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Original research article

Graded levels of sugar syrup in broiler rations and its effect on growth performance and blood biochemical parameters

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ABSTRACT

Dietary energy for chickens normally includes cereal grains and fat. This innovative study investigated the effect of replacing part of the corn and fat in broiler chicken rations with graded levels of sugar syrup on growth performance and biochemical parameters. Experimental treatments consisted of feeding a corn-soy basal diet alone, or with graded levels of sugar syrup in increments of 5%, 10% and 15%. All starter diets were isonitrogenous and isocaloric. Body weight gain and efficiency of feed utilization of chicks fed the control diet alone were not significantly ($P < 0.05$) different from chicks fed diets supplemented with either 5% or 15% sugar syrup. Supplementation of sugar syrup to broiler diets had no significant effect on blood glucose, creatinine, total protein, or liver enzymes. Adding 5% sugar syrup to broiler rations significantly decreased blood cholesterol and triglycerides in chickens fed the sugar syrup diet compared with birds fed the control diet. In conclusion, the results shows sugar syrup can be used in poultry ration to replace part of the corn as a source of energy. These results allowed the authors to recommend the safe usage of sugar syrup in broiler rations.

1. Introduction

The most vital nutrient in the poultry ration is considered "dietary energy" even though energy itself is not converted into glucose in meat or eggs except for liponeogenesis. Moreover, it is used as fuel for the synthesis of meat and eggs. Therefore, 60% to 65% of metabolizable energy in the poultry ration is imputed to carbohydrates. Dietary carbohydrates are important sources of energy for poultry. Cereal grains such as corn, sorghum, wheat, and barley contribute most of the carbohydrate component to poultry diets. The majority of the carbohydrate content in cereal grains occurs as starch, which is readily digested by poultry (Franco et al., 1995). Therefore, in poultry rations, cereal grains are the most acceptable source of energy. The physiological mechanisms by which poultry respond to different dietary energy concentrations are not known, although several possible mechanisms have been proposed (NRC, 1984). In order to increase dietary energy, the addition of oil and fat is commonly practiced. A number of studies suggest the use of fatty acids in the diet for increasing energy (Guo et al., 2004; Hosseini-Mansoub and Bahrami, 2011; Fritsche et al., 1991b; Leeson and Summers, 1976; Fuller and Dale, 1982; Ketels and De Groote, 1987). Very little research has involved the use of sugar in animal feed (Jimenez-Moreno et al., 2011, 2013; Gonzalez-Alvarado et al., 2010; Burritt et al., 2005; Lumpkins et al., 2004; Hall, 2002; Iji et al., 2011; Chamberlain et al., 1993) although the NRC suggested a poultry ration using up to 15% pure sucrose (NRC, 1994).

The saliva and crop of the chicken contain some α-amylase enzyme, but little starch digestion has been demonstrated in the crop and proventriculus gizzard. Digestion of most polysaccharides into monosaccharide and their subsequent absorption, takes place in the small intestine. Alpha-amylase is secreted from the pancreas

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into the duodenum and this hydrolyses the α-1,4-linkages on both sides of the 1,6-branching points in starch, producing mainly maltose and some branched oligosaccharides (isomaltose). The enzyme maltase, also called α-glucosidase, splits maltose, while oligo-1, 6-glucosidase (isomaltase) produced by the intestinal mucosa hydrolyses the branched oligosaccharides into glucose. The brush border membrane of the jejunum contains other disaccharidases that complete the digestion of complex dietary polysaccharides into monosaccharide. Sucrose is hydrolyzed by sucrase into glucose and fructose, while lactase converts any lactose into glucose and galactose (Mahagna and Nir, 1996). It is known that sugar is a better energy source than starch in the animal system. The greatest maltase activity is in the jejunum, followed by the ileum, with the lowest value in the duodenum (Sklan and Noy, 2003). It is therefore seen that the metabolizability of sucrose is significantly higher than starch.

A recent advance in feed technology and animal nutrition is the development of sugar syrup, an intermediary product of sugar refining as energy feed for poultry (John, 2008). In the Middle East where the cost of grain is increasing exponentially, the ready availability of sugar syrup has been considered a recourse to poultry feed. Molasses is the last residual produced by sugar mills. It is highly viscous (<100,000 cP at 25°C) with 48% sugar and more than 20% ash. Because of repeated boiling (about 13 times) the sugar is caramelized and binds to organic substances like glue and polysaccharides, which depresses the digestibility of dry matter. In fact, sugar companies have not shown an interest in increasing the quality of molasses since its main use has been for alcohol production, and therefore, was not measured as an energy source in animal feeds. As well, it is often used as a binder, dust reducer and sweetener with a low inclusion rate, so the demand for use of molasses in animal rations has been low. Al Khaleej Sugar Co, the largest sugar refinery in United Arab Emirates decided to focus on improving the quality of molasses as a suitable feed ingredient and defined the process parameters at 76% sugar. The resulting product, termed "Sugar Syrup" (referred to hereafter as "sugar syrup"), provides an instant energy feed and is a better substitute for starch/grains and vegetable oil. Sugar syrup has no physical limitations on incorporation in ration and maintains the binding effect while being more aromatic and palatable. It is also heavily incorporated in mash feeds and contains no aflatoxin.

Chickens need glucose for tissue multiplication, egg production and maintenance. Instead of glucose, metabolizable energy was used in nutritional requirement calculations. Today, nutritionists specify the need to use 2 kg feed per 1 kg meat and 4 kg per one dozen eggs. The normal poultry ration consists of about 60% grain. Out of 2,900 kcal ME, the requirement for poultry is about 2,000 kcal which comes from grain or starch. Therefore, glucose is a vital nutrient in the ration (Kocher et al., 2002). The success of introducing sugar syrup depends on its wider acceptance as a glucogenic feed. The above information encourages animal scientists to examine and further refine sugar syrup as a future energy feed in the Middle East. In order to investigate the efficacy of sugar syrup as a dietary energy for poultry, a feeding trial was carried out to investigate the effect of using graded levels of sugar syrup to replace part of the corn and fat in chicken rations on the growth performance of broilers, and blood biochemical parameters.

2. Materials and methods

2.1. Birds and dietary treatments

Triplicate groups of 100 chicks (one-day-old Hubbard commercial broiler chicks, straight run), were randomly assigned to 4 dietary treatments. The chicks were housed on floor pens, 100 per pen, with 3 groups of 100 birds per dietary treatment. The calculated nutrient composition of the dietary treatments (Tables 1 and 2) was based on the ingredients composition tables of Hashim et al. (2013). The experiment was conducted over a five-week period. Feed and water were given on an *ad libitum* basis.

2.1.1. Starter and finisher diets

All starter diets were isonitrogenous (22% CP) and isocaloric (3,000 cal/kg), and fed to birds for 3 weeks. Diet 1 (control) was a corn-soybean starter diet with no added sugar syrup. Diets 2, 3, and 4 were corn-soybean rations containing 5%, 10%, and 15% sugar syrup, respectively (Table 1). The finisher diets were isonitrogenous (20% CP) and fed birds for 2 weeks. Diet 1 (control) was corn-soybean finisher with no added sugar syrup. Diets 2, 3, and 4 were corn-soybean finisher rations containing 5%, 10%, and 15% sugar syrup, respectively (Table 2).

2.2. Blood samples

Blood samples were collected in test tubes with heparin as an anticoagulant. On day 35, 2 chicks were selected at random from each replicate group. Samples were centrifuged for 10 min at 1,000 × g. Plasma was then separated, pooled and stored in eppendorf tubes at −20°C until analysis.

2.3. Tissue and liver samples

At the end of the experiment, 3 chickens (of average weight) from each replicate group were slaughtered, processed and the eviscerated carcasses were weighed. Tissue and liver samples were collected; liver samples underwent histopathological examination (fatty liver syndrome) at the Al-Ain Municipality Animal Veterinary Hospital, Al Ain, UAE. The conventional slaughterhouse procedure was used, with carcass yield determined according to methods outlined and reported by AOAC (1984). Growth performance parameters were measured, and live body weight, feed intake at 21 and 35 days of age, mortality rate and feed conversion ratio were calculated.

2.4. Biochemical analysis

Plasma total calcium, phosphorus, sodium, potassium and iron were determined using procedures for the Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-OES) described by Varian, Inc. ICP-OES Spectrometers operation manual (2002). Blood plasma glucose, creatinine, total protein, alanine aminotransferase, asparatate aminotransferase, gamma glutamyl transferase, cholesterol, HDL-cholesterol and triglycerides were measured using commercial systems (Udichem Elite, United Diagnostics Industry, Dammam, Kingdom of Saudi Arabia) and based on methods used and outlined by Wissam et al., 2008.

2.5. Statistical analysis

The collected data were subjected to a one-way ANOVA (Snedecore and Cochran., 1980) and performed using a program for microcomputers (Statistix, V. 4.0, Analytical Software, Tallahassee, FL., 32317). Also, certain data were subjected to analysis of variance testing with sub-sampling for the effect of the level of sugar syrup as well as linear, quadratic and cubic effects. A probability level of <0.05 was required for significance.