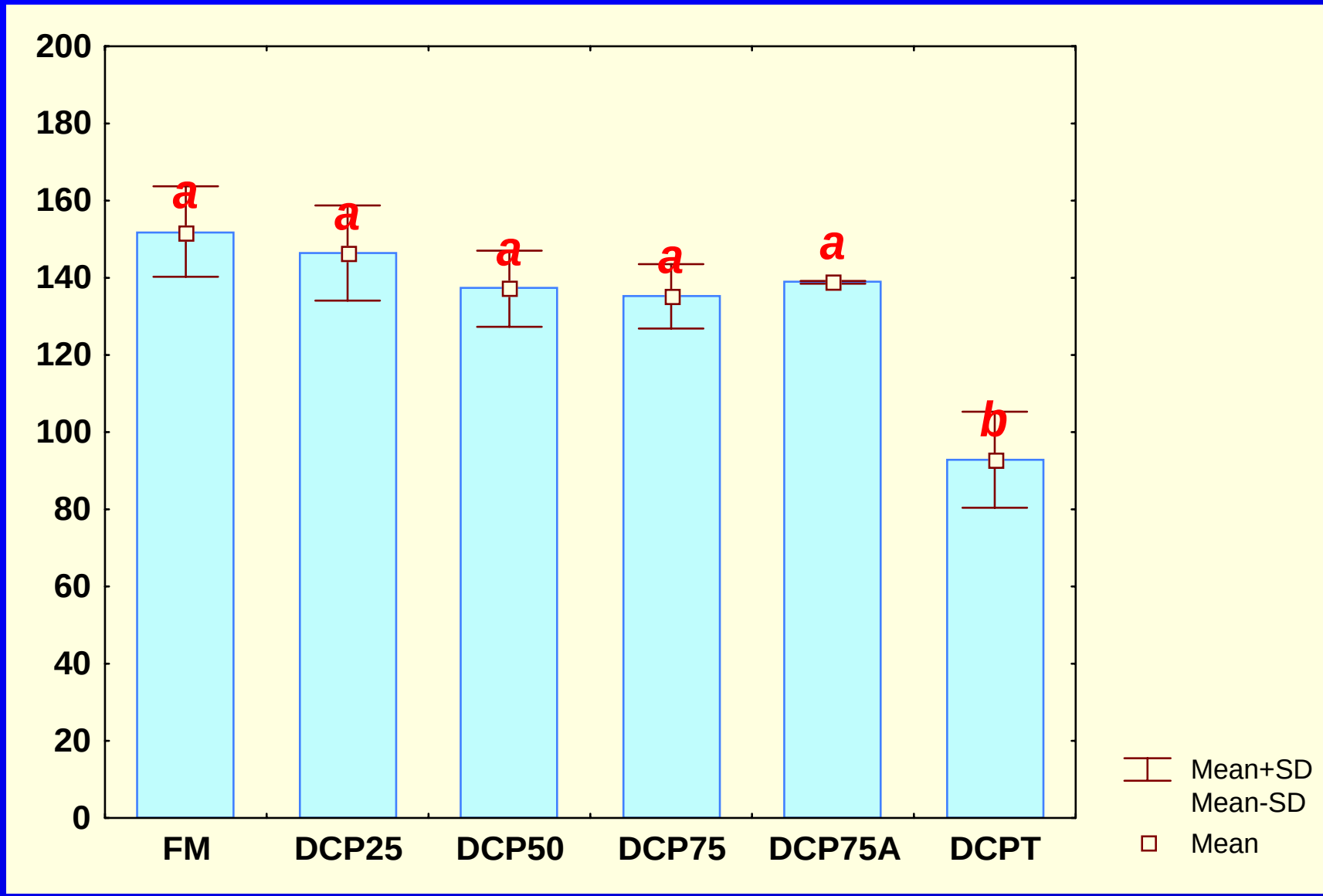
- **Fish: rainbow trout (Initial body weight:39.18±0.07g)**
- 实验鱼：虹鳟（平均初重39.18±0.07g ）
- **18 fish/tank （18尾鱼/桶）**
- **fed twice daily to satiation (09：00 and 17：00)**
- 每天饱食投喂2次(09：00 and 17：00)
- **T: 15±1℃；D.O: 7.2±0.5mg/l；pH: 7.5±0.3.**
- **8 weeks growth trial（实验期为8周）**

3. *Index* 检测指标

- **Weight gain rate (WGR,%)增重率**
- **specific growth rate (SGR,%/day) 特定生长率**
- **feed conversion ratio (FCR) 饲料系数**
- **protein efficiency ratio (PER)蛋白质效率**
- **Apparent digestibility coefficients (ADCs) of dry matter, crude protein, energy, amino acid干物质消化率、粗蛋白消化率、能量消化率和氨基酸消化率**

II. Results 结果

WGR相对增重率 (%)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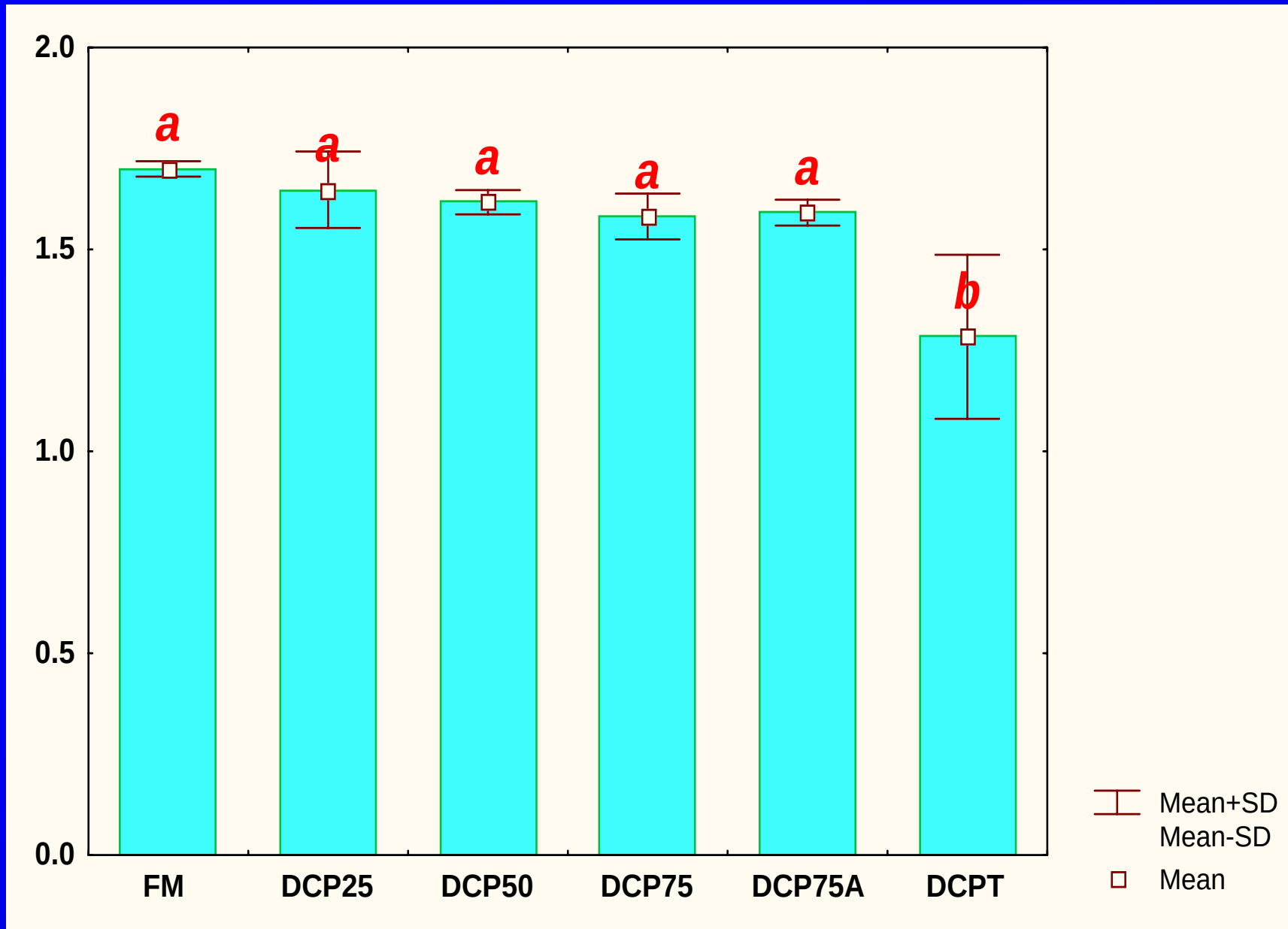
DCP50
DCP75
DCP75A
DCPT
Mean+SD
Mean-SD
Mean

SGR 特定生长率(%)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DCP75A
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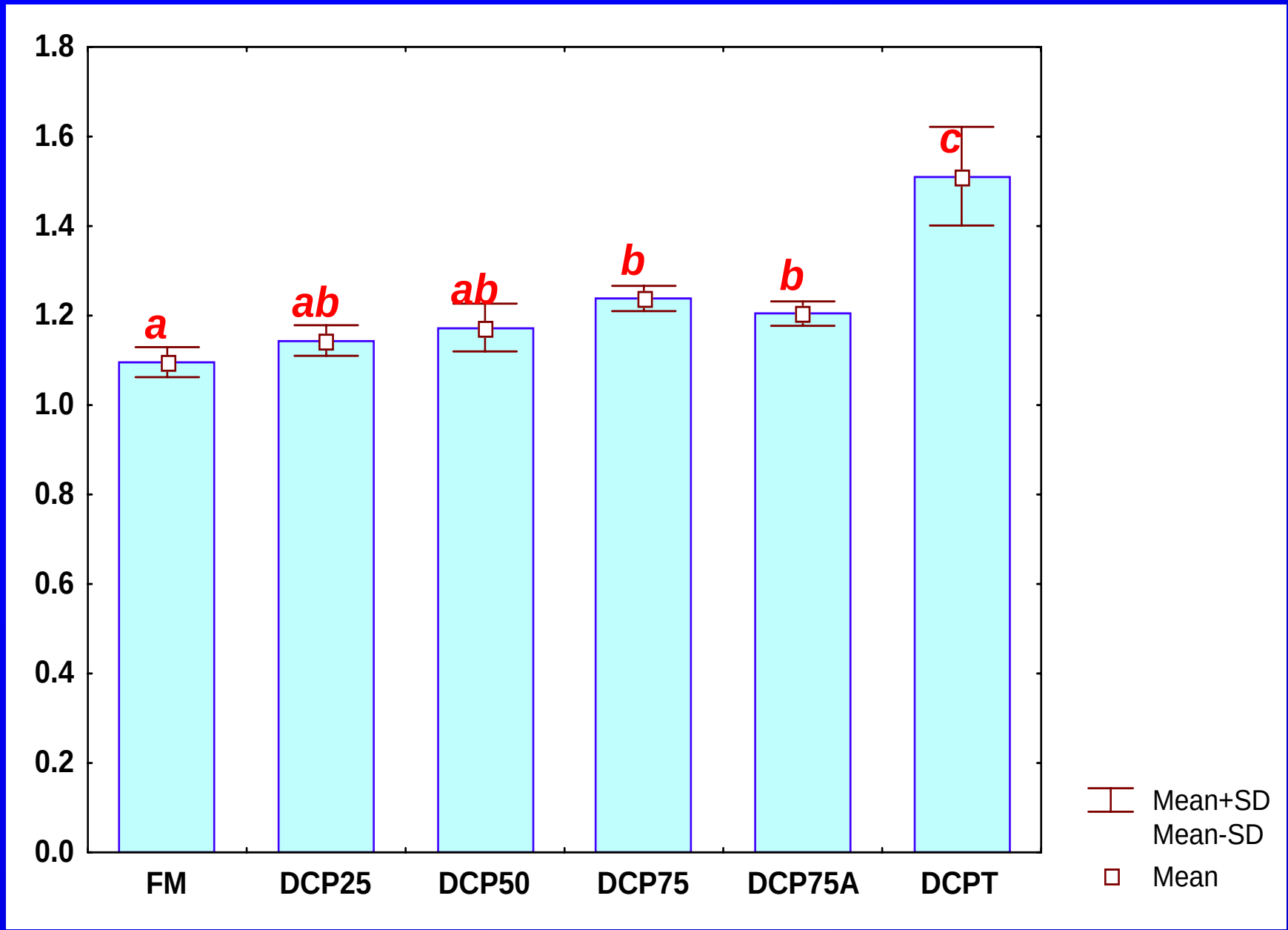
Mean+SD
Mean-SD
Mean

FCR 饲料系数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FM
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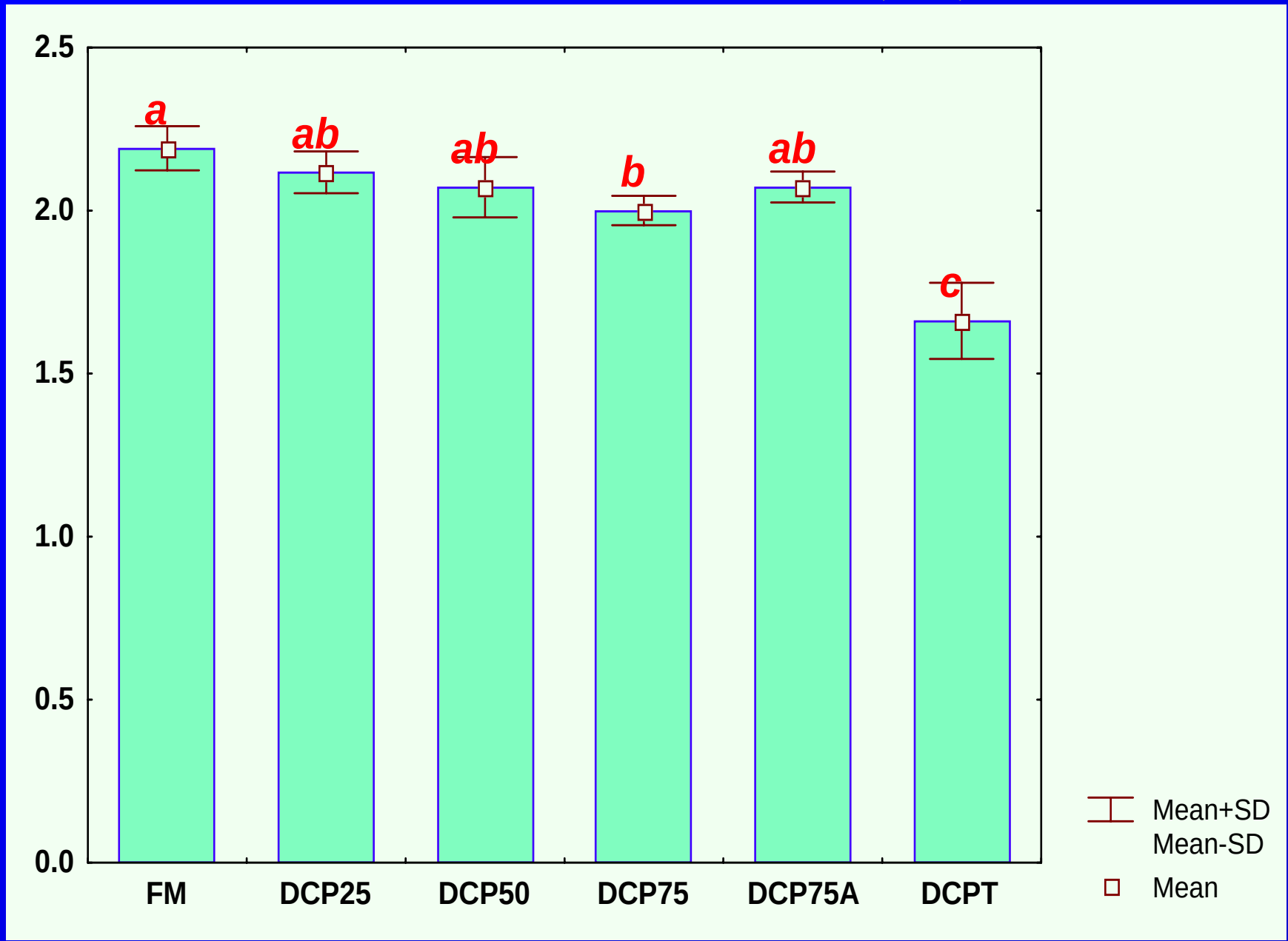
DCP75A
DCPT
Mean+SD
Mean-SD
Mean

PER 蛋白质效率(%)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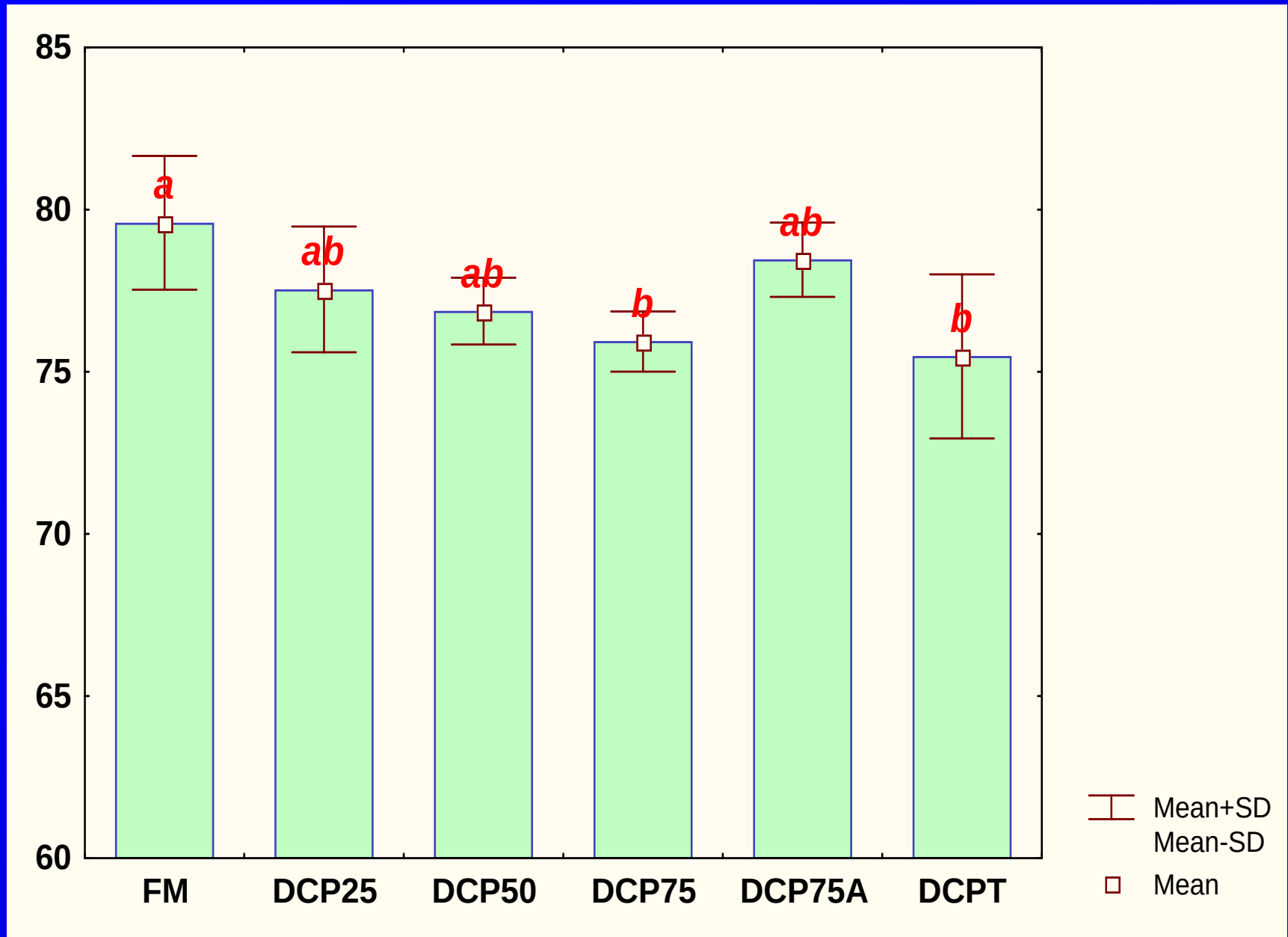
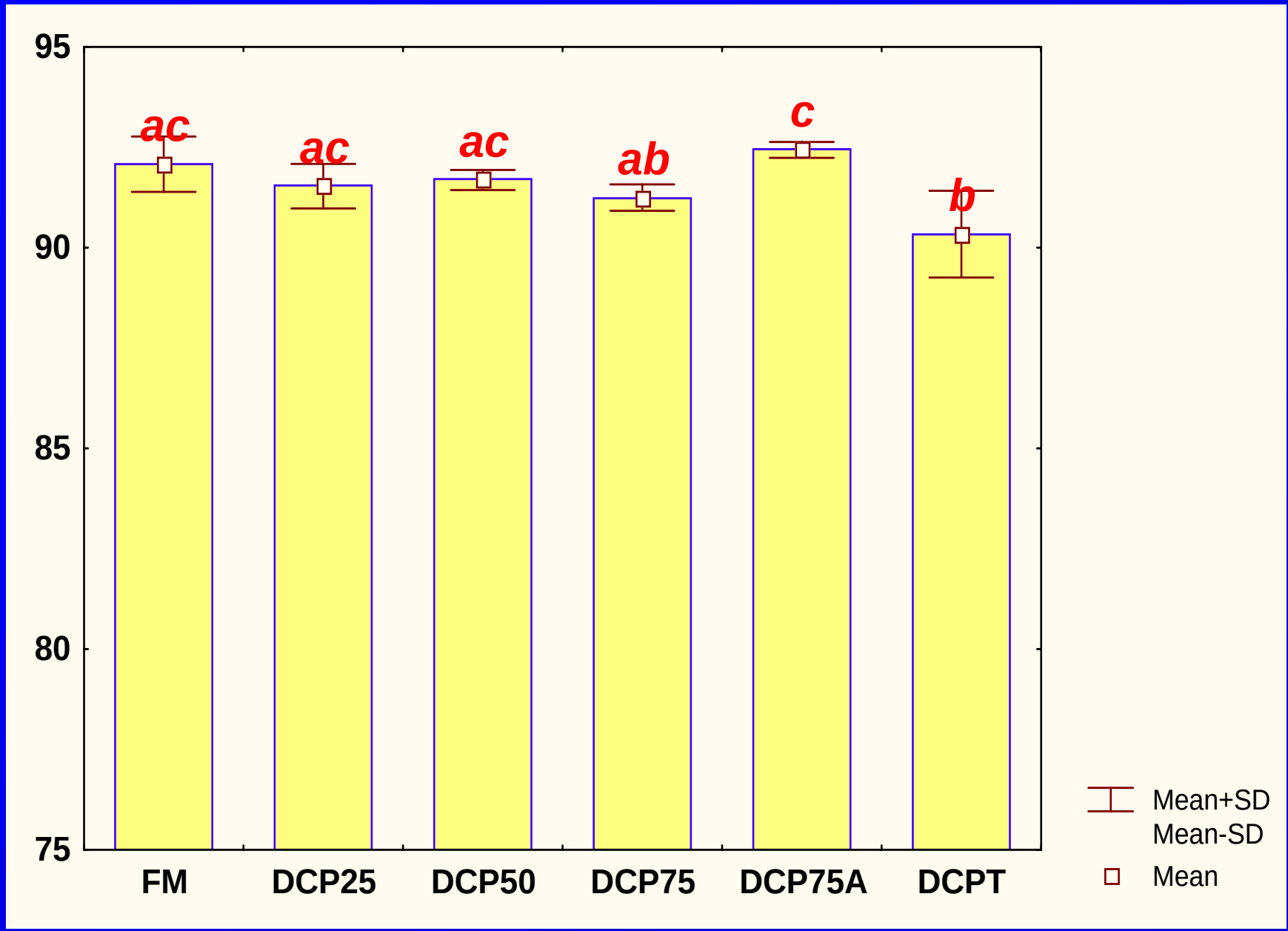
DCP75A
DCPT
Mean+SD
Mean-SD
Mean

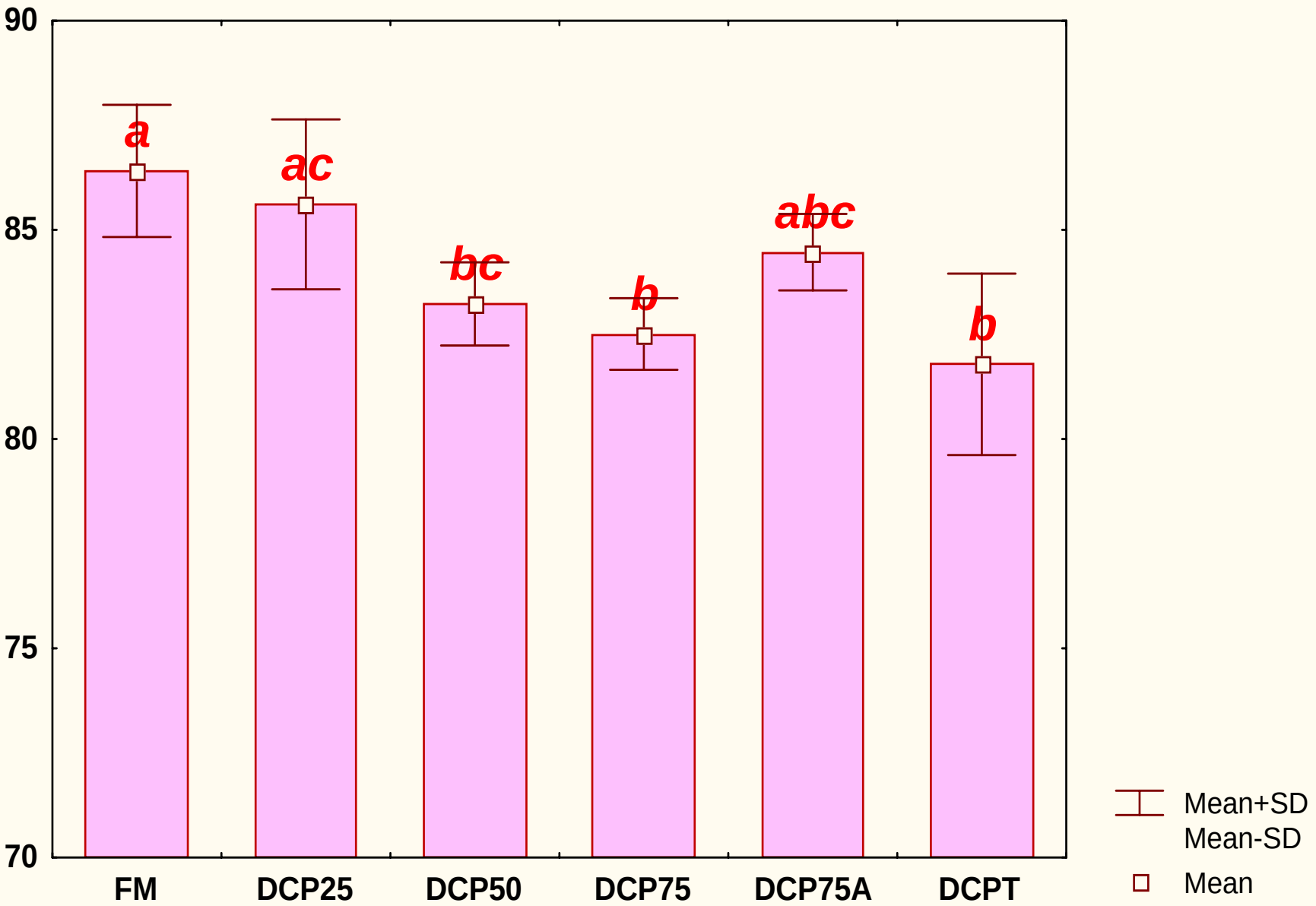
ADCs of Dry matter 干物质表观消化率 (%)



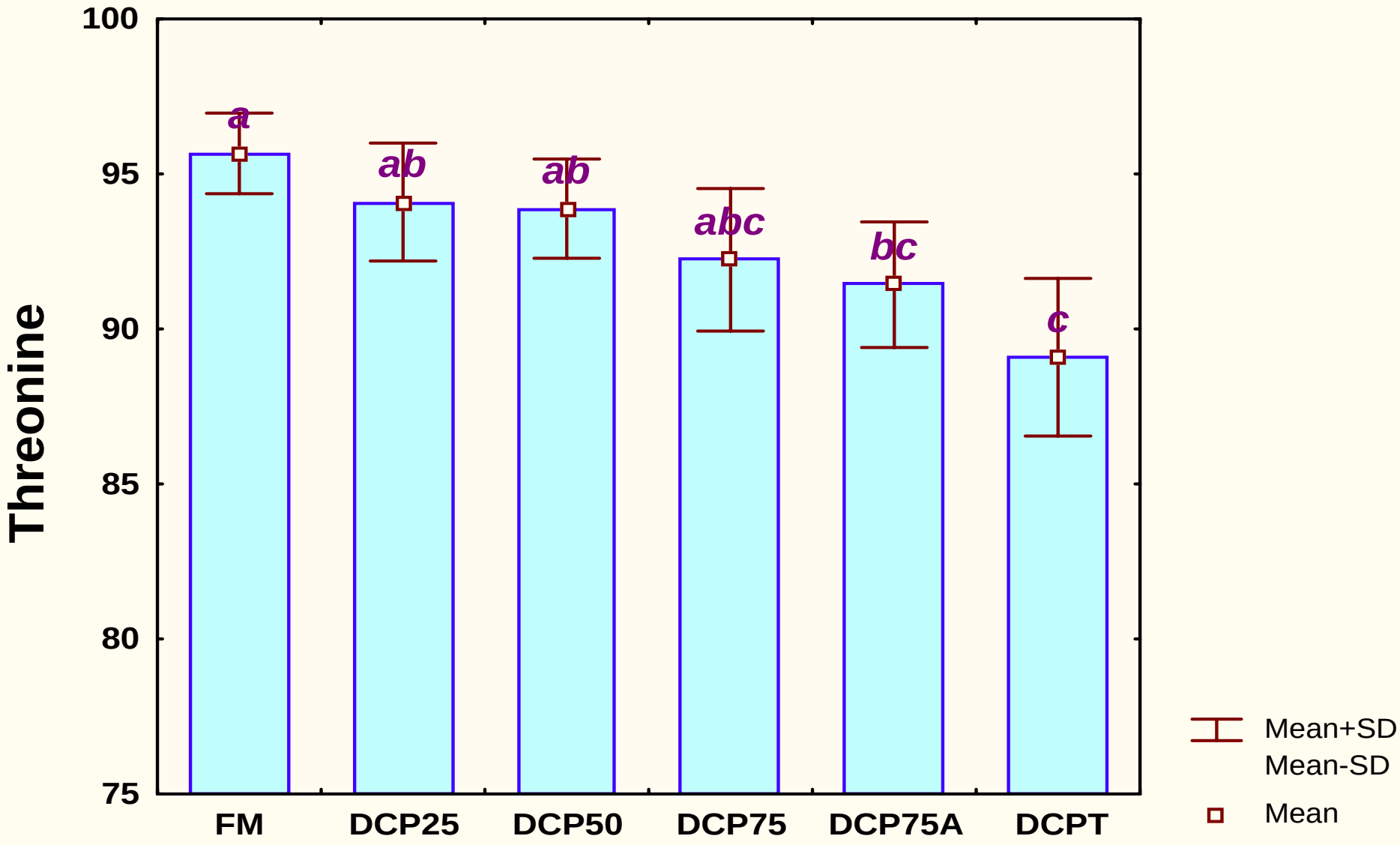
ADCs of Crud protein 蛋白质表观消化率(%)



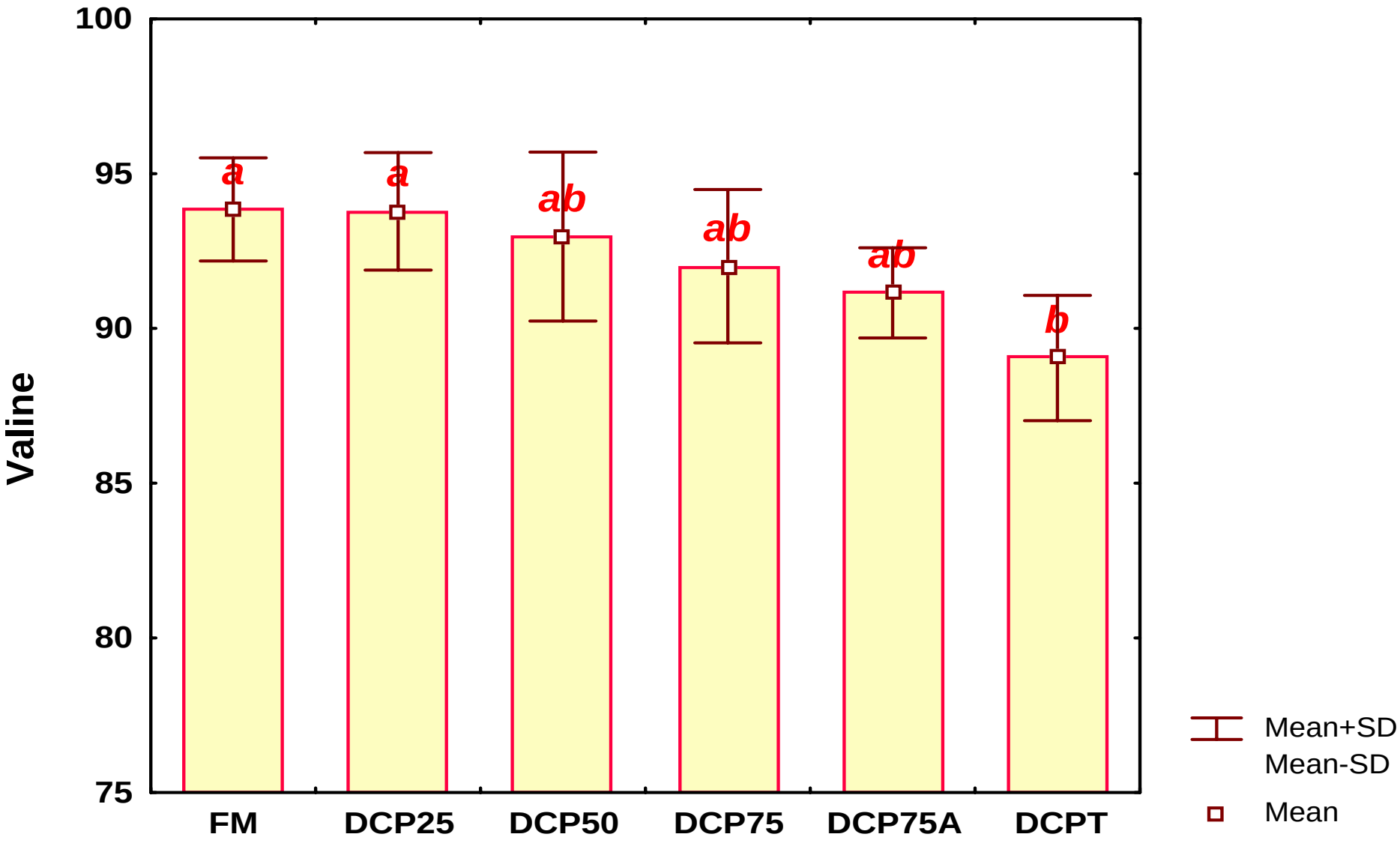
ADCs of Energy 能量表观消化率(%)



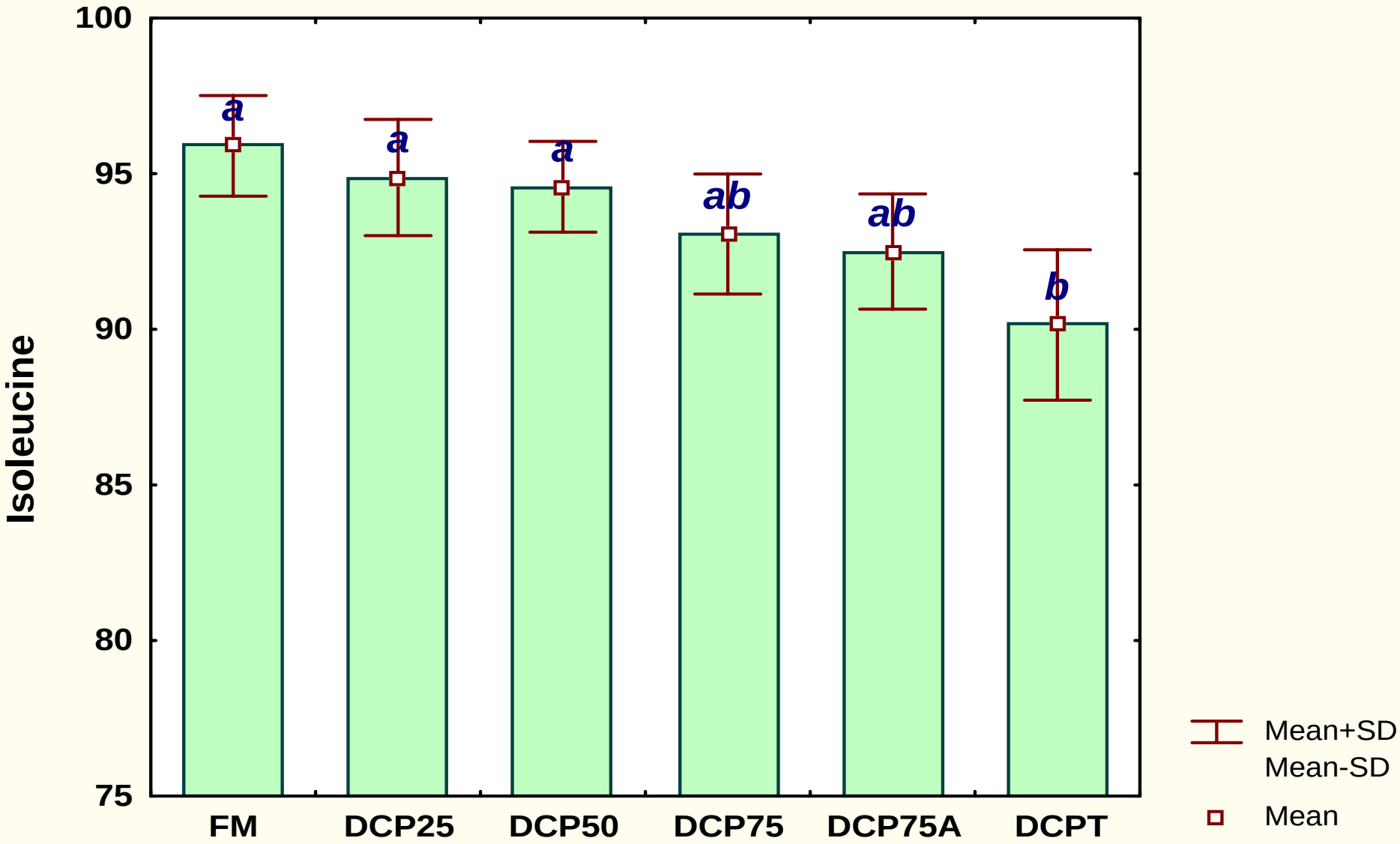
ADCs of Threonine (苏氨酸消化率)



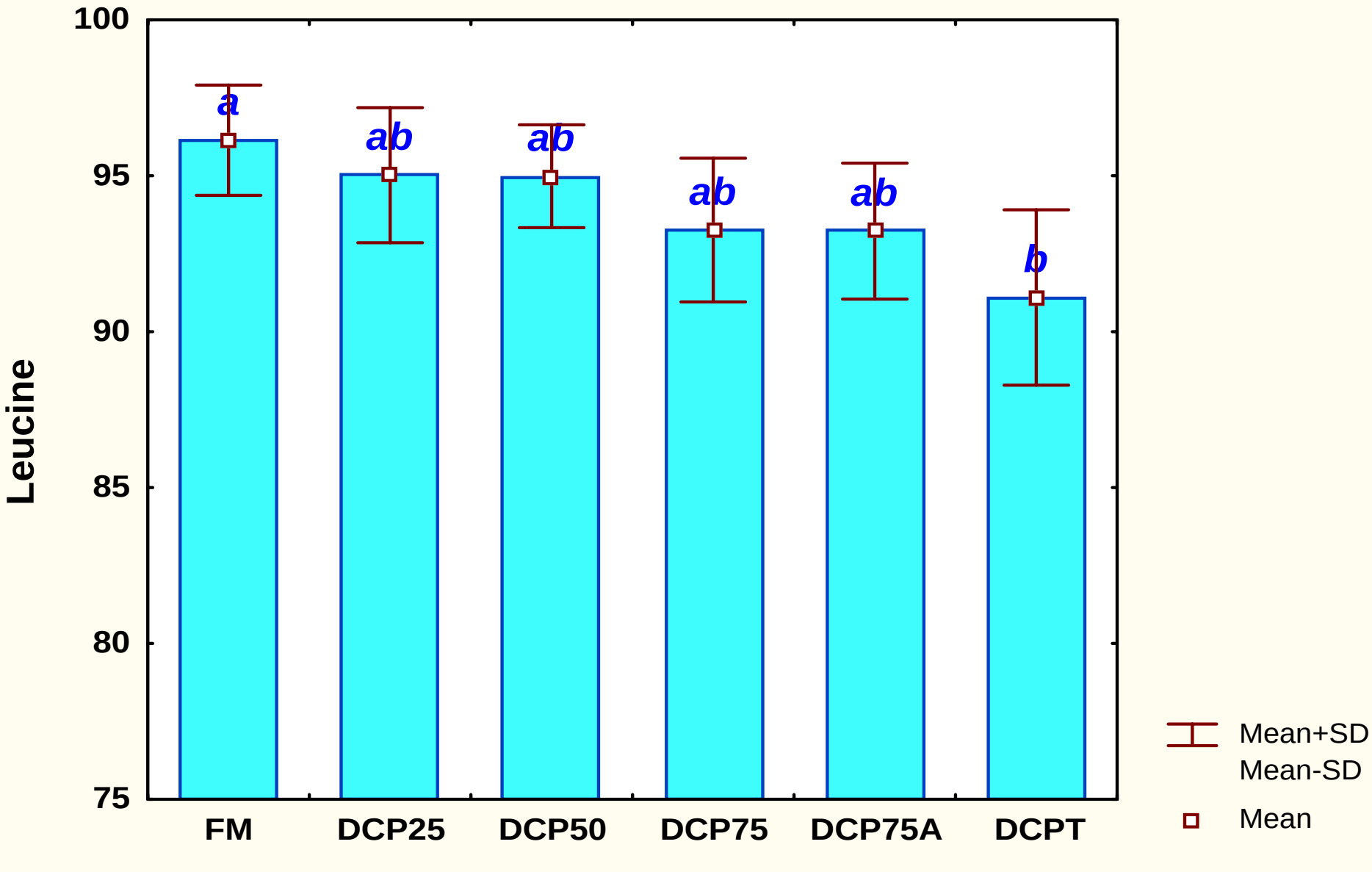
ADCs of Valine （缬氨酸消化率）



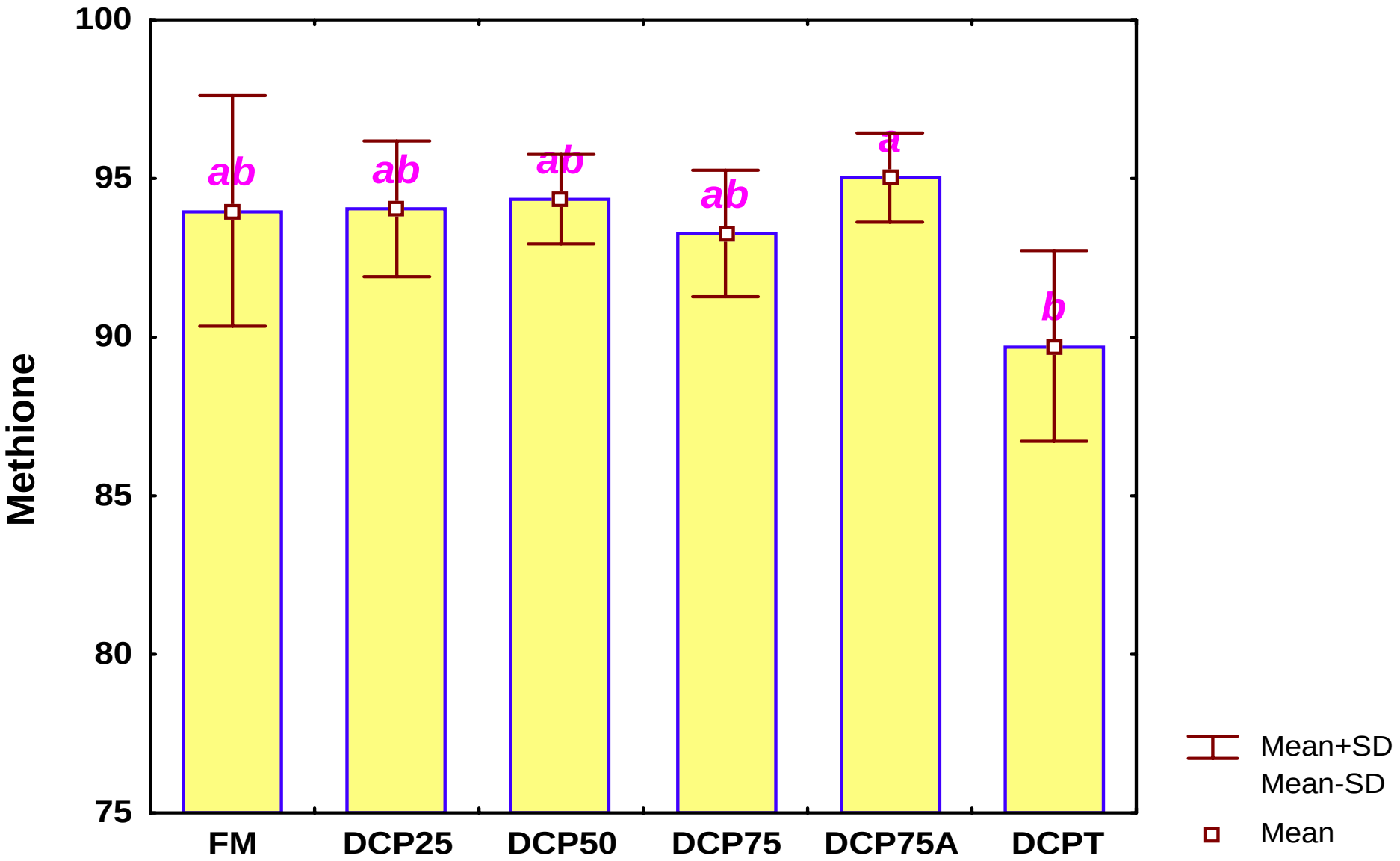
ADCs of Isoleucine （异亮氨酸消化率）



ADCs of Leucine （亮氨酸消化率）



ADCs of Methione （蛋氨酸消化率）



ADCs of Lysine （赖氨酸消化率）

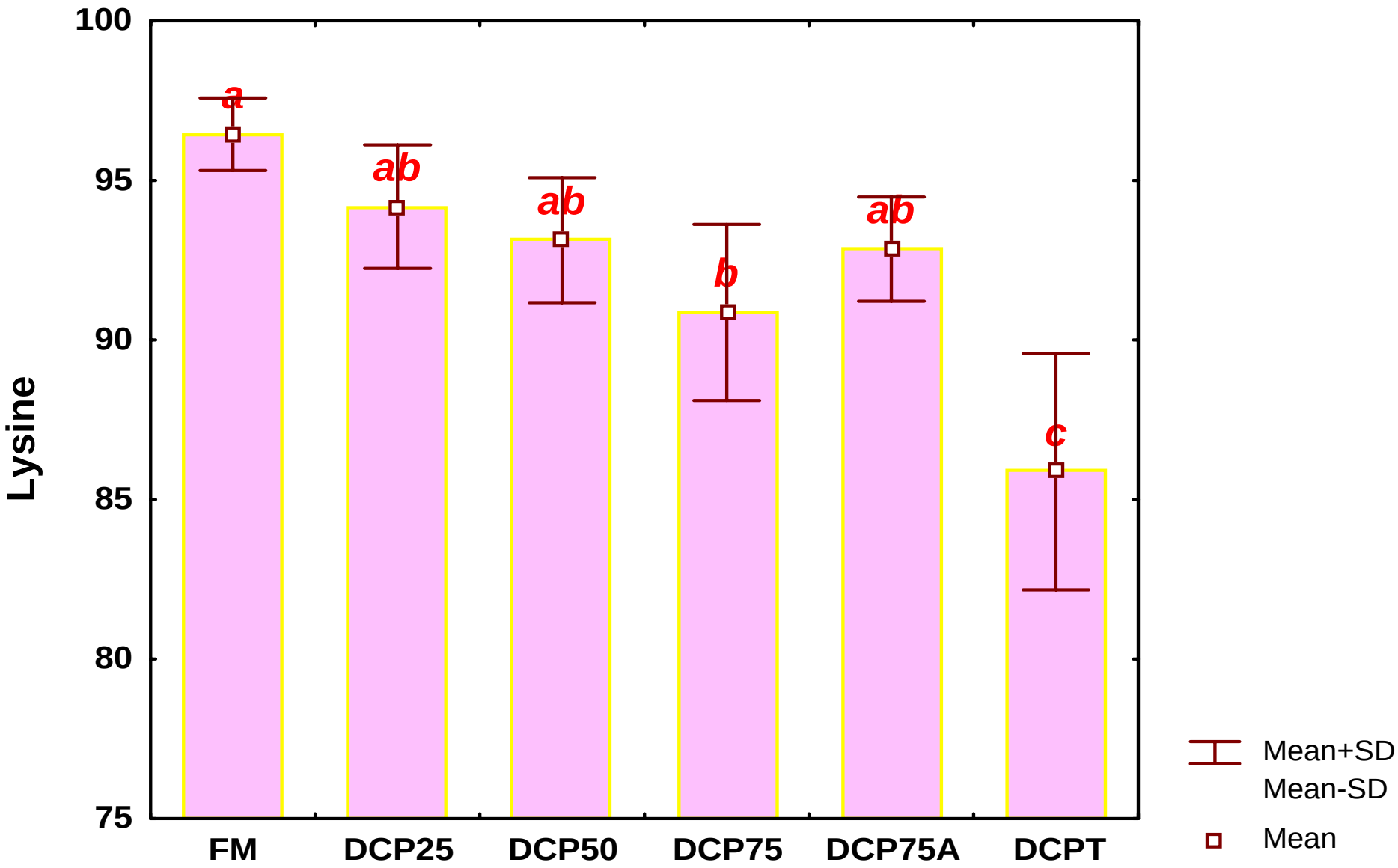


Table 4 鱼体成分分析结果
Body composition of rainbow trout (mean ± S.E.M., n=3)

Diets	Crude protein of whole body 全鱼粗蛋白	Crude fat of whole body 全鱼粗脂肪	Crude fat of liver 肝脂	Crude fat of fillet 肌脂	Ash of whole body 全鱼灰分	Moisture of whole body 全鱼水分
FM	54.4±0.7	30.2±1.8	6.8±0.7	13.6±2.7	7.8±0.3	73.8±1.2
DCP25	54.3±3.4	30.2±4.3	9.4±1.5	12.4±3.1	8.2±1.0	73.7±2.2
DCP50	54.6±1.5	28.5±2.3	8.6±2.5	12.7±3.5	8.2±0.7	74.6±1.6
DCP75	53.7±1.7	29.2±0.8	9.4±1.5	15.2±1.5	8.4±0.4	74.6±0.5
DCP75A	56.1±4.6	28.4±3.8	8.3±1.3	12.1±1.8	8.1±1.4	75.0±2.1
DCPT	51.0±3.1	32.8±2.9	7.6±0.9	13.8±1.4	8.8±0.8	74.0±1.3

III. Conclusions 结论

- **DCP could be included in the rainbow trout diet up to 30.5% as a substitute for fish meal, replacing about 50% of fish meal protein.**
  - DCP可替代虹鳟鱼饲料中50%的鱼粉蛋白，绝对添加量可达30%以上。
- **The first limiting amino acid of DCPT is lysine, lower ADCs are main factors for lower growth rate**
  - DCP替代实验料中赖氨酸含量偏低和较低的饲料表观消化率是导致该组饲料养殖效果差的原因之一。
- **Amino acid balance will improve the function of DCP replacing diets**
  - 外源氨基酸对改善DCP替代鱼粉饲料的功能有显著作用

花鲈（温水性，海水肉食性）

Japanese sea bass，*Lateolabrax Japonicus*

warm water, marine carnivorous fish

Table 1 实验饲料配方
Formulation of the experimental diets(%)

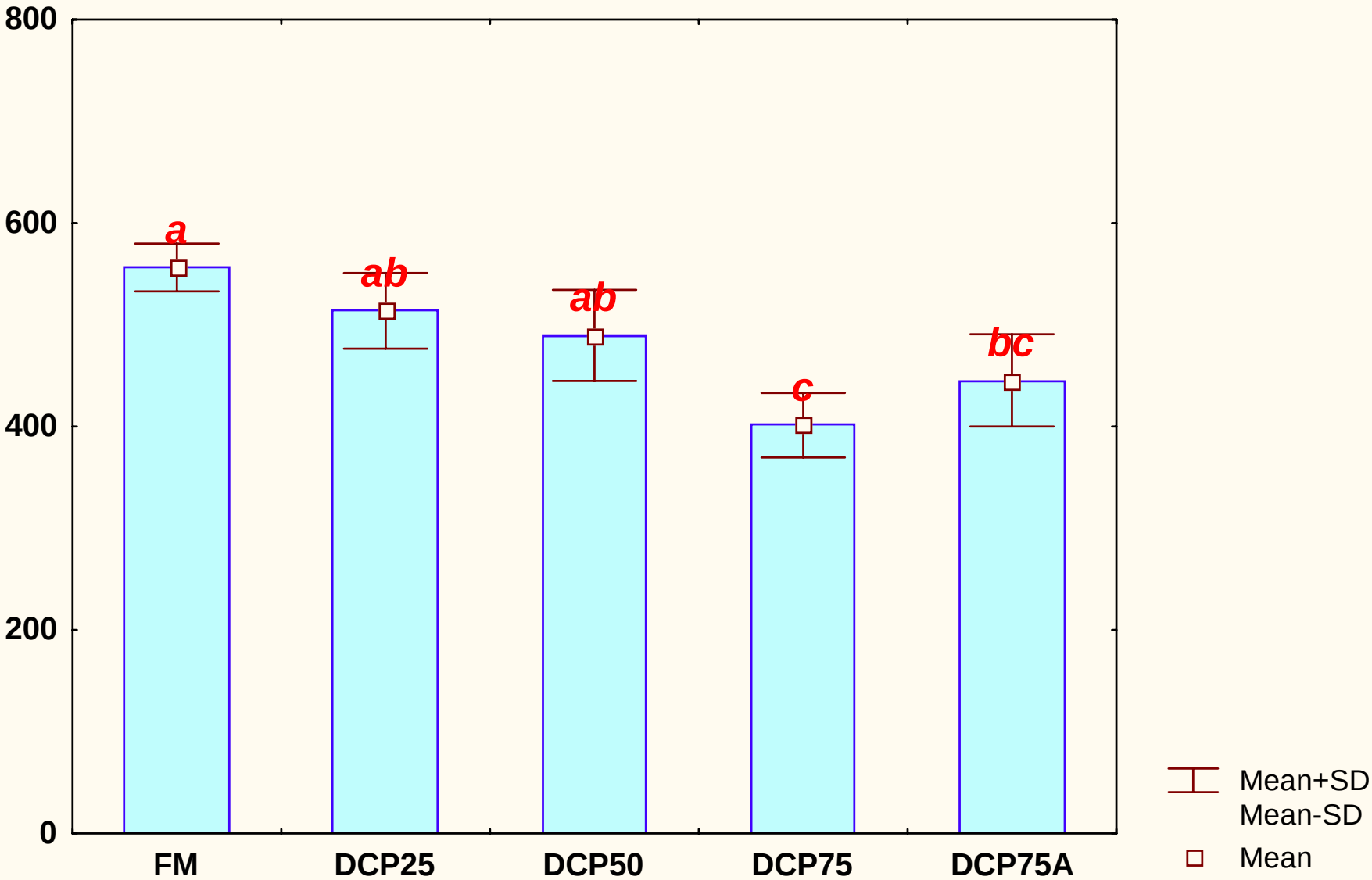
Ingredients	FM	DCP25	DCP50	DCP75	DCP75A
豆粕Soybean meal	8	8	8	8	8
脱酚棉籽蛋白DCP	0	15.2	30.5	46.5	46
鱼粉Fishmeal	45	33.75	22.5	11.25	11.25
大豆磷脂Lecithin	2	2	2	2	2
鱼油Fish oil	4.6	5.6	6.5	7	7
面粉Flour	31.3	26.05	20.8	15.65	15.9
谷朊粉Wheat gluten	5	5.3	5.6	5.5	4.5
预混料Vitamins/Minerals premix	4	4	4	4	4
赖氨酸Lysine					0.93
蛋氨酸Methionine					0.32
指示剂Y_2O_3	0.1	0.1	0.1	0.1	0.1

2. Fish, holding conditions and procedures

- **Fish: Japanese sea bass (Initial body weight:5.04±0.02g)**
- **实验鱼：鲈鱼（平均初重5.04±0.02g ）**
- **16 fish/tank （16尾鱼/桶）**
- **fed twice daily to satiation (09：00 and 17：00)**
- **每天饱食投喂2次(09：00 and 17：00)**
- **T: 25±1 ℃；D.O: 7.2±0.5mg/l；pH: 7.5±0.3.**
- **8 weeks growth trial（实验期为8周）**

II. Results 结果

相对增重率WGR (%)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FM
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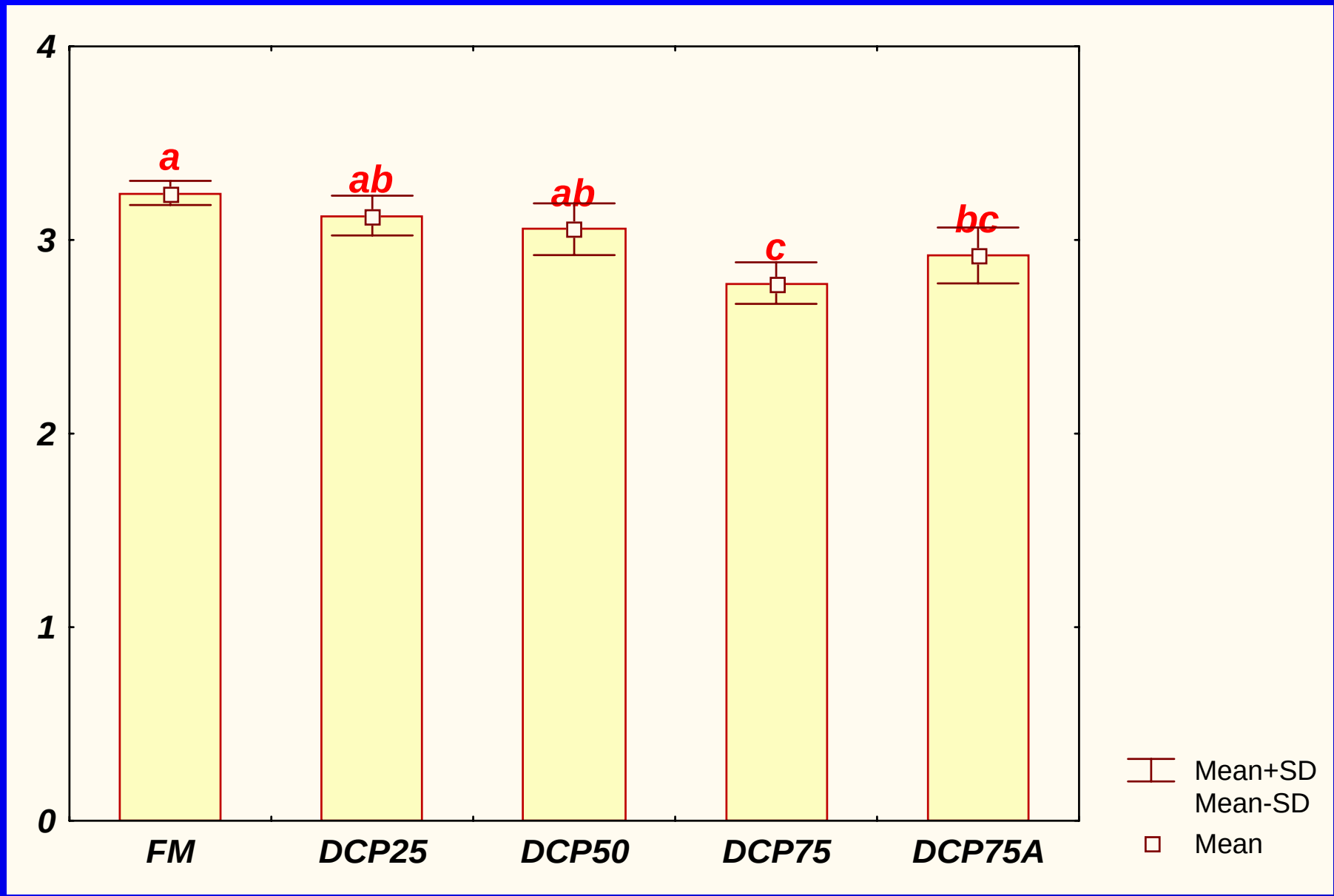
DCP75
DCP75A
Mean+SD
Mean-SD
Mean

特定生长率SGR(%)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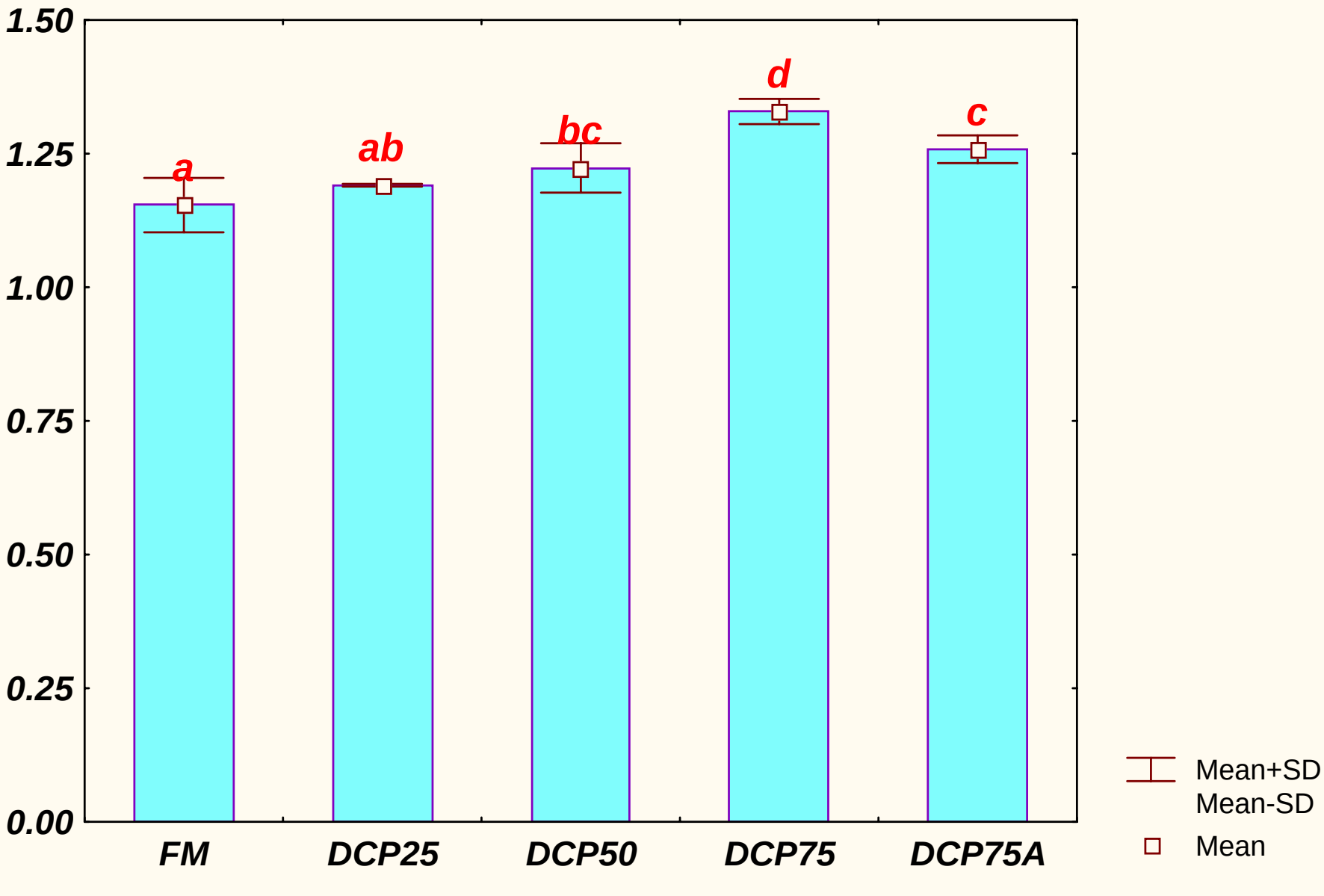
饲料系数 FCR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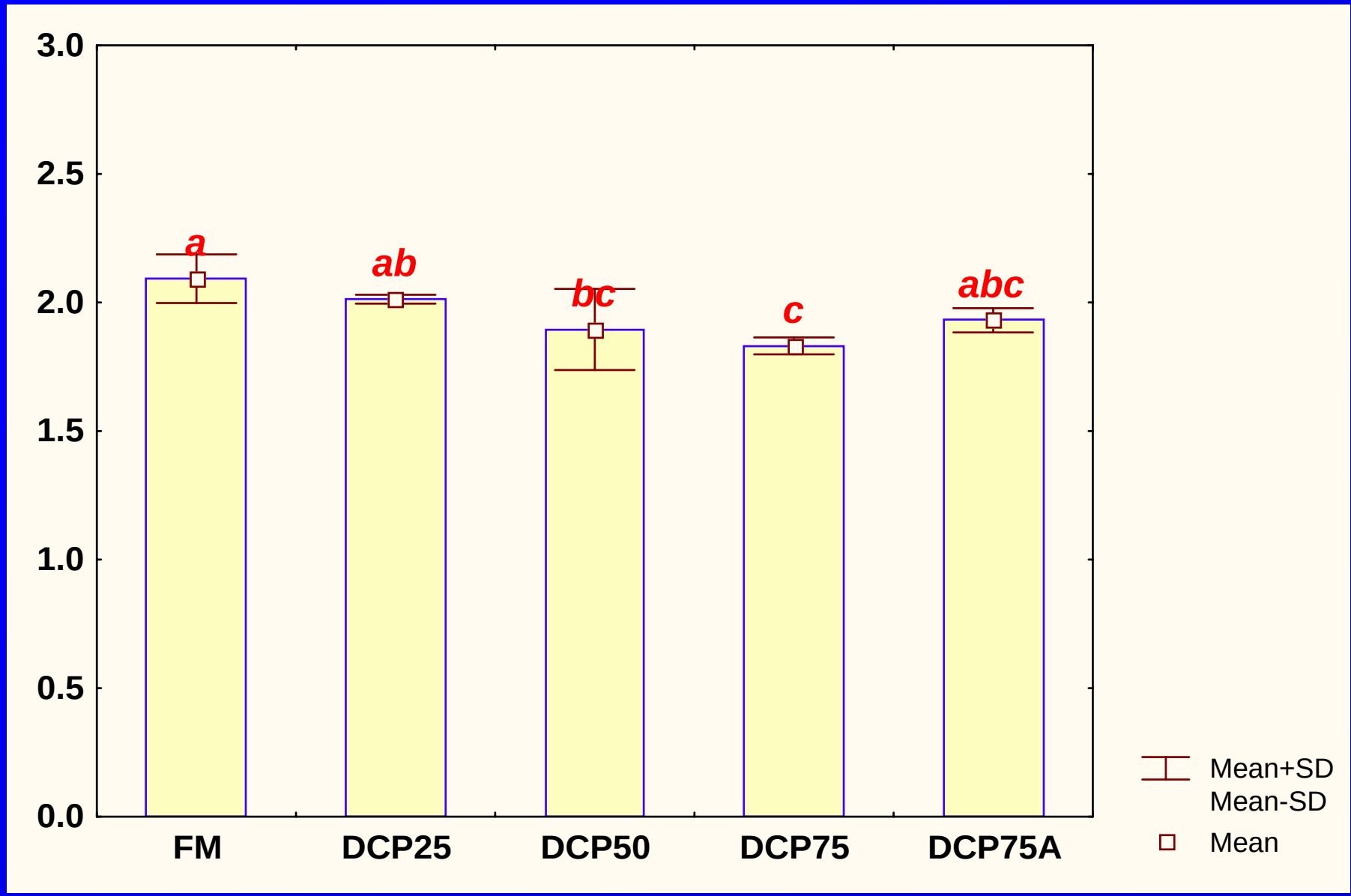
蛋白质效率PER(%)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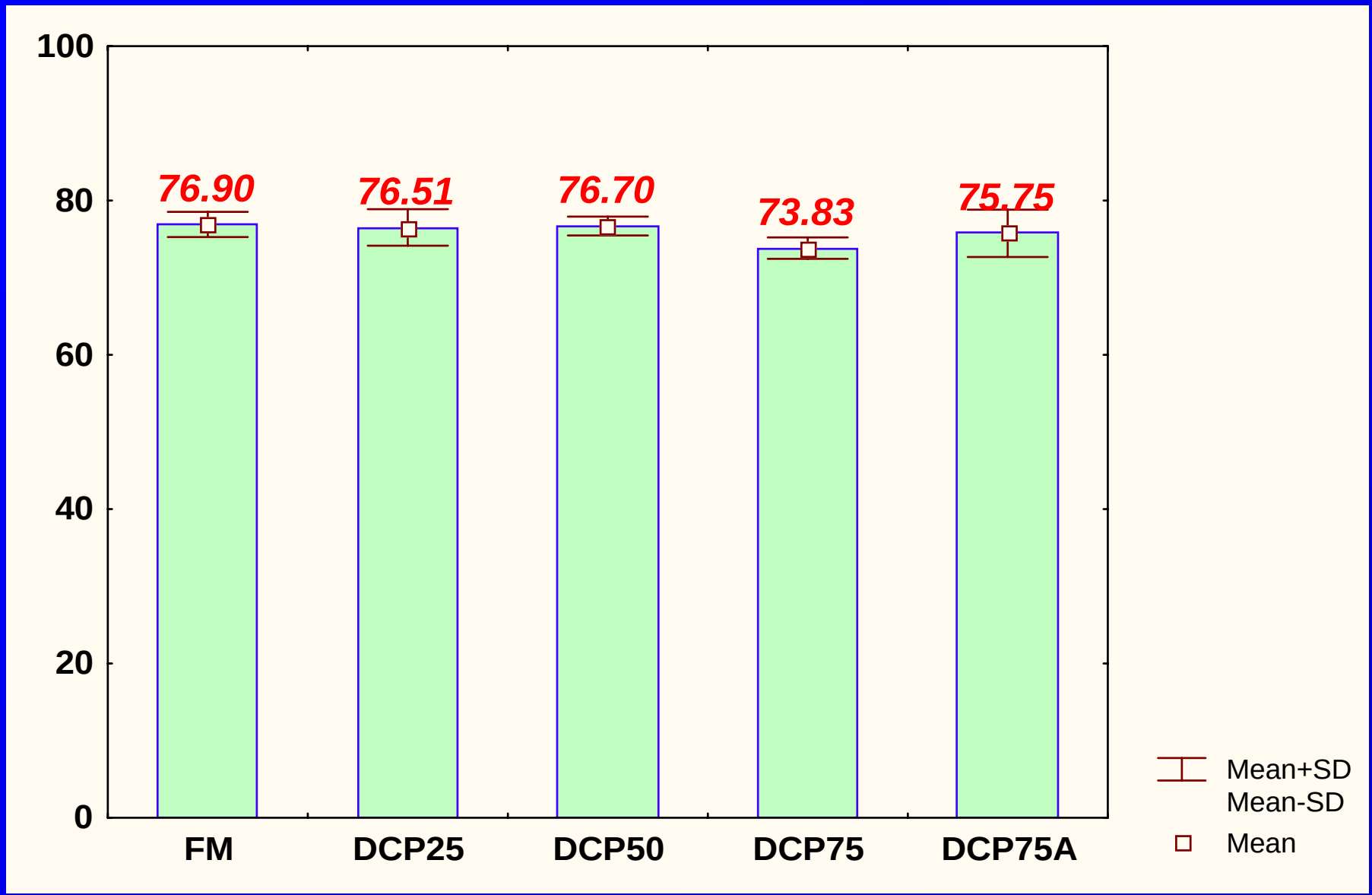
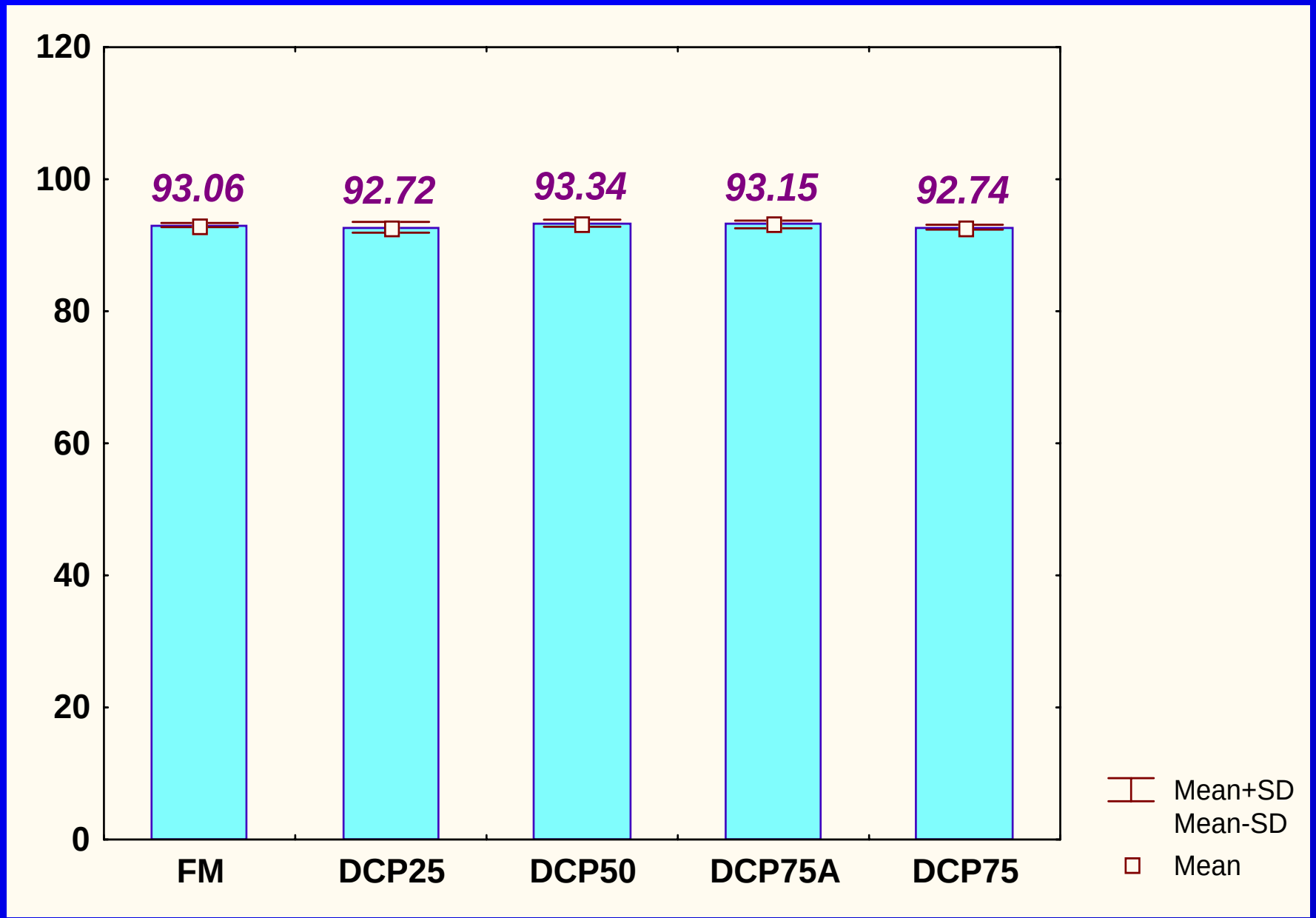
DCP75A
Mean+SD
Mean-SD
Mean

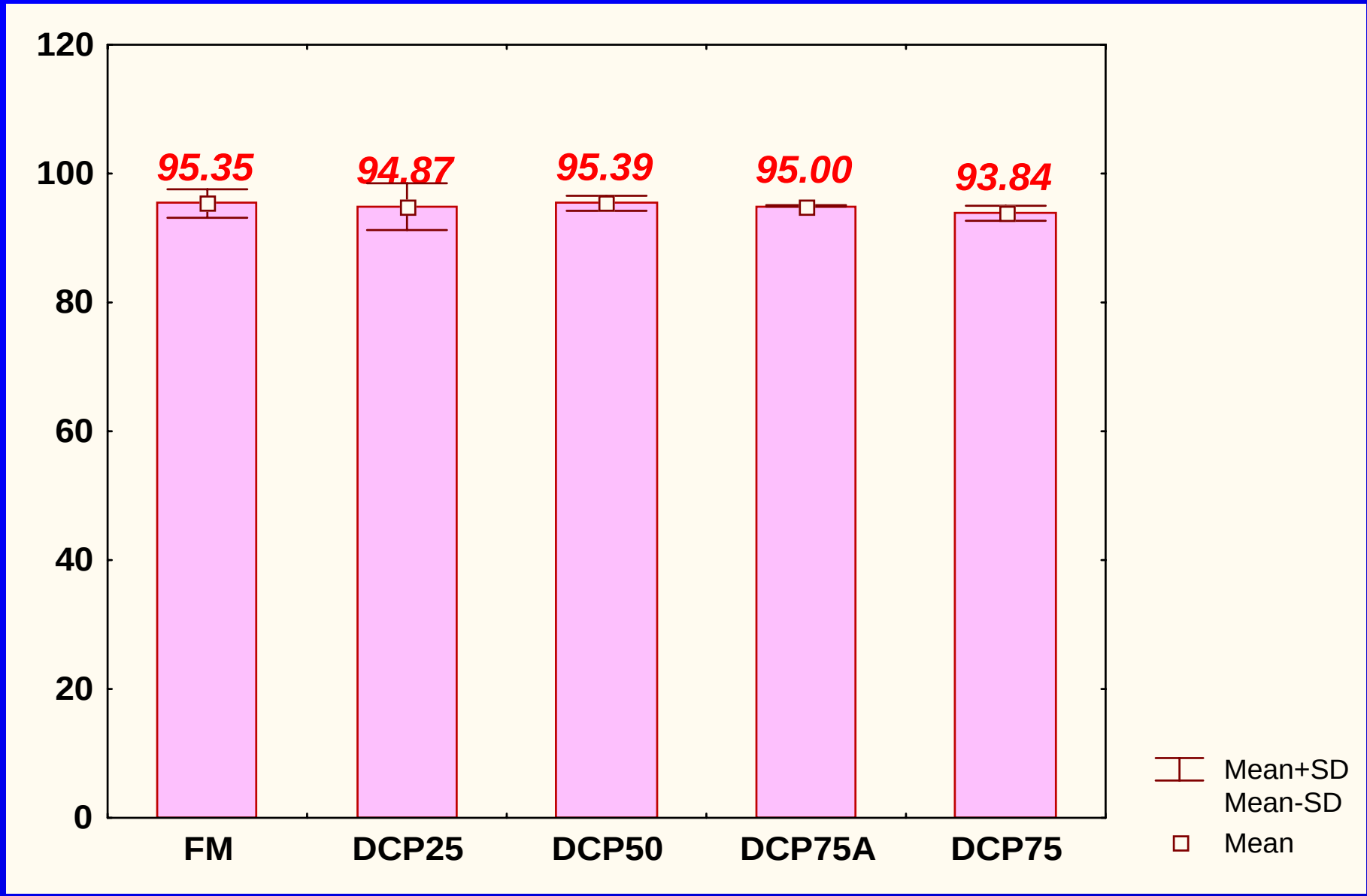
干物质消化率ADC of Dry matter (%)



蛋白消化率ADCs of Crud protein(%)



脂肪消化率ADCs of Crud lipid (%)



能量消化率ADCs of Energy(%)

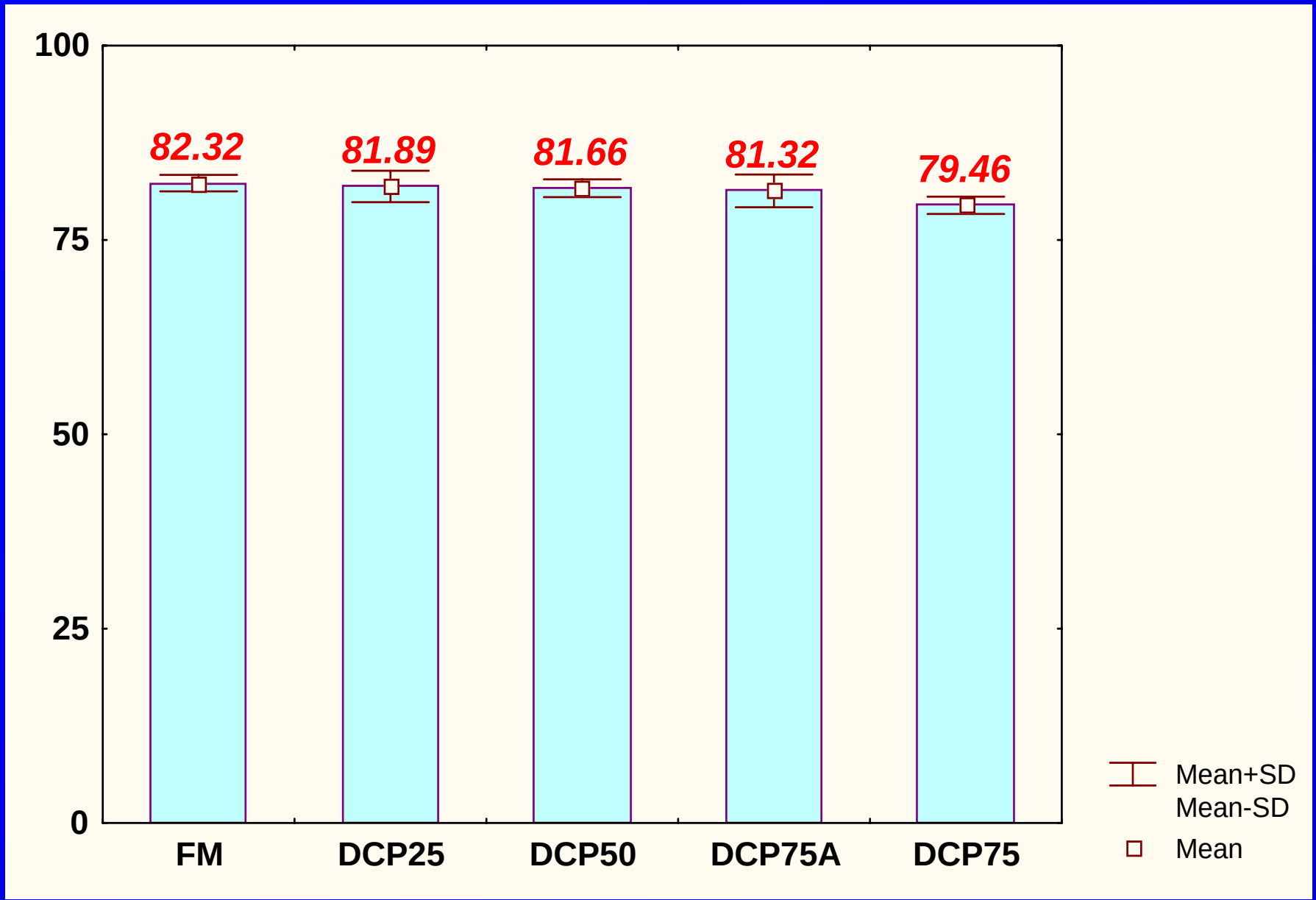


Table 2 鱼体成分分析结果
Body composition of rainbow trout (mean ± S.E.M., n=3)

Diets	Crude protein of whole body 全鱼粗蛋白	Crude fat of whole body 全鱼粗脂肪	Crude fat of liver 肝脂	Crude fat of fillet 肌脂	Ash of whole body 全鱼灰分	Moisture of whole body 全鱼水分
FM	48.70 ±3.83	30.73 ±4.52	16.78 ±5.04	5.46 ±0.97	11.47 ±1.01	68.17 ±1.68
DCP25	49.34 ±2.84	29.96 ±2.69	21.40 ±2.95	4.41 ±0.81	11.35 ±0.80	69.10 ±1.01
DCP50	48.49 ±1.55	31.35 ±1.21	20.85 ±4.58	5.23 ±0.96	11.16 ±0.38	68.86 ±0.24
DCP75A	50.28 ±2.45	28.51 ±2.54	21.73 ±4.84	4.64 ±0.71	12.00 ±0.54	69.45 ±1.21
DCP75	47.65 ±1.34	31.03 ±3.53	21.02 ±2.84	4.72 ±0.86	11.35 ±0.54	68.99 ±1.64

III. Conclusions 结论

- **Replacing 50% or 75%+Lys and Met. of fish meal protein by DCP will not significantly affect growth performance of Japanese sea bass.**
- DCP可替代花鲈饲料中50%的鱼粉蛋白，补充赖氨酸和蛋氨酸可以提高替代水平至75%而不显著影响生长。
- **Limiting amino acids (Lys and Met) might be factors for lower growth rate**
- 限制性氨基酸的缺乏可能是导致DCP是用饲料生长率降低的主要因素

南美白对虾

Penaeus vannamei

Table 1 实验饲料配方
Formulation of the experimental diets(%)

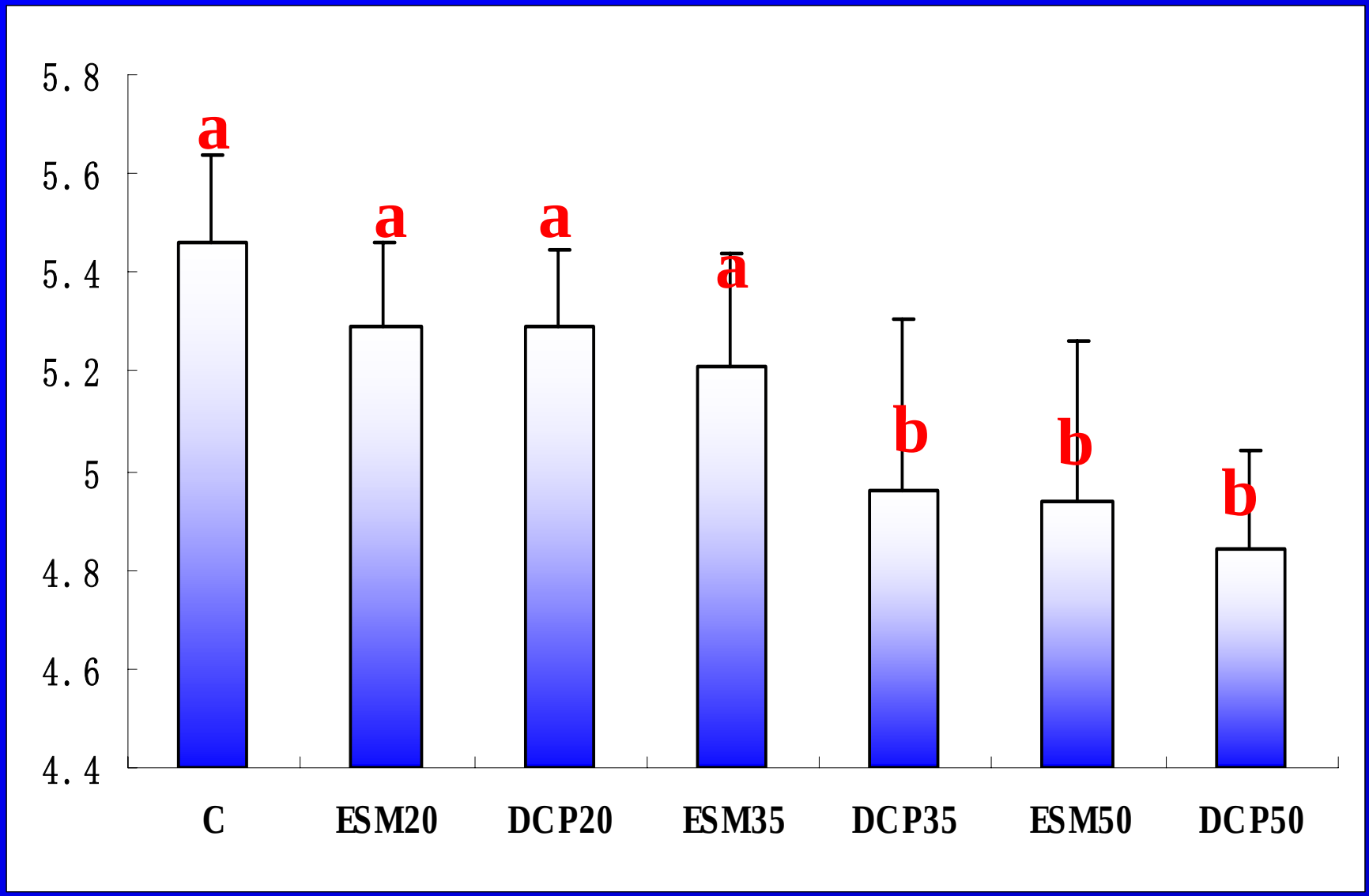
Ingredients	C	ESM20	DCP20	ESM35	DCP35	ESM50	DCP50
鱼粉Fishmeal	36.0	28.8	28.8	23.4	23.4	18	18
鱿鱼内脏粉Squid meal	5.0	5.0	5.0	5.0	5.0	5.0	5.0
花生粕Peanut meal	15.0	15.0	15.0	15.0	15.0	15.0	15.0
啤酒酵母 yeast	4.0	4.0	4.0	4.0	4.0	4.0	4.0
虾壳粉Shrimp meal	5.0	5.0	5.0	5.0	5.0	5.0	5.0
膨化豆粕 Extruded soybean meal	0.0	9.30	0.0	16.28	0.0	23.25	0.0
脱酚棉籽蛋白DCP	0.0	0.0	8.75	0.0	15.32	0.0	21.88
面粉Flour	22.22	22.22	22.22	22.22	22.22	22.22	22.22
卵磷脂Lecithin	1.5	1.5	1.5	1.5	1.5	1.5	1.5
鱼油Fish oil	2.0	2.0	2.0	2.0	2.0	2.0	2.0
豆油soybean oil	2.0	2.0	2.0	2.0	2.0	2.0	2.0
预混料 Vitamins/Minerals premix	2.03	2.03	2.03	2.03	2.03	2.03	2.03
纤维素Fibrin	5.25	3.15	3.70	1.57	2.53	0.0	1.37

Table 2 实验饲料营养成分组成
Chemical composition of the experimental diets(%)

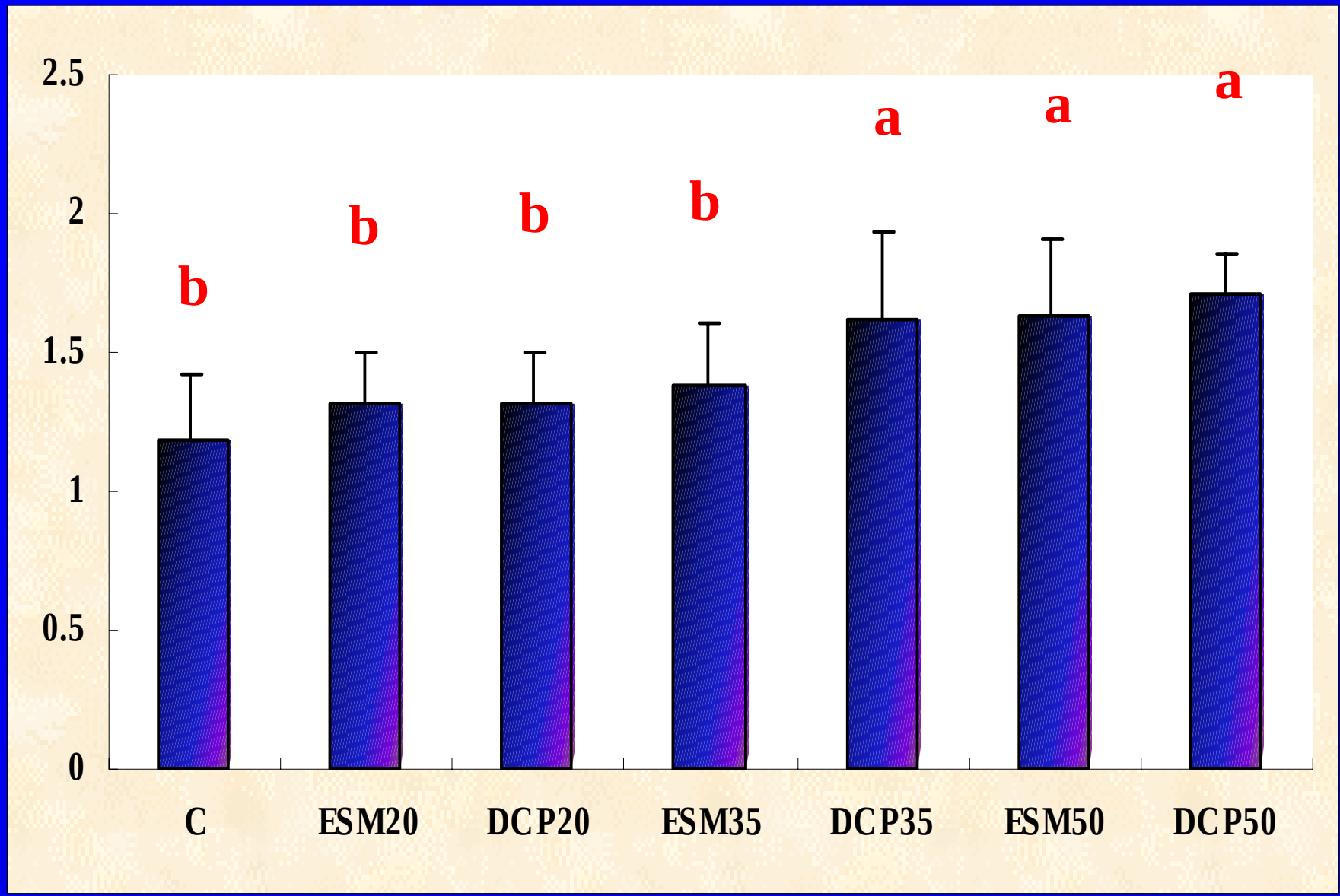
Diets	C	ESM20	DCP20	ESM35	DCP35	ESM50	DCP50
干物质 Dry matter	89.52	90.21	89.73	89.56	90.41	90.25	89.64
粗蛋白 Crude protein	41.89	41.38	41.29	41.65	41.64	41.48	41.51
粗脂肪 Crude lipid	9.02	8.81	8.79	8.93	8.65	8.92	8.83
灰分Ash	10.03	9.83	9.93	9.91	9.79	9.78	9.84

II. Results 结果

特定生长率SGR(%)


5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
a
a
a
a
b
b
b
C
ESM20
DCP20
ESM35
DCP35
ESM50
DCP50

饲料系数 FCR



蛋白质效率PER(%)

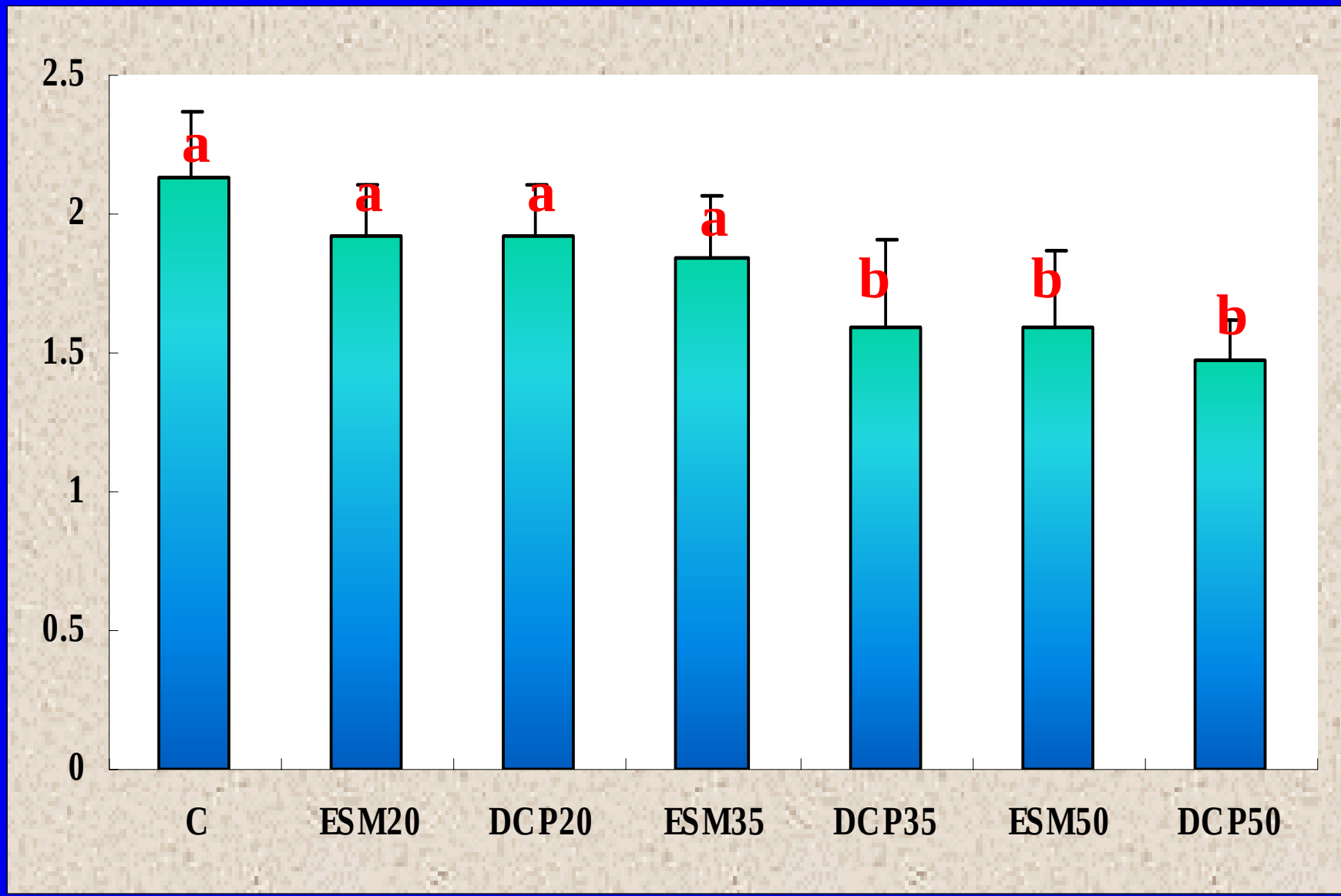


Table 2 鱼体成分分析结果
Body composition of rainbow trout (mean ± S.E.M., n=3)

Diets	Crude protein of whole body 全鱼粗蛋白	Crude fat of whole body 全鱼粗脂肪	Ash of whole body 全鱼灰分	Moisture of whole body 全鱼水分
C	69.39±1.17	9.15±0.29	10.90±0.30	72.36±0.51
ESM20	70.66±0.07	9.90±0.04	11.52±0.50	72.21±0.22
DCP20	69.72±2.20	9.63±0.11	10.57±0.18	72.81±0.92
ESM35	70.16±0.51	9.13±0.06	11.46±0.46	73.15±0.49
DCP35	69.44±0.55	9.04±0.05	11.27±0.43	72.95±1.03
ESM50	70.95±0.83	9.26±0.43	11.15±0.61	72.33±0.93
DCP50	69.53±1.03	9.35±0.15	10.95±0.26	72.47±0.67

III. Conclusions 结论

DCP could replace about 20% of fish meal protein in the *Penaeus vannamei* diet .

DCP可替代南美白对虾饲料中20%的鱼粉蛋白。

Thank for your attention