《Research Note》

Effect of Carbohydrate in the Diet on *Eimeria tenella* Infection

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KOLTVEIST¹⁾ has fed chickens, which were infected with *Eimeria tenella*, with semipurified diets containing different protein or carbohydrate sources. The groups fed either glucose or starch did not differ significantly in mortality. However, the influence of other saccharide in food is not yet known. The purpose of the present study is to determine the effect of the presence of carbohydrate in the diet on *E. tenella*.

Ten-day-old, wing banded, White Leghorn male chicks were divided into groups of each five birds, being so distributed as equal in body weight, and they were caged in batteries of wire-floor. The experimental diets are shown in Table 1. These diets included about 50%

Table 1. Composition of semipurified diet

Ingredient	(%)
Carbohydrate*	49.58
Casein (Vitamin free)	20.00
Gelatin	10.00
Corn oil	8.00
Cellulose	3.00
Calcium gluconate	1.00
Glycine	0.50
L-Arginine	1.00
D,L-Methionine	0.50
Mineral mixture**	6.00
Vitamins***	0.41
Ethoxquin (Antioxidant)	0.01

* Carbohydrate: D-Fructose, maltose, saccharose, dextrose (glucose), D-galactose, lactose, mannose, amylopectin, amylose or starch (potato).

** Mineral mixture consists of the following materials in mg per kg of diet: NaCl 846 mg, K₂HPO₄·4H₂O 1622.4 mg, CaHPO₄·2H₂O 1309.8 mg, CaCO₃ 1512 mg, MgSO₄ 525.6 mg, FeC₆H₅O₇·10H₂O 138 mg, MnSO₄·4H₂O 34.2 mg, KI 4.8 mg, ZnCO₃ 1.8 mg, CuSO₄·5H₂O 1.8 mg, CoCl 1.8 mg and Na₂ MoO₄·2H₂O.

*** Vitamins supplement consists of the following materials in mg per kg of diet: Vitamin A 100,000 IU, vitamin D₃ 10,000 ICU, thiamine-HCl 5 mg, riboflavin 5.5 mg, niacin 29 mg, Ca-pantothenate 9.5 mg, choline chloride 200,000 mg, inositol 100,000 mg, p-aminobenzoic acid 200 mg, α-tocopherol 40 mg, folic acid 1.2 mg, biotin 1.2 mg, menadione 1 mg, cyanocobalamin 0.01 mg and pyridoxine-HCl 6.7 mg.

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Table 2. Effect of carbohydrate on the weight gain, oocyst production, mortality and cecal lesion score of groups of 14 day old chicks inoculated with 35,000 sporulated oocysts of *E. tenella*

Carbohydrate in feed (Concentration: 49.58%)	Inoculation	Mean nos. of oocysts produced from 5 to 7 days after inocul- ation (Mean $\pm$ SD millions/ bird)	Mean weight gain in 7 days (Mean $\pm$ SD grams)	Mortality (%)	Mean lesion score of cecum (Score/bird)
<i>d</i> -Fructose	Yes	101.5 $\pm$ 21.4*	50.2 $\pm$ 6.4	0	3.4*
	No	0	71.6 $\pm$ 5.6	0	0
Maltose	Yes	138.5 $\pm$ 15.9*	45.2 $\pm$ 6.1	0	2.8
	No	0	69.2 $\pm$ 8.8	0	0
Saccharose	Yes	122.5 $\pm$ 14.3*	48.8 $\pm$ 4.3	0	2.6
	No	0	69.0 $\pm$ 9.0	0	0
Dextrose (Glucose)	Yes	144.6 $\pm$ 16.4*	46.6 $\pm$ 3.4	0	2.6
	No	0	71.0 $\pm$ 9.3	0	0
<i>d</i> -Galactose	Yes	1.2 $\pm$ 0.2*	-19*	80	2.0*
	No	0	-16*	80	0
Lactose	Yes	96.7 $\pm$ 8.7*	8.6 $\pm$ 4.7*	0	2.0*
	No	0	39.8 $\pm$ 7.9*	0	0
Mannose	Yes	75.7 $\pm$ 11.2	8.3 $\pm$ 4.7*	0	2.0*
	No	0	17.2 $\pm$ 9.1*	0	0
Amylopectin	Yes	145.1 $\pm$ 23.1*	42.0 $\pm$ 8.3	0	2.6
	No	0	66.0 $\pm$ 2.6	0	0
Amylose	Yes	100.1 $\pm$ 14.5*	3.8 $\pm$ 3.5*	0	2.2
	No	0	14.6 $\pm$ 8.9*	0	0
Starch	Yes	107.1 $\pm$ 24.6*	19.9 $\pm$ 3.9*	0	3.2*
	No	0	56.6 $\pm$ 9.9*	0	0
Commercial ration	Yes	78.8 $\pm$ 13.5	46.6 $\pm$ 8.3	0	2.6
	No	0	69.8 $\pm$ 6.8	0	0

Number of chick per group is five birds

Significantly different from commercial ration group, 5%.

carbohydrate. The carbohydrate used was: *d*-fructose, maltose, saccharose, glucose, *d*-galactose, lactose, mannose, amylopectin, amylose, and potato starch. Each chick was inoculated orally with 0.4 ml of a suspension containing 35,000 sporulated oocysts of *E. tenella*. Each group was evaluated for oocyst production, weight gain or loss, mortality and cecal lesion score²⁾.

The results are shown in Table 2.

Non-Infected Groups: The chicks fed commercial ration gained about 70 g of the body weight. The weight gain of the chicks fed *d*-fructose, maltose, saccharose, glucose or amylopectin was similar to that of the chicks which received commercial ration. The body weight gain of the chicks fed lactose, mannose or amylose was significantly lower than that of the chicks fed commercial ration. The weight gain of the chicks fed starch slightly lower than that of the chicks fed commercial ration. The chicks fed *d*-galactose revealed body weight loss and produced 80% mortality. The chicks fed lactose caused watery diarrhea.

Infected Groups: The body weight of the chicks fed commercial ration increased about 47 g. The body weight of the chicks fed amylopectin, glucose, saccharose, maltose or *d*-fructose was similar to that of the chicks which fed commercial ration. The body weight gain

of the chicks fed lactose, mannose, amylose or starch was significantly lower than that of the chicks which were fed commercial ration. The chicks fed *d*-galactose showed body weight loss, and caused 80% mortality. Any other group exhibited no death resulted.

Number of oocysts excreted from the chicks fed commercial ration was 78.8×10^6 from 5 to 7 days after infection. The oocyst output of the chicks fed mannose was similar to that of the chicks which received commercial ration. The oocyst output of the chicks fed lactose, amylose, starch or *d*-fructose was significantly higher than that of the chicks which were fed commercial ration. The oocyst output of the chicks fed saccharose was higher than that of the chicks which fed lactose, amylose, starch or *d*-fructose. Maltose, glucose and amylopectin showed highest oocyst output. *d*-Galactose prevented oocyst output.

The cecal lesion score of the chicks fed commercial ration was 2.6. The cecal lesion score of the chicks fed *d*-fructose or starch was higher than that of the chicks which were fed commercial ration. The cecal lesion score of the chicks fed maltose, saccharose, glucose, amylopectin or amylose was similar to that of the chicks which were fed commercial ration. *d*-Galactose, lactose or mannose groups showed lowest cecal lesion score. In this study, cecal lesion score and number of oocysts excreted were not related.

TYZZER³⁾ has reported that chicks fed lactose were suffered from diarrhea. Diarrhea due to lactose was also observed in the present experiment and it seemed that diarrhea was caused by increase of water intake. *d*-Galactose had not positive effect on the growth of chicks or oocyst production, but it had toxic effect. Growth of host and oocyst production of *E. tenella* were affected by the kinds of carbohydrate in the feed of the host. *d*-Fructose, maltose, saccharose, glucose, amylopectin and starch were effective to support the growth of chicks and/or production of oocyst. Just as in the relationship between coccidium and certain vitamins, it was suggested that the carbohydrate requirements of the host and the parasite are closely related. (Japan. Poultry Sci., 16, 00~000, 1979)

References

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Eimeria tenella 感染における飼料中の炭水化物の影響

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KOLTVEIT¹⁾ は *E. tenella* 感染鶏に異なる蛋白質または炭水化物を含む半精製飼料を給与したことを報告している。その炭水化物源は glucose および starch であった。両者を給与した鶏群は死亡率に有意差を示さなかった。しかしながら、飼料中における他の糖類の影響はまだ知られていない。本研究は *E. tenella* 感染ヒナに各種の炭水化物の飼料を与えて、その影響を検討した。

10 日齢、白色レグホン種雄ヒナに翼帯をつけ、各群平均体重が等しくなるようにし、5 羽群ずつを金網床ケージのバッテリーに入れ飼育した。実験飼料の組成は Table 1 に示した。この飼料は約 50% の炭水化物を含み、用いた炭水化物は d-fructose, maltose, saccharose, glucose, d-galactose, lactose, mannose, amylopectin, amylose および potato starch であった。*Eimeria tenella* の孢子形成オーシスト 35,000 個を含む懸濁液 0.4 ml をヒナに経口接種した。各群のオーシスト産生、体重、死亡率および盲腸病変を調べた。その結果は Table 2 に示すごとくである。

無感染群: 市販飼料で飼育したヒナの体重は約 70 g 増えた。d-fructose, maltose, saccharose, glucose または amylopectin で飼育したヒナの体重増加は市販飼料で飼育したヒナのそれと同じだった。Lactose, mannose または amylose で飼育したヒナの体重増加は市販飼料で飼育したヒナのそれよりも有意に低かった。Starch で飼育したヒナの増体重は市販飼料で飼育したヒナのそれよりもわずかに低かった。d-Galactose で飼育したヒナは体重が減少し、80% 死亡率を示した。Lactose で飼育したヒナは水様性下痢を生じた。

E. tenella 感染群: 市販飼料で飼育したヒナの体重は約 47 g 増えた。Amylopectin, glucose, saccharose, maltose または d-fructose で飼育したヒナの体重は市販飼料のそれと差がなかった。Lactose, mannose,

amylose または starch で飼育したヒナの体重増加は市販飼料のそれよりも有意に低かった。d-Galactose で飼育したヒナは体重が減少し、80% 死亡率を示した。他の群は死亡するものが見られなかった。

市販飼料給与群での感染 5~7 日におけるオーシスト産生数は 78.8×10^6 であった。Mannose で飼育したヒナのオーシスト産生は市販飼料のそれと同じであった。Lactose, amylose, starch または d-fructose で飼育したヒナのオーシスト産生は市販飼料のそれよりも有意に高かった。Saccharose で飼育したヒナのオーシスト産生は lactose, amylose, starch または d-fructose 給与群のそれよりも高かった。Maltose, glucose または amylopectin は最も高いオーシスト産生を示した。d-Galactose はオーシスト産生を抑制した。

市販飼料で飼育したヒナの盲腸病変値は 2.6 であった。d-Fructose または starch で飼育したヒナの盲腸病変値は市販飼料で飼育したヒナのそれよりも高かった。Maltose, saccharose, glucose, amylopectin または amylose で飼育したヒナの盲腸病変値は市販飼料で飼育したヒナのそれと同じだった。d-Galactose, lactose または mannose 群は最も低い盲腸病変値を示した。今回の研究において、盲腸病変値とオーシスト産生数の間に関係がなかった。

古く TYZZER も lactose によって下痢が生じることを報告している。Lactose による下痢はヒナの飲水量が増加するためであろう。宿主の成長と *E. tenella* のオーシスト産生は宿主の飼料中の炭水化物の種類によって影響をうけた。d-Galactose は宿主および寄生虫体にも毒性が見られた。d-Fructose, maltose, saccharose, glucose, および amylopectin はヒナの成長およびまたはオーシスト産生に有効であった。すなわち、コクシウムとある種のビタミンの関係のごとく、宿主と寄生虫体の炭水化物の要求は密接な関係にあることが示唆された。

(家禽会誌, 16, 137~140, 1979)

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