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ORIGINAL ARTICLE

Effect of energy source (oil vs. sucrose) on broiler growth performance, blood chemistry and gastrointestinal morphology

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ABSTRACT
This experiment was designed to examine the effect of substituting fat in broiler grower diet with sucrose on; growth parameters, gastrointestinal morphology, and blood chemistry parameters in broiler chickens. Fifty six broilers were divided into two treatment groups (n =28 in each group). Two dietary treatments were formulated and experimented: corn-soy–based diet containing 5% oil (control) and corn-soy–based diet formulated including sucrose (7%). The two diets were is nitrogenous and is caloric. All the birds were exposed to the same handling and growing conditions. The experiment went for 21 days (on birds aging from 21 to 42 days). At the end of week 6(42 days of age), all broilers in each treatment were slaughtered via neck slit. All birds were eviscerated for carcass and gastrointestinal morphological characterization. Blood samples were taken to measure blood metabolites (blood lipoprotein, albumin, triglyceride, glucose, and cholesterol levels). The results showed that the replacement of fat with sucrose significantly increased the weekly gain during the study period as well as the final body weight. The replacement of fat with sucrose significantly increased the carcass weight and altered; gastrointestinal morphology (weight of gizzard and small intestine), blood lipoprotein (HDL and LDL) and total cholesterol levels. In conclusion, the substitution of fat with sucrose in corn-soy–based diet within experimented nutrient specifications has a positive impact on broiler growth performance.
Keywords: *fat, sucrose, growth performance, blood chemistry, broiler.*

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INTRODUCTION

Starch is well known to be the main nutrient that delivers energy to poultry in their diets. Starch is mainly digested and absorbed as glucose to supply energy necessary for growth and maintenance. Fat can be added in poultry diet to increase energy density and has been reported to posses many advantages when added into poultry diets. Fat is known to reduce diet dustiness and thus can increase feed intake when diet offered in mash form. Furthermore, nutritionists recommend adding fat in broiler diets during heat stress period to increase caloric density to compensate for reduction in feed intake. However, fat is easily exposed to rancidity and has been reported to reduce pellet durability when included at high levels in the diet [1]. Fat has been also reported to be negatively correlated with starch digestibility by alpha amylase [2, 3]. Fat and starch ratio should not be overlooked when formulating broiler diet. In a feeding study to evaluate the influence of four starch to fat ratios (14, 12, 7, 4) at different energy levels: broiler feed intake, weight gain and carcass yield were significantly improved without influencing feed conversion [3] . Thus, incorporating a high-energy ingredient source other than fat is recommended to enhance broiler growth performance. Sucrose is a disaccharide that is composed from glucose and fructose which can be easily digested and utilized by poultry [4] and can provide a higher AMEn (more by 420 kcal/kg) than glucose alone [5]. Glucose has been reported to increase nitrogen retention in animal body by reducing amino acid oxidation [6] and it has an amino acid sparing effect [7]. The benefits of maintaining caloric density in the diet (without fat) through addition of sucrose may enhance broiler growth performance. The main objective of this study was to examine the influence of sucrose as an alternative feed ingredient

to fat on broiler growth performance, blood chemistry and any associated changes in gastrointestinal morphology characteristics.

MATERIAL AND METHODS

This experiment is one of a series to evaluate the effect of sucrose as alternative energy source on broiler feed intake, growth performance and digestive system morphology. The details about broiler shandling, feed preparation, digestive system morphology measurements, blood sampling and biochemical analysis, and statistical analysis were similar to the methodology previously mentioned by Al-Rabadi e*t al* [8]. Fifty six Hubbard broilers were raised in floor cages during the period of the experiment (from week 4 to week 6). Broilers were divided into equal groups (28 birds per treatment and 4 birds per experimental unit) and were fed isocalroic and isonitrogenous diets that differ in the level of sucrose (0 and 7%). Ingredient composition of both experiment diets and their related chemical compositions are shown in table 1.

RESULT AND DISCUSSION

Table 2 shows that effect of feed treatment (energy source: fat vs sucrose) on both cumulative feed intake and weekly gain of broilers at different growing periods. Due to feed waste, which was observed with feeding mash in both diets, cumulative feed intake measurements were overlooked from the discussion in this experiment. In comparison to pelleted diet, offering poultry mash diet has been reported to have a higher feed waste [9, 10, 11]. Feed waste have been reported to be higher (23%) when feed offered as mash when compared to diet offered as pellets (5%) [12]. The result of this study showed that weekly gain for broilers fed sucrose based diet was higher during week 4 when compared to fat based diet. However, there was no significant impact of feed treatment on weekly gain during week 5 and week 6. Fat digestibility has been reported to increase as the broiler grows [13, 14] and this may explain the non significant effect of dietary treatment during week 5 and week 6. Total weight gain, overall, during the experiment's period (week 4, 5 and 6) was higher for sucrose based diet compared to fat based diet (Table 2). Consequently, the final body weight was higher in sucrose based diet. Furthermore, the addition of soyabean oil in poultry diet has been reported to reduce starch digestibility [15]. On the other hand, sucrose is known as a disaccharide that can be easily digested into glucose and fructose by digestive enzymes and rapidly absorbed. Glucose has been reported to reduce amino acid oxidation [6] and thus increase nitrogen retention in the animal body [7]. In this study, sucrose based diet may increase glucose to lipid ratio and this could be the reason behind enhancing broiler weight gain. Starch to lipid ratios has been reported to positively correlate with broiler weight gain [3]. Inclusion of date fruit (rich ingredient source of sucrose) in broilers diet has been reported to increase final body weight in broilers [16, 17]. In addition, fat inclusion in diet has been reported to reduce feed intake [3] and consequently may reduce energy intake, thus broiler growth. Increasing fat in diet from 4.5 to 7.5% has been reported to reduce feed intake and weight gain (8.8% and 15.9%, respectively) [18].

The effect of dietary treatment on blood chemistry (total cholesterol (TC), triglyceride (TG), high density lipoprotein (HDL), light density lipoprotein(LDL), very light density lipoprotein (VLDL), total protein (TP), albumin(AL) and glucose (GL)) is shown in table 3. There was no significant effect of dietary treatment on TG, VLDL, TP, AL and GL levels. Sucrose based diet has significantly increased both TC and LDL levels (133.31 and 100.94 mg/dI, respectively) in blood compared to fat based diet (114.02 and 75.13 mg/dl). However, sucrose based diet had a lower HDL (8.40 mg/dl) compared to fat based diet (13.5 mg/dl). No information, in literature, is available in regards to the influence of sucrose treatment on broiler-blood chemistry. However, few studies investigated the influence of sucrose rich ingredients such as date fruit, date syrup and date waste as energy sources on broilers blood chemistry [16, 19, 20] but the outcomes were inconsistent. Blood metabolites level in poultry are dependent on many factors such as diet content(formulation), breed and genetic lines, age, gender and husbandry conditions [21] which makes comparison among experiments extremely difficult.

Table 4 shows the effect of dietary treatment on carcass yield and digestive organ weights. Carcass, breast and thigh weights were higher in sucrose based diet compared to fat based diet. However, there were no significant differences in proventriculus, spleen, large intestine, abdominal fat, liver and heart weights between broilers fed in the two dietary treatments. In this study, gizzard and small intestine weights were lower in broilers fed sucrose-based diet (18.45 and 44.53 gram, respectively) compared to broilers fed fat-based diet (20.71 and 54.91 gram, respectively). Fat has been reported to reduce feed passage rate through the digestive system [14] as well as alter digestive system motility. Fat is also known to cause delayed gastric emptying [22] . The reduction in feed passage rate and delay in gastric emptying may increase diet retention time in the organs and consequently may increase the organ weights.

Table 1. Ingredient (%) and calculated chemical composition (%) of the experimental diets

Ingredient (%)	Fat based diet	Sucrose based diet
Corn	45.68	54.5
SBM	33.11	29.88
Barley	3.72	0
Methioine	0.07	0
Limstone	2.98	1.22
Soybean oil	5	0
Salt	0.8	0.19
Vit and mineral premix[a]	0.2	0.2
Antifungal[b]	0.2	0.2
Monocalcium phosphate	1.23	0.36
BroconConcentrate[c]	0	6.11
Sucrose	0	7
Wheat bran	7	0.24
Chemical composition[d]		
DM (%)	90	90
AMEn (kcal/kg)	2900	2900
Protein (%)	20	20
Crude fibre (%)	4.297	3.62
Methioine (%)	0.38	0.382
Lysine (%)	1.068	1.097
Cystein (%)	0.22	0.213
Ca(%)	1.46	0.9
Available P (%)	0.455	0.35
Na (%)	0.338	0.165
Cl (%)	0.526	0.15

[a] Vitamin premix provided per kilogram of premix: Vitamin A,700,000 IU; vitamin D3, 150,000 IU; vitamin E, 75 mg; vitaminB1, 100 mg; vitamin K, 175 mg; vitamin B5, 600 mg; manganeseoxide, 4,000 mg, ferrous sulphate, 9,000 mg, zinc oxide, 6,000 mg,magnesium oxide, 2,500 mg, potassium iodide, 70 mg, sodiumselenite, 125 mg, copper sulphate, 100 mg, cobalt sulphate, 50mg, dicalcium phosphate, 7,000 m, sodium chloride, 10,000 mg. [b] Mold inhibitor for animal feed (Kemin Industries, USA)[c]Brocon Concentrate ® (Wafa, B V, Alblasserdam, Holland) provide (%, as on fed basis): metabolizable energy = 2,200 kcal/kg;crude protein = 35%; crude fiber = 4.8; non-phytate phosphorus = 2.2%; Methionine = 1.6%; lysine = 2.4%; cysteine = 0.3%).[d] Calculated on the basis of analyzed values of feed ingredients(feed composition tables) from poultry NRC (1994).

Table 2. Effect of feed treatment on feed intake (gram) weekly weight gain (gram) at different growing stages (mean ±Standard deviation)

	Energy source		P value
	Fat based diet	Sucrose based diet	
Week 4			
CFI (g)	801.25±25.25	747.5±17.92	0.104
Weekly gain (g)	428.85±20.49	678.7±51.24	0.001
Week 5			
CFI (g)	1062.8±21.62	880.42±30.48	0.0002
Weekly gain (g)	521.15±15.5	441.3±53.08	0.18
Week 6			
CFI (g)	1264.1±22.34	1099.1±21.88	<0.0001
Weekly gain (g)	405.53±16.74	473.33±49.32	0.22
Week 4-week6			
CFI (g)	3128.1±42.21	2676.0±36.03	<0.0001
Gain (g)	1335.5±20.13	1593.3±49.65	0.001
Initial body weight (g)	566.22 ±26.70	531.77 ±27.55	0.93
Final body weight (g)	1992.30±49.78	2125.10 ±149.70	0.005

Table 3. Effects of diet on blood chemistry parameters ((mg/dl)) in broilers at 42 days old (mean ±Standard deviation)

	Energy source		P value
	Fat based diet	Sucrose based diet	
Cholesterol	114.02±4.45	133.31±4.07	0.006
Triglyceride	126.92±4.49	119.85±4.28	0.27
HDL	13.50±1.40	8.40±0.42	0.008
VLDL	25.38±0.89	23.97±0.85	0.27
LDL	75.13±5.79	100.94±3.64	0.002
Total Protein	5.91±0.13	5.43±0.175	0.052
Albumin	2.15±0.07	2.11±0.06	0.67
Glucose	236.22±4.29	233.95±7.49	0.79

Table 4. Effect of feed treatment on carcass weight (gram)and various organ weights (gram) (mean ±Standard deviation)

	Energy source		
	Fat based diet	Sucrose based diet	P value
Carcass weight (g)	689.59±6.71	746.15±12.34	0.001
Breast weight (g)	246.64±4.97	271.02±7.38	0.016
Thigh weight (g)	190.87±3.43	203.13±5.11	0.066
Gizzard weight (g)	20.71±0.30	18.45±0.63	0.006
Proventriculus weight (g)	4.87±0.18	4.96±0.85	0.91
Spleen weight (g)	1.85±0.15	1.64±0.08	0.24
Small intestine weight (g)	54.91±1.73	44.53±1.44	0.0004
Large intestine weight(g)	14.49±0.50	13.10±0.76	0.15
Abdominal fat weight(g)	4.63±0.27	4.01±0.63	0.39
Liver weight (g)	23.25±1.05	24.17±0.41	0.43
Heart weight(g)	5.48±0.09	5.87±0.24	0.48

CONCLUSION

Under nutrient specifications in this experiment, substituting fat in broiler diet with sucrose enhanced the weight gain and the final body weight in broilers during growing stage, altered some of blood lipoprotein levels and induced some morphological changes in broiler digestive system.

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