Sugar syrup: the new energy feed for poultry

In the Middle East where the cost of grains is rising, sugar syrup has been found to be an economical and effective energy source for poultry feed.

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In the Middle East where the cost of grains is increasing, Al Khleej Sugar Co. Dubai, one of the largest sugar producers in the world, is supplying sugar syrup at an affordable price to poultry feed producers. Its quality assurance is encouraging feed manufacturers to adopt this new technology. The company's development team examined the possibility of improving the quality of molasses to make it a suitable feed ingredient. Once the process parameters were defined the company began production of a high quality molasses with 70% sugar called AKS Sugar Syrup. Molasses is highly viscous syrup with 48% sugar and more than 20% ash. Because of its multiple boiling stages the sugar is caramelised and bound to the organic substances, like glue and polysaccharides, which depresses the digestibility of molasses. Until recently the use of molasses as an energy source in animal feed was not considered, although it is often used as a binder, dust reducer and sweetener at a low inclusion rate.

Sugars are defined as mono-saccharides (simple sugars), disaccharides and oligosaccharides. These carbohydrates are separated from polysaccharides (long chains of mono-saccharides) by their solubility in 80% ethanol. Sugars are non-neutral detergent fibre carbohydrates (NFC) as well as non-structural carbohydrates (NSC) because they are not included in NDF and are found in the cell contents. Glucose and fructose are the simple sugars most commonly found in plants. The most abundant disaccharide in plants is sucrose, which is a molecule of glucose bonded to fructose. Lactose (glucose + galactose) is found in milk. Maltose is a disaccharide with the same glucose to glucose α-linkage as starch. Oligosaccharides are chains of monosaccharides that are two to approx. twenty units long. They include stachyose and raffinose found in soybeans. Plants do not generally have a large oligosaccharide content. With the exception of oligosaccharides, sugars are digestible by mammalian enzymes.

Table 1 - Energy availability of starch and sugar

Particulars	GE (kcal/kg)	ME (kcal/kg)	Metabolisability (%)
Starch	3760	2918-3396	78-90
Sucrose	3960	3900	98

Table 2 - Comparison analysis of corn and sugar syrup

Particulars	Corn	Sugar syrup
Dry matter (%)	89	80
Crude Protein (%)	9.6	4.6
Fibre (%)	2.5	0
Fat (%)	4.1	0.2
Ash (%)	1.5	6
NDF (%)	14.5	0
ADF (%)	2.6	0
Starch (%)	75	0
Sugars (%)	0	70
Met.Energy MJ/kg	13	14
Calcium (%)	0.1	0.92
Phosphorous (%)	0.3	0.2
Magnesium (%)	0.1	0.17
Potassium (%)	0.4	0.85
Sodium (%)	0.1	0.1
Lysine (%)	0.8	0.02
Glucose+Fructose	0	65

The sugar content of feedstuffs can vary greatly. Mature grains, such as corn or oats, may contain very little sugar because most of it has been converted to storage polysaccharides. By-product feeds such as molasses, bakery waste, citrus pulp, and almond hulls tend to have a high sugar content. However, the processing methods and source material can lead to great variation. Fermented feeds including silages, distillers grains or brewers grains should have little remaining glucose, fructose or sucrose as they will have been largely consumed during fermentation.

Sugar digestion in poultry

The saliva and crop of the chicken contain some α-amylase, but little starch digestion has been demonstrated in the crop and proventriculus gizzard. The digestion of

Table 3 - The feed:egg relationship

	Feed (105 g)	Egg (52 g)
Protein	18	18
Fat	6	14
Carbohydrate	63	1.5

Advantages of sugar syrup in feed

- Increases the palatability of feed
- Improves dry matter digestibility
- Reduces dustiness of feed
- Inhibits mould formation on feed
- Stops insect infestation during storage
- Used as a binder for feed pelleting
- Increases energy density of the ration
- Masks less palatable ingredients
- Substitutes grain in feed formula
- Sugar syrup is free of aflatoxin
- Decreases the viscosity of digesta in gut.

Table 4 - Carbohydrate digestion in poultry

GI Tract Region	Enzyme (or secretion)	Substrate	End Product	pH
Mouth	Saliva	Lubricates and softens food		
	Amylase (ptyalin)	Starch Dextrin	Dextrin Glucose	
Crop	Mucus	Lubricates and softens food		4.5
Stomach	HCl	Lower stomach pH		2.5
Duodenum	Amylase (amylopsin)	Starch Dextrin	Maltose Glucose	6.0 to 6.8
Jejunum	Maltase	Maltase	Glucose Glucose	5.8 to 6.6
	Isomaltase	Isomaltase	Glucose Fructose	
	Sucrase	Sucrose	Glucose Galactose	
	Lactase	Lactose		
Ceca	Microbial activity	Cellulose, Polysaccharides,	Volatile fatty acids,	5.7 to 6.9
	(limited)	Starches, Sugars	Vitamin K, B Vitamins	

Source: (S. Leeson and A.K. Zubair)

most carbohydrates (poly saccharides) into monosaccharides and their subsequent absorption take place in the small intestine. Alpha-amylase is secreted from the pancreas into the duodenum and this hydrolyses the 1,4' α-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 monosaccharides. Sucrose is hydrolysed by sucrase into glucose and fructose, while lactase converts any lactose into glucose and galactose.

Sugars have been accepted as better energy donors than starch in the animal system. The greatest maltase activity occurs in the jejunum, followed by the ileum, while the lowest value was seen in the duodenum. It is seen that the metabolisability of sucrose is significantly higher than starch (*Table 1*).

Sugar syrup is a rich energy feed that could be well incorporated into feeds. Since its energy value is equal to corn it could be an economical substitute in poultry feeds (*Table 2*). This could bring a change in poultry feed formulations because sugar syrup contains no indigestible material and is therefore an instant energy feed. It also adds aroma and palatability to the feed. Since the syrup contributes energy without the addition of lipids, the formation of cholesterol in egg and meat could be minimised. Even though sucrose is considered a food additive for humans, sugar syrup could be used as a major feed item for poultry.

Glucose in chickens

Chickens need glucose for tissue multiplication, egg production and maintenance. Instead of glucose, metabolisible energy (ME) was used in nutritional requirement calculations. Today, nutritionists specify 2 kg feed for 1 kg meat and 4 kg feed for 1 dozen eggs (*Table 3*). Most poultry rations contain around 60% grain. Out of 2900 kcal ME, 2000 kcals come from grain or starch. Therefore, glucose is a vital nutrient in the ration.

It is observed that around 63 g carbohydrate, particularly starch, is fed to a laying hen per day (252 kcals). However the egg contains only 1.5 g carbohydrate, whilst 6 g fat is fed and 14 g fed is secreted in the egg. This shows that glucose is largely oxidised for liponeogenesis and oxidative energy. The feeding of oil can reduce liponeogenesis; however, the requirement of oxidative energy is very high for egg synthesis. The bottom line is that birds require significant levels of glucose in the diet. The supply of glucose in the form of sugar syrup would certainly alleviate the digestive load, making it more efficient in energy conversion.

Research data supports that plasma glucose controls feed intake in poultry. Therefore, dietary glucose has a vital role in poultry nutrition. There is a trend to add fatty acids to poultry rations to increase ME. The fat deposition increases the body weight of chickens. Practical type diets containing a high concentration of corn are very effective in improving the available carbohydrate status of very young poults. There is only minimal amylase activity in the saliva and crop, so most carbohydrates including starch and some fibre components are subsequently degraded to simple sugars that are absorbed in the jejunum (*Table 4*). Alpha amylase from duodenum hydrolyses the 1.2' α-linkages on both sides of the 1.6' branching points of the starch molecule, producing mainly maltose and some branched oligosaccharides. Maltose and other disaccharides are subsequently degraded to monosaccharides that are potentially absorbed. About 65% of starch is digested in the duodenum, while starch disappearance is as high as 97% at the terminal ileum. There is considerable variance in reported values for amylase activity in the duodenum and jejunum, although there is good evidence for a significant increase in enzyme production as the bird gets older.

The feeding of grain has an effect on the viscosity of the gut. Most studies have reported that a reduction in digesta viscosity is associated with improved performance. It has also been suggested that it is the viscosity of the arabinoxylans that impart their anti-nutritional activities, manifested by depressed nutrient absorption and poor growth in poultry. It is thought that the highly viscous digesta from wheat, barley and oat-based diets inhibit the access of the digested nutrients to the gut epithelial cells. The incorporation of sugar syrup in the ration may alleviate the gut viscosity problem. ■