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Research Paper

Evaluation of Sugar Syrup as a Partial Substitute for Maize in Broilers' Ration

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A study was conducted to evaluate sugar syrup as a partial substitute for maize on feed consumption, growth rate, feed conversion ratio, carcass yield and economic importance of using sugar syrup in the ration of broilers. Three hundred one day old Hubbard classic chicks were randomly distributed to five treatments each with three replications in CRD with 0, 7, 14, 21, and 28% of maize substituted by sugar syrup for T_1, T_2, T_3, T_4, and T_5, respectively. The results obtained indicated that there was no significant difference (P>0.05) in DM intake, body weight gain and mortality during the entire growth period. There was significant difference (P<0.05) in feed as well as protein and energy conversion ratio among the treatment groups during the whole growth period. Slaughter weight, eviscerated weight, drumstick-thigh weight and percent as well as breast weight and percent showed non significant difference (P>0.05) among treatments. But significant difference (P<0.05) was observed in eviscerated percentage. Abdominal fat weight and percent was greater for T_1 and T_2 as compared to T_4 and T_5. Birds in T_4 and T_5 score higher chicks' sale to feed cost than T_2, T_1 and T_3. In summary, increasing the substitution level of sugar syrup for maize increases profit. The study highlighted that sugar syrup could substitute maize up to 28% in formulating broilers' ration without adverse effect on growth performance.

Key words: Broiler chicken, sugar syrup, maize, substitute

INTRODUCTION

The estimated poultry population in Ethiopia is about 50.38 million poultry which includes cocks, cockerels, pullets, laying hens, non-laying hens and chicks. Most of the poultry are chicks (38.91%), followed by laying hens (32.77%) CSA (2012). Poultry production is one of the most important agricultural sectors, in which human food production is relatively fast, initial cost for investment is low and has low labour requirement that can be made available as household labour. The traditional system of poultry production is characterized by its low input and a corresponding low output. The commercial sector itself is also highly skewed with few companies controlling most commercial production (Tadelle *et al.,* 2000).

In tropical Africa, the levels of livestock productivity and availability of livestock products such as meat, milk and eggs for human consumption are the lowest in the world. Broiler meat may help in bridging the gap between supply and demand of animal proteins because it is the quickest and economical source of human food of high biological value (Anonymous 2005).

In developing countries, poultry meat production has increased gradually in past years. It is well recognized that the quality and chemical composition of produced meat are highly affected by chicken feed composition (Jubbarah and Elzubeir, 2006). One serious problem of poultry production in Ethiopia is cereal grains are often difficult to obtain for poultry feeding as they form the stable diet of the people. Moreover, the price of cereals is

also high (Amha, 1990). Efficient and economical broiler production depends upon a number of conditions such as genetic makeup of the birds, housing, feeding, disease prevention and marketing. The success of rearing broilers for maximum weight gain not only depends upon the strain of the birds and management but also on feed quality. It is believed that 70 to 75% of total cost on broiler production is incurred on feed (Mahmood *et al*., 2005).

Use of sugar syrup in poultry feed has many advantages. One of these benefits is that it is easy for chicken to feed on sugar syrup. The syrup helps improve the digestion of dry matter in the chicken's stomach. As a result of its sticky nature, sugar syrup reduces dustiness of feed. Unlike cereals, it is difficult for mould to form on sugar syrup. Therefore, there is no danger of the feed being contaminated by moulds. It is also not prone to insect infestation during storage. Sugar syrup is also used as a binder in feed pelleting. Its taste makes it possible for the chickens to feed on ingredients that are less appealing due to their taste. Sugar syrup improves digestion when added to other feed formulas and facilitates the gradual movement of digested feed through the intestine of the chickens to allow for absorption of the nutrients. Although the use of sugar syrup as an alternative to grain in poultry feed formulation is suitable, the technology requires the right advice on how to make the correct formulation for specific birds before farmers can use it (Ayako, 2008).

Even though sugar is not a large portion of diet; sugar byproducts could be an important energy donor and the best alternative to grains for livestock if incorporated in rations appropriately. Molasses, the major sugar industry byproduct is fed to cattle in many forms, although the feeding of molasses to poultry is restricted Ghurair and John (2005). Sugar syrup is an intermediate product in a sugar factory which is a new energy rich feed for poultry John (2010). Sugar syrup is an energy rich feed that could be well incorporated into feeds. Since its energy value is almost the same as corn, it could be an economical substitute in poultry feeds John (2008). It 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 minimized. The feeding of grain has an effect on the viscosity of the gut. Most studies have reported that a reduction in digester viscosity is associated with improved performance. The incorporation of sugar syrup in the ration may alleviate the gut viscosity problem John (2008).

Since sugar syrup is available in Ethiopia and the cereal grains are either expensive or preferably used for human consumption, it would be of importance to evaluate the feeding value of such available product and its substitution-ability to cereal grains (Maize) in the ration of broilers. Therefore, the study was designed to evaluate sugar syrup as a substitute for maize in broilers' ration, to assess feed intake, growth rate, feed conversion ratio and carcass yield characteristics of broilers fed different levels of sugar syrup and to determine the economic feasibility of using sugar syrup in the ration of broilers.

MATERIALS AND METHODS

Description of the study site

The study was conducted at Haramaya University (Haramaya campus) poultry farm which is located in about 515 km East of Addis Ababa, between Dire Dawa and Harar towns at an altitude of 1950 meters above sea level. The area is located at latitude and longitude of 9° N and 42° E, respectively. The average annual rainfall of the area is 790 mm with an average temperature of 16 °C (Mishra *et al*., 2004).

Experimental feeds

The feed ingredients used for ration formulation were sugar syrup, soybean meal, wheat short, maize, noug seedcake, limestone, lysine, vitamin premix and salt. Treatment rations were formulated by substituting sugar syrup for maize at a level of 0, 7%, 14%, 21% and 28%. After formulating the whole ration the dry feed ingredients were mixed first. Then, sugar syrup was added to the ingredients on DM basis first by measuring in litter. After combination of the whole experimental feeds, each of the treatment diets were directly sun dried for about 1 hour to avoid the difficulty in storage. Rations were formulated to contain iso-nitrogenous and iso-caloric basis as 22% CP and 3100 kcal/kg for starters phase and 20% CP and 3200 kcal/kg ME for finishers phase, respectively NRC (1994).

Experimental design and treatments

Completely Randomized Design (CRD) with five treatments and three replicates was used in the study. Fifteen pens were used for the three hundred one day old chicks and chicks were randomly assigned to each pen.

Management of experimental chicks

Three hundred one day old Hubbard classic chicks (commercial broiler strains) were purchased from Debre Zeit Agricultural Research Center. Sugar syrup is a sticky fluid and it was mixed with the other feed ingredients depending on the substitution level for maize in each treatment. The feeding was twice a day at 0730 and 1630 hours *ad libitum*. Water was always *ad libitum* and provision was in the morning and afternoon. The chicks

were vaccinated against New Castle Disease and Gumboro.

Data collection

Chemical analysis of feed ingredients

Laboratory analysis of feed ingredients was done at Haramaya University Nutrition and Soil Laboratories by taking representative samples from each feed ingredient and experimental diets.
Dry matter (DM) was determined by overnight drying 5 grams from each representative samples at 100 °C to 105 °C according to AOAC (1995). The DM of sugar syrup was also determined first by freeze drying in freeze drier and then by oven drying. Crude protein was quantified by the standard micro-Kjeldahl Nitrogen method as described in AOAC (2005) using a BehrosetInKje M digestion apparatus and a Behr S 1 steam distillation apparatus (Labor-Technik GmbH, Düsseldorf, Germany). The distilled ammonia was trapped in 2 % boric acid solution and titrated with 0.1N HCl. Crude protein was estimated by multiplying the nitrogen content with a factor of 6.25. Ether extracts were analyzed by extraction of samples of 2 g each in a Soxhlet extractor for 4 hours with diethyl ether (boiling point 40-60°C). After extraction, the flask and extract was oven dried at 100°C for 1 hour, cooled in a desiccator for one hour and weighed. Ether extracts were quantified by expressing the difference in weight as a percentage of the original sample weight. Crude fiber (CF) was determined according to AOAC (2005). Ash was determined as the weight of the residue after 5 g of sample had been ashed at 550 °C in a muffle furnace overnight. Nitrogen Free Extracts were estimated by difference (DM-CP-EE-CF-Ash). Ca and P content of the feeds were determined by atomic absorption spectrometer. CP was analyzed by multiplying the nitrogen (N) content of the feed with 6.25. Metabolizable energy (ME) content of the feed ingredients as well as experimental diets was determined by using the method of Wiseman (1987) as:

ME (kcal/ kg DM) = 3951 + 54.4 EE - 88.7 CF - 40.80 Ash

Measurements

Average dry matter intake (ADMI), body weight gain, feed conversion ratio, carcass yield, mortality percentage and economic advantage were used to evaluate the difference between the treatment rations. Average DM, CP and ME intake was calculated by multiplying the total feed consumption by the respective DM, CP and ME contents of the starter and finisher rations. Body weight changes were assessed every week by weighing the chicks. Mean daily weight gain (ADG) was determined by dividing the average body weight gain by the number of experimental days. The average feed conversion ratio was expressed by dividing the average DM intake by mean body weight gain (g). Mortality was determined for each treatment as a percentage of total mortality at the end of the whole experiment. At the end of the experiment, six broilers (three males and three females) were randomly picked from each replication for carcass evaluation. Dressing percentage was calculated as percent of live weight after bleeding and de-feathering. Eviscerated percentage was calculated by removing the viscera, head, shank, trachea and lungs but with giblets (heart, liver, gizzard) and skin and expressed as percent of live weight. The abdominal fat and breast meat weight were measured individually and equated with percent live weight. Drumstick and thigh together were measured and expressed as percent of the live weight.

Partial budget analysis

It was done according to Upton, (1979) to determine the economic importance of using sugar syrup. The cost of sugar syrup and maize was 2 birr per liter and 4 birr per kilo gram, respectively. Total variable cost includes the cost of chicks, feeds and the supplemented vitamin premix during the whole experiment for each treatment groups. Total return (TR) was considered as the difference in sale and purchase price. The net income (NI) was expressed by subtracting total variable cost (TVC) from total return (TR). The change in net income (ΔNI) was expressed as the difference between the changes in total return (ΔTR) and total variable cost (ΔTVC). The marginal rate of return (MRR) measures the increase in net income (ΔNI) related with each additional unit of expenditure (ΔTVC) expressed in percentage. The sale of chicks' to cost of feed ratio was also calculated to evaluate profitability and use efficiency of rations.

Statistical analysis

Data of the experiment was subjected to analysis of variance using the General Linear Model (GLM) procedure SAS (2009). Differences among treatment means were compared using least significant difference (LSD) test.

RESULTS

Laboratory result showed that the energy content of sugar syrup and maize was 3752.98 and 3752.84 kcal/kg, respectively and fiber content of sugar syrup was zero. This makes sugar syrup to be an effective energy feed and a good potential substitute for maize in poultry

Table 1. Chemical composition of feed ingredients.

Chemical composition	Maize	Wheat short	Soybean meal	Noug seedcake	Sugar syrup
DM (%)	87.60	89.10	93.90	92.70	66.30
Ash (%DM)	2.10	3.90	5.50	6.10	5.60
EE (%DM)	3.90	4.95	11.48	6.20	0.56
CF (%DM)	3.66	5.90	5.68	17.28	0.00
CP (%DM)	6.85	14.43	40.83	30.23	1.75
P (%DM)	0.63	0.93	0.63	1.12	0.02
Ca (%DM)	0.79	0.67	0.28	0.46	1.07
ME (kcal/kg DM)	3752.84	3537.83	3847.30	2506.70	3752.98

DM = Dry Mater; EE = Ether Extract; CF = Crude Fiber; CP = Crude Protein; P = Phosphorus; Ca = Calcium; ME = Metabolizable Energy.

Table 2. Chemical composition of experimental rations.

Treatment	DM (%)	Ash (%DM)	EE (%DM)	CF (%DM)	CP (%DM)	Ca(%DM)	P(%DM)	ME (Kcal/kgDM)
Starter diet								
T_1	91.20	9.20	4.10	7.60	22.60	0.91	0.80	3123
T_2	91.20	9.00	3.50	7.40	22.80	0.95	0.70	3120
T_3	91.20	9.10	3.50	7.30	21.80	1.10	0.60	3123
T_4	91.20	10.60	3.20	6.70	22.50	1.00	0.60	3103
T_5	91.30	10.50	3.30	6.70	22.00	1.20	0.60	3107
Finisher diet								
T_1	90.30	7.50	4.10	7.30	20.00	0.90	0.60	3222
T_2	90.60	7.20	4.00	7.30	20.60	1.20	0.50	3227
T_3	90.30	7.50	3.95	7.20	20.90	1.10	0.50	3223
T_4	90.30	7.50	3.50	6.90	20.40	1.00	0.60	3221
T_5	90.40	7.60	3.42	6.80	20.00	0.90	0.50	3220

DM = Dry mater, EE = Ether Extract; CF = Crude fiber; CP = Crude Protein; P = Phosphorus; Ca = Calcium; ME = Metabolizable Energy; T1 = 0% of maize substituted by sugar syrup; T2 = 7% of maize substituted by sugar syrup; T3 = 14% of maize substituted by sugar syrup; T4 = 21% of maize substituted by sugar syrup; T5 = 28% of maize substituted by sugar syrup.

ration. The nutrient composition of the each ingredients used during the experiment is indicated in (Table 1). Based on the chemical composition of the feed ingredients, ration formulation was done for each treatment group. After the trial chemical analysis of the experimental diets containing deferent proportion of sugar syrup was done as shown in (Table 2).

Feed consumption

The effect of feeding different substitution levels of sugar syrup for maize on DM and nutrient intake of broilers during starter, finisher phases as well as the whole growth period is shown in (Table 3). Average daily and total intake of DM, CP, and ME during the starter, finisher phases and for the whole experimental period was not affected (P>0.05) by treatment. This is an indication that substitution of maize by sugar syrup up to 28% did not have a significant impact on intake of DM and nutrients by broilers. The mean total feed intake by Hubbard broiler strains during the whole experimental period (49 days) was 3850 g/bird for mean total body weight gain of 1386.83 g/bird.

Body weight gain

The growth rate of the experimental chicks during starter, finisher and the whole growth period is presented in (Table 4). Body weight change and average daily weight gain were not affected (P>0.05) by treatment rations.

Feed and nutrient conversion ratio

As indicated in (Table 5) there was no significant difference (P>0.05) in feed and energy conversion ratio in broilers fed the starter and finisher rations. Protein conversion ratio was similar during the starter phase but it showed significant difference (P<0.05) among birds fed the finisher rations and was greater for T_2 than T_4 and T_5. Values for T_3 were also higher than T_5. However, T_1 was not significantly different (P > 0.05) from other groups. Feed conversion ratio (FCR) as well as protein and energy conversion ratio was significantly different (P<0.05) during the whole growth period.

Carcass parameters

There was no significant difference (P>0.05) in slaughter weight, dressed carcass, drumstick-thigh, breast meat weight and percentage as well as eviscerated carcass weight among treatment groups as shown in (Table 6). But there was significant difference (P<0.05) in eviscerated carcass percentage and broilers in T_2 and T_3

Table 3. Dry matter and nutrient intake of broilers fed diets with different substitution levels of sugar syrup for maize during the starter phase (1-28 days), finisher phase (29-49 days) and the whole growth period (1-49 days).

Parameter	Treatment						
	T1	T2	T3	T4	T5	P	SEM
Starter phase							
DM intake (g/bird)	1034	1143	1240	1195	1078	0.42	78.9
DM intake (g/bird/day)	36.9	40.8	44.3	42.7	38.5	0.42	2.82
Protein intake (g/bird/day)	11.7	13.0	13.5	13.4	11.9	0.59	0.88
ME intake (kcal/bird/day)	161.5	178.4	193.6	185.5	167.4	0.46	12.28
Finisher Phase							
DM intake (g/bird)	2663	3161	2723	2784	2228	0.29	256.0
DM intake (g/bird/day)	126.8	150.5	129.7	132.6	106.1	0.29	12.20
Protein intake (g/bird/day)	31.8	37.0	34.5	32.9	30.4	0.45	2.58
ME intake (kcal/bird/day)	489.8	579.6	531.5	518.9	489.8	0.69	40.96
Whole Period							
DM intake (g/bird)	3694	4304	3963	3980	3306	0.28	298.1
DM Intake (g/bird/day)	75.5	87.8	80.9	81.2	67.5	0.28	6.08
Protein intake (g/bird/day)	15.8	18.4	17.0	17.0	14.2	0.28	1.30
ME intake (kcal/bird/day)	237.7	276.7	254.8	255.8	212.5	0.28	19.2

Note: There was no significant difference between means in dry matter and nutrient intake among broilers during the whole experiment (P>0.05); SEM = Standard error of the mean; DM = Dry mater; ME = Metabolizabe energy; T1= 0% of maize substituted by sugar syrup; T2 = 7% of maize substituted by sugar syrup; T3 = 14% of maize substituted by sugar syrup; T4 = 21% of maize substituted by sugar syrup; T5 = 28% of maize substituted by sugar syrup.

Table 4. Body weight change of broilers fed diets with different substitution levels of sugar syrup for maize during the starter phase (1-28 days), finisher phase (29-49 days) and the whole growth period (1-49 days).

Parameter	Treatment					
	T1	T2	T3	T4	T5	SEM
Starter Phase						
Initial weight (g/bird)	54.8	56.7	54.7	54.5	55.2	0.52
Final weight (g/bird)	1018	952	993	1032	924	33.10
Weight change (g/bird)	963	895	938	978	869	33.40
ADG (g/bird/day)	34.4	32.0	33.5	35.0	31.0	1.20
Finisher Phase						
Initial weight (g/bird)	1018	952	993	1032	924	33.10
Final weight (g/bird)	1464	1417	1442	1528	1359	62.20
Weight change (g/bird)	446	465	449	496	435	42.20
ADG (g/bird/day)	22.3	23.3	22.6	25.0	21.7	2.08
Whole Period						
Initial weight (g/bird)	54.8	56.7	54.7	54.5	55.2	0.52
Final weight (g/bird)	1464	1417	1442	1528	1359	62.20
Weight change (g/bird)	1409	1361	1387	1474	1304	62.40
ADG (g/bird/day)	29.9	28.9	29.4	31.2	27.7	1.27

Note: There was no significant difference between means in body weight change during the whole experiment (P>0.05); ADG = Average daily body weight gain; SEM = standard error of the mean; g = gram; T1= 0% of maize substituted by sugar syrup; T2 = 7% of maize substituted by sugar syrup; T3 = 14% of maize substituted by sugar syrup; T4 = 21% of maize substituted by sugar syrup; T5 = 28% of maize substituted by sugar syrup.

had greater value than that of T_5. Abdominal fat weight and percent was greater ($P<0.05$) for T_1 and T_2 as compared to T_4 and T_5. Values for T_3 were also greater than T_5. There was no significant difference ($P>0.05$) in mortality percentage among the treatments.

Partial budget analysis

Net profits from broilers were determined based on the cost of feed each bird consumed from the respective treatments and chicks cost as shown in (Table 7). The

Table 5. Feed and nutrient conversion ratio of broiler fed diets with different substitution levels of sugar syrup for maize during the starter phase (1-28 days), finisher phase (29-49 days) and the entire growth period (1-49 days).

Parameter	Treatment					
	T1	T2	T3	T4	T5	SEM
Starter Phase						
Protein conversion ratio (g CPI/g gain)	0.25	0.29	0.29	0.28	0.27	0.02
Energy conversion ratio (kcal MEI/g gain)	3.4	3.9	4.1	3.8	3.8	0.26
FCR (g feed/g gain)	1.1	1.3	1.3	1.2	1.2	0.06
Finisher phase						
Protein conversion ratio (g CPI/g gain)	1.2^{abc}	1.4^{a}	1.3^{ab}	1.1^{bc}	1.0^{c}	0.07
Energy conversion ratio(kcal MEI/g gain)	20	22	19	18	16	1.08
FCR (g feed/ g gain)	6.1	6.8	6.0	5.6	5.1	0.34
Entire Period						
Protein conversion ratio (g CPI/g gain)	0.55^{b}	0.66^{a}	0.60^{ab}	0.56^{b}	0.53^{b}	0.0
Energy conversion ratio (kcal MEI/g gain)	8.3^{b}	10.0^{a}	9.0^{ab}	8.5^{b}	8.0^{b}	0.38
FCR (g feed/g gain)	2.6^{b}	3.2^{a}	2.8^{ab}	2.7^{b}	2.5^{b}	0.1

Note: Means followed by different superscript letters within a row are significantly different (P<0.05); SEM = Standard Error of the Mean; CPI = Crude Protein Intake; MEI = Metabolizable Energy Intake; g = gram; FCR = Feed Conversion Ratio.

Table 6. Carcass yield characteristics of broilers fed different substitution levels of sugar syrup for maize from 1-49 days of the trail period.

Parameter	Treatment						
	T1	T2	T3	T4	T5	P	SEM
Slaughter weight (g)	1500.0	1585.9	1512.4	1536.6	1430.8	0.37	53.9
Dressed carcass weight (g)	1319.2	1398.3	1330.7	1345.8	1245.6	0.30	49.50
Dressed carcass (%)	87.9	88.1	87.9	87.6	87.0	0.07	0.29
Eviscerated carcass weight (g)	999.2	1066.8	1009.5	1019.4	924.5	0.19	41.36
Eviscerated carcass (%)	66.4^{ab}	67.1^{a}	66.6^{a}	66.1^{ab}	64.4^{b}	0.013	0.56
Drumstick-thigh weight (g)	291.4	320.5	296.2	302.7	266.7	0.064	12.80
Drumstick -thigh (%)	19.4	20.2	19.5	19.6	18.7	0.067	0.36
Breast meat weight (g)	320.9	338.2	336.0	345.2	308.8	0.497	15.90
Breast meat (%)	21.3	21.4	22.2	22.4	21.5	0.424	0.50
Abdominal fat weight (g)	31.1^{a}	33.4^{a}	28.1^{ab}	19.1^{bc}	15.8^{c}	0.0041	3.74
Abdominal fat (%)	1.99^{a}	2.13^{a}	1.78^{ab}	1.27^{bc}	1.07^{c}	0.0037	1.10

Note: Means followed by different superscript letters within a row are significantly different (P<0.05); SEM = Standard Error of the Mean.

net return (NR) of broilers fed in T_5 was lower than others. The highest NR was observed in T_2 followed by T_4 and T_3. The reasons for the low and high NR observed in the groups could be due to the feed composition and the differences in the number of broilers that reach market. When MRR is considered T_4 was more profitable than others. The birds in T_4 and T_5 score higher chicks' sale to feed cost than T_2, T_1 and T_3. The result indicates that when other factors that affect broiler performance are controlled increasing the substitution level of sugar syrup increases profit.

DISCUSSION

From the current trial the actual DM percentage of sugar syrup was 66.3% which was in agreement with the finding of Braun and de Lange (2004) who noted 65% DM in sugar syrup, but was lower than the DM% reported by John (2008) which was 80%. As to the current result John (2008) indicated that sugar syrup contains no indigestible material and its energy value is the same to corn. The CP level was within the recommended levels 22.5% and 20.5% for Hubbard broilers during the starter and finisher phases, respectively **(**NRC, 1994; Hellwig and Ranson, 2006). The ME value of the diets in this trial was not far from the recommended value of 3100 and 3200 kcal/kg for the starter and finisher phases (NRC, 1994). Inline to this experiment non significant difference in feed intake within groups fed 0%, 5%, 10% and 15% sugar syrup in the ration was reported by (John, 2010). The previous results reported by Melaku, (2011) and Zena, (2011) indicated mean total feed intake of 4947.97 and 4118.1 g/bird for an average total body weight gain

Table 7. Partial budget analysis for broilers fed different substitution levels of sugar syrup for maize during 1-49 days age.

Variable	Treatment				
	T1	T2	T3	T4	T5
Cost of day old chicks (ETB/Treatment)	360	360	360	360	360
Starter feed consumed (kg)	28.9	32.0	34.7	33.5	30.2
Finisher feed consumed (kg)	73.9	86.0	79.3	79.6	66.1
Cost of starter feed (ETB)	4.20	4.14	4.07	4.01	3.95
Cost of finisher feed (ETB)	3.95	3.88	3.80	3.73	3.65
Total feed cost (ETB)	513.3	566.2	542.5	531.2	460.6
Total variable cost(ETB)	873.3	926.2	902.5	891.2	820.6
Number of broilers reach market	47.0	53.0	49.0	52.0	44.0
Selling price/bird (ETB)	65.0	65.0	65.0	65.0	65.0
Total return	3055.0	3445.0	3185.0	3380.0	2860.0
Net return	2187.7	2518.8	2282.5	2488.8	2039.4
ΔNR	-----	331.1	94.8	301.1	-148.3
ΔTVC	-----	52.9	29.2	17.9	-52.7
MRR (%)	------	626	325	1682	281
Chicks sale/feed cost	5.95	6.08	5.87	6.36	6.21

ETB = Ethiopian Birr, ΔTVC = change in total variable cost, ΔNR = change in net return; MRR = marginal rate of return; T1 = 0% of maize substituted by sugar syrup; T2 = 7% of maize substituted by sugar syrup; T3 = 14% of maize substituted by sugar syrup; T4 = 21% of maize substituted by sugar syrup; T5 = 28% of maize substituted by sugar syrup.

of 2246.65 and 1790.1 g/bird, respectively for Hubbard broiler strains during 49 days of experiment. These were higher than the current result obtained which was 3850 g/bird for mean total body weight gain of 1386.83 g/bird for the same breed. The difference may be due to the composition of the feeds used and the body weight gain of the birds. But similar to the results of this study, John (2011) failed to note a significant difference in growth rate of birds fed diets containing no sugar syrup and 15% sugar syrup. In line with the current study Hashim *et al*. (2013) reported that there are no significant differences ($P > 0.05$) among breast or thigh meats fed rations with different levels of sugar syrup.

Sasidhar, (2006) reported that the main concern in producing broilers is the excessive accumulation of carcass fat, particularly in the abdominal area, as this fat is not accepted by consumers it becomes a waste product to the processor. As indicated in (Table 6) there was significant difference ($P<0.01$) in abdominal fat weight and percent of broilers. Abdominal fat weight and percent was greater ($P<0.05$) for T_1 and T_2 as compared to T_4 and T_5. Values for T_3 were also greater than T_5. The current result is in accordance with John (2008) who reported that sugar syrup contributes energy with insignificant addition of lipids as a result of which formation of cholesterol in egg and meat could be minimized.

The current result highlights that sugar syrup is a good concentrated source of energy that can effectively replace maize in broiler diets if cost is reasonably cheaper than maize. Gillespie (2004) reported that feed conversion ratio is affected by a number of factors including genetic makeup of the strain, feed type, temperature and management of the flock. But the result obtained from this experiment in feed conversion ratio (FCR) is in agreement with FAO (2006) who reported 2-4 feed conversion ratios for poultry. In accordance with the current result John (2008) also reported that sugar syrup contributes energy with insignificant addition of lipids as a result of which formation of cholesterol in egg and meat could be minimized. Schumacher *et al*. (1986) also reported that sucrose in the diet improved dressing percentage and reduced fat thickness.

Conclusions

The percent mortality, mean daily and total DM, CP and ME intake as well as body weight gain of broilers fed on the diets containing different levels of sugar syrup were not significantly different ($P>0.05$) among treatments during starter, finisher and the entire growth period. Significant difference ($P<0.05$) was observed in feed as well as energy and protein conversion ratio (FCR) among treatment rations during the entire growth period. Slaughter weight, eviscerated weight, drumstick-thigh weight and percent as well as breast weight and percent showed non-significant difference ($P>0.05$) among birds fed different rations but eviscerated carcass percentage showed significant difference ($P<0.05$) among treatments. There was significant difference ($P<0.01$) in abdominal fat weight and percent among treatment rations. Finally, this study highlighted that sugar syrup can substitute maize up to 28% without any impact on feed intake and performance of broilers. Thus, sugar syrup can be an important energy source for the feeding

of broilers, which can reduce the human-animal competition for the conventional energy source for poultry, i.e., cereal grains. However, further research should be conducted to determine the effect of higher inclusion level of sugar syrup on broilers performances.

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