EFFECT OF REPLACING YELLOW CORN WITH DIFFERENT LEVELS OF SOME UNTRADITIONAL ENERGY SOURCES IN RATIONS ON LAYING HENS PERFORMANCE

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Abstract

A total of 270 Mamoura chickens (243 hens and 27 cocks) of 24 weeks old were randomly divided into 9 triplicate groups (10 birds X 3 replicats X 9 treats). The replicate contains one cock and nine hens. They were reared in conventional floor brooder houses and fed the experimental diets for 24 weeks experimental period. Nine experimental diets were formulated in which the first (T1) contained yellow corn (YC) and soybean meal (SBM) as the main sources of energy and protein, respectively. In the other diets YC in T1 was replaced by either sorghum grains (SG) or cassava root meal (CRM) at substitution levels of 25 % (T2 and T6, respectively), 50 % (T3 and T7, respectively), 75 %(T4 and T8, respectively) and 100% (T5 and T9, respectively). All diets were adjusted to be iso-nitrogenous of about 16 % CP and iso-caloric of a bout 2800 Kcal ME/Kg. Laying hen performance, egg quality, fertility and hatchability were measured. A metabolism trial was also carried out to determine the nutrient digestibilities and metabolizabilities of the experimental diets.

The obtained results showed that, there were no significant differences between the control group and those of 25 and 50 % substitution levels of either SG or CRM for YC in live body weight, weight gain, egg production, feed conversion, fertility, hatchability and economic efficiency which significantly surpassed those of 75 and 100 % replacement. No significant differences were found among all treatments in egg weight, feed intake and measurements of egg quality except yolk colour which gradually decreased with the increase in substitution level of SG or CRM. Birds fed on the control diet and those fed on 25 and 50 % substitution levels of SG or CRM on the expense of YC resulted in significant better digestibility and metabolizability values than those on 75 and 100 % substitution levels. With the exception of some significant differences in concentration of plasma calcium and phosphorus, no significant differences were detected among all dietary treatments in concentration of plasma total protein, total lipids, glucose and cholestrol or in that of blood hemoglobin and also in hematocrit value.

In conclusion, when the performance of laying hens are put into consideration in addition to the economic efficiency, it appears that, either SG or CRM can be incorporated in layer diets at a substitution level up to 50 % for YC without any deleterious effects. This is of great benefits specially in case of yellow corn shortage.

INTRODUCTION

Yellow corn (YC)is one of the most important sources of energy for poultry rations. It represents about 60 - 70 % of the ration, therefore the raising in its price from time to time owing to its universal use was reflected on rations prices and hence, on the final products of poultry, *i. e.* meat or egg. It is still difficult to produce sufficient amount of YC in Egypt due to the limited cultivable areas, and the imported amounts did not cover the great gab between the demand and supply of YC. However, many attempts have been carried out to search for alternative cheap sources of energy to replace YC in poultry rations.

Sorghum grains (SG) could be considered a promising cereal grain for livestocks. It is cultivated widely in upper Egypt and may be used to replace a part of YC in poultry diets. Douglas and Sullinan (1987) and Fayek *et al.* (1989) reported that SG could totally replace YC in poultry rations. Branton *et al.* (1989) found a significant reduction in egg production when SG completely replaced YC in laying hen diets. Mandal *et al.* (1993) reported that SG could constitute 37.5 % of layer diets, (in place of YC,) without affecting production traits.

Tapioca or cassava root meal (CRM) is very rich in starch and could be considered as one of energy sources that can be used in poultry rations (Vogt and Penner, 1963). Schiltyssek (1989) used 0, 8, 18 and 24 % CRM in place of YC in diets for brown laying hybrids and found no differences in laying performance, feed intake and feed conversion among treatments. Castro and Costa (1991) found no significant differences among the groups of laying hens fed on diets containing 0, 10, 20, or 30 % CRM on the expense of YC in egg production and egg weight, slight depression in feed conversion for the groups of 10 and 20 replacement. Tewe *et al.* (1992) reported that CRM (HCN < 100 mg/Kg) as a source of carbohydrate and energy can completely replace YC in poultry finishing diets.

The study reported herein aimed at investigating the possibility of using different levels of SG or CRM as untraditional sources of energy to replace YC in laying hen diets and the effect of such replacement on laying hens performance, fertilty, hatchability, nutrient digestibilities and some blood constituents taken in consideration the econmic efficiency.

MATERIALS AND METHODS

The experimental work of the present study was carried out at EL-Serw Animal Production Research Farm, Animal Production Research Institute, ARC, Egypt. A total of 270 Mamoura chickens (243 hens and 27 cocks) 24 weeks of age were randomly devided into 9 triplicate groups (10 birds X 3 replicates X 9 treatments). Each replicate contains one cock and nine hens. They were reared in conventional floor brooder houses and fed on the experimental diets for 24 weeks experimental period. Nine experimental diets were formulated (Table 1) in which the first (T1) contained mainly YC and SBM as sources of energy and protein, respectively and served as a control diet (T1). In the other diets YC in T1 was replaced by either sorghum grain (SG) or cassava root meal (CRM) at levels of 25 % (T2 and T6 respectively), 50 % (T3 andT7 respectively), 75 % (T4 and T8 respectively) and 100 % (T5 and T9 respectively). All diets were adjusted nutritionally to be iso-nitrogenous of about 16 % CP and iso-caloric of about 2800 k cal ME/kg diet. Feed and water were offered daily *ad. lib.* and lighting durated for 16 h daily. All birds were kept under strict hygienic control by a veterinarian through - out the experiments. Data on body weight (BW), weight gain (WG), egg production (EP), feed intake (F1), egg weight (EW), egg mass (EM) and feed conversion (FC) were recorded. An economic study was carried out to deduce the economic use of the experimental diets for egg production. At 32 weeks of age, a total of 162 eggs, i. e. 18 eggs from each treatment, was taken to determine some egg quality parameters as described in details by Hussien (1998). At 44 weeks of age, a total of 972 eggs, i. e. 108 eggs from each treatment, was collected in order to evaluate fertility, hatchability and embryonic mortality at 18 and 21 days of incubation. At the end of the experiment, 9 metabolism trials were carried out using 3 cocks from each treatment to estimate nutrient digestibilities, metabolizabilities and feeding values of the experimental diets. The chemical analysis of the experimental diets, excreta and the edible parts of fresh eggs were carried out according to A. O. A. C. (1980), while the method of Jakobsen *et al.* (1960) was used for separating fecal protein in excreta samples. Statistical analysis was carried out using the general linear model program of SAS (1990).

RESULTS AND DISCUSSION

Laying hen performance Results of laying hen performance are summarized in Table 2. All treatments commenced with hens of similar initial BW at 24 weeks of age, while at the end of the experiment (48 weeks) the BW of hens was significantly influenced by dietary treatments. Birds that fed the control diet (T1) and those of SG and CRM at substitution levels of 25 and 50 % (T2 & T3 and T6 & T7, respectively) attained statistically similar final BW and significantly surpassed those of 75 and 100 % substitution levels(T4 & T5 and T8 & T9, respectively). Results of WG showed the same trend as that of BW.

Concerning total EP, percentage EP and EM, no significant differences were observed in such parameters between the birds fed on the control- diet and those fed on diets containing 25 and 50 % SG or CRM instead of YC. While significant lower values were obtained with the birds fed on diets containing 75 and 100 % SG or CRM instead of YC, without significant differences among them. No significant differences were detected among all dietary treatments with either EW or FI. The best FC values were attained with T1 and those of T2, T3, T6 and T7 with no significant differences among them. The lower values, however, were obtained by the birds of T4, T5, T8 and T9 with no significant differences among them.

It is commonly noticed that the use of either SG or CRM at levels up to 50 % in place of YC in layer diets did not affect laying hen performance, while, the use of substitution levels of 75 and 100 % resulted in lower hen performance. This might be due to the persence of some antinutritional factors such as tannins in SG and HCN in CRM which may be responsible for the inferior performance at the higher substitution levels. These findings are in good agreement with those of Park *et al.* (1985) and Mandal *et al.* (1993) for SG and Enriquez and Ross (1974) and Ademosun and Eshiett (1980) for CRM.

Fertility, hatchability and embryonic mortality results of fertility, hatchability and embryonic mortality (Table 3) took statistically the same trend as that in laying hen performance, since the groups of substitution levels of SG or CRM at 25 and 50 % (T2 & T3 and T6 & T7, respectively) gave similar egg fertility, hatchability and embryonic mortality values as those of the control group (T1). While significantly lower values of such parameters were found with the groups of 75 and 100 % substitution levels of SG a CRM on the expense of YC.

Nutrient digestibility and metabolizability as shown in Table 4, values of DM ratio ranged between 0.33 and 0.34 with no significant differences among all dietary treatments. Also no significant differences were detected among all dietary treatments in the metabolizability of DM, NFE and ash, while significant differences were found in

EE metabolizability and CP and CF digestibility among the dietary treatments. The clear observation is that the control group and those of 25 and 50 % substitution levels of SG or CRM in place of YC recorded similar values of nutrient digestibilities and metabolizability surpassing those of 75 and 100 % substitution levels. These results are in harmony with those of the performance results. It may be said that portion of the reason of the laying performance reduction that observed when the substitution levels of either SG or CRM for YC in the diets was increased than 50 % may be attributed to the lower extent of nutrients utilization and digestibility.

Egg quality data of egg quality and chemical composition of the edible parts of fresh eggs are shown in Tables 5 and 6. No significant differences were detected among all dietary treatments for all studied parameters with the exception of those found in egg yolk colour. The yolks of eggs produced from the birds fed on the control diet had the deepest yellow colour and differed significantly from those of the other dietary treatments. Gradual paler egg yolk colour was significantly observed as the substitution level of SG or CRM increased. The most pale color was observed in eggs produced from hens fed diets containing 100 % SG or CRM in place of YC. This was expected, since it is well known that SG are poor in carotene and xanthophyll as compared to YC (Titus and Fritez, 1971) whereas CRM contains no xanthophyll pigments (Singh, 1981).

Blood constituents Table 7 shows that with the exception of some significant differences that observed in concentration of plasma calcium and phosphorus, no significant differences were detected among all dietary treatments in the concentration of plasma total protein, total lipids, glucose, cholesterol or blood hemoglobin and also in hematocrit value.

It was noticed that increasing the level of SG was followed by decrease in plasma phosphorus content while increasing CRM level was followed by increase in such parameter. No clear cut trend was observed in plasma calcium content for the dietary treatments.

The other blood constituents were not affected by the dietary treatments . These findings are in agreement with those of Raya *et al.* (1990) using Dokki 4 and Rhode Island red laying hens .

Economic efficiency(EEF) data on EEF (Table 8) revealed that the diet containing CRM at substitution level of 25 % for YC (T6) recorded the best value followed insignificantly by those of the control diet (T1) and the diets containing SG or CRM at substitution levels of 25 % For YC (T2) and 50 % for YC (T3 and T7). The lowest EEF values were observed with diets of 75 and 100 % SG or CRM in place of YC (T4 & T5 and T8 & T9, respectively), with no significant differences among them. The inclusion rate of corn oil, in order to equaliz ME in the diets, is the main reason affecting poor EEF when the substitution levels were over 50 %.

It could be concluded that SG or CRM can economically be incorporated in hen diets at a substitution level up to 50 % for YC without any deleterious effect on the performance of laying hens. This is of great benefits specially in case of shortage in yellow corn.

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Table 1. composition and chemical analysis of the experimental diets of different energy sources.

Treatments	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9
Ingredients:	100% YC	25 % SG	50 % SG	75 % SG	100 % SG	25 % CRM	50 % CRM	75 % CRM	100 % CRM
Yellow corn	68.00	51.00	34.00	17.00	00.00	51.00	32.00	15.00	00.00
Soybean meal (44 %)	16.67	15.50	14.50	13.50	12.00	19.47	21.97	24.97	26.95
Sorghum grain (SG)	----	17.00	34.00	51.00	68.00	----	----	----	----
Cassava root meal	----	----	----	----	----	16.50	32.00	45.00	57.00
Fish meal (72 %)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Weat bran	3.50	3.00	3.70	4.40	5.20	----	----	----	----
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Ground limestone	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Vit. & Min. Premix*	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Common Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
DL-Mcthionine	0.03	0.05	0.08	0.10	0.12	0.03	0.03	0.03	0.05
L-Lysinc	---	---	---	---	---	---	---	---	---
Corn oil	---	0.45	0.72	1.00	1.38	---	1.00	2.00	3.00
Total	100	100	100	100	100	100	100	100	100
Determined analysis % :									
Dry matter (DM)	89.03	88.54	88.59	88.57	88.73	88.60	88.61	89.30	89.35
Crude protein (CP)	16.36	16.20	16.42	16.19	16.08	16.18	16.17	16.34	16.32
Ether extract (EE)	3.18	3.35	3.14	3.28	3.36	3.10	3.10	3.38	3.37
Crude fiber (CF)	4.28	4.31	4.32	4.50	4.56	4.30	4.32	5.00	5.02
N-free extract (NfE)	48.75	48.05	48.34	48.25	48.40	48.70	48.70	48.47	48.58
Ash	16.46	16.63	16.37	16.35	16.33	16.32	16.32	16.11	16.06
Gross nergy, Kcal/g DM	3.950	3.928	3.958	3.921	3.884	3.935	3.932	3.962	3.894
Calculated values:	16.11	16.10	16.11	16.12	16.05	16.06	15.97	16.20	16.13
Crude protein %	2802	2811	2806	2802	2803	2795	2800	2803	2820
ME, Kcal/Kg	174	175	174	174	175	174	175	173	175
C/P ratio	3.09	3.43	3.59	3.77	4.05	2.55	2.98	3.47	4.03
Ether extract %	3.00	2.97	2.99	2.98	2.99	3.24	3.63	4.01	4.32
Crude fiber %	3.54	3.54	3.54	3.54	3.54	3.54	3.55	3.56	3.56
Ca %	0.69	0.69	0.69	0.70	0.70	0.68	0.69	0.69	0.70
Total P %	0.83	0.81	0.79	0.77	0.75	0.87	0.91	0.97	1.00
Lysine %	0.34	0.34	0.34	0.34	0.33	0.34	0.34	0.34	0.36
Methionine %	0.59	0.58	0.59	0.58	0.58	0.58	0.58	0.57	0.58
Methionine + Cystine									

*Each 2.5 kg of Vit. & Min. mixture contains: Vit. A 12000,000IU, Vit. D_3 2000,000IU, Vit. E 10,000mg, Vit. K_3 2000mg, Vit. B_1 1000mg, Vit. B_2 4000mg, Vit. B_6 1500mg, Vit. B_{12} 10mg, Pantothenic acid 10,000mg, Nicotinic acid 20,000 mg, Folic acid 1000mg, Biotin 50mg, Choline chloride 500,000mg, Copper 10,000mg Iodine 1000mg, Manganese 55,000mg, Iron 30,000mg, Zinc 55,000mg and Selenium 100mg.

Table 2 . Performance of Mamoura laying hens fed the experimental diets of different energy sources.*

Performance criteria	Treatments								
	T1	T2	T3	T4	T5	T6	T7	T8	T9
	control	25 % SG	50 % SG	75 % SG	100 % SG	25 % CRM	50 % CRM	75 % CRM	100 % CRM
Initial LBW (24 wks), g	1806 ± 3	1811 ± 7	1813 ± 9	1799 ± 6	1798 ± 5	1806 ± 2	1814 ± 5	1804 ± 3	1800 ± 1
Final LBW (48 wks), g	2167 ± 21^a	2167 ± 20^a	2169 ± 21^a	1978 ± 7^b	1978 ± 5^b	2167 ± 16^a	2168 ± 18^a	1980 ± 7^b	1979 ± 6^b
Weight gain , g	361 ± 18^a	356 ± 13^a	356 ± 24^a	182 ± 13^b	180 ± 8^b	361 ± 18^a	354 ± 13^a	176 ± 4^b	179 ± 7^b
Egg production egg/ bird	114.6 ± 2^a	114.4 ± 2^a	114.4 ± 2^a	106.5 ± 2^a	104.2 ± 2^b	114.5 ± 2^a	114.5 ± 2^a	107.0 ± 2^b	102.3 ± 2^b
Egg production% (hen-day	68.10 ± 1.2^a	68.12 ± 1.2^a	68.40 ± 1.3^b	63.40 ± 1.3^b	62.04 ± 1.2^b	68.16 ± 1.0^a	68.17 ± 1.2^a	63.68 ± 1.2^b	60.84 ± 1.2^b
Average egg weight, g	51.19 ± 0.7	51.14 ± 0.4	50.94 ± 0.9	49.08 ± 0.2	49.44 ± 0.8	50.65 ± 0.5	51.01 ± 0.8	49.22 ± 0.3	49.95 ± 0.3
Average egg mass , kg	5.862 ± 0.1^a	5.852 ± 0.1^a	5.829 ± 0.2^a	5.226 ± 0.1^b	5.151 ± 0.2^b	5.801 ± 0.1^a	5.839 ± 0.2^a	5.267 ± 0.1^b	5.108 ± 0.1^b
Feed intake, kg/brid	16.70 ± 0.7	16.76 ± 0.7	16.68 ± 0.7	16.80 ± 0.8	16052 ± 0.7	16075 ± 0.7	16074 ± 0.7	16.84 ± 0.8	16.53 ± 0.8
Daily feed intake, g/brid	99.39 ± 4	99.75 ± 4	99.28± 4	99.98 ± 5	98.36± 4	99.68± 4	99.64 ± 4	100.21± 4	98.40 ± 4
Feed conversion (kgs feed/kg eggs)	2.848 ± 0.1^b	2.864 ± 0.1^b	2.861 ± 0.1^b	3.214 ± 0.1^a	3.208 ± 0.1^a	2.887 ± 0.1^b	2.867 ± 0.1^b	3.196 ± 0.1^a	3.236 ± 0.1^a

* a, b: Means within the same row with different superscripts are significantly different ($p \leq 0.05$).

Table 3. Fertility and hatchability of eggs produced by Mamoura laying hens fed the experimental diets of different energy sources.*

Experimental diets :	Fertility %	Hatchability %
T_1 (100 % YC)	94.44 ± 1.6^a	83.29 ± 1.2^a
T_2 (25 % SG)	93.52 ± 1.9^a	82.22 ± 1.4^a
T_3 (50 % SG)	93.52 ± 0.9^a	84.13 ± 1.2^a
T_4 (75 % SG)	86.11 ± 1.6^b	70.95 ± 0.5^b
T_5 (100 % SG)	85.18 ± 0.6^b	70.63 ± 0.6^b
T_6 (25 % CRM)	94.44 ± 1.6^a	83.35 ± 0.8^a
T_7 (50 % CRM)	95.37 ± 0.9^a	83.47 ± 1.1^a
T_8 (75 % CRM)	84.26 ± 2.5^b	70.28 ± 0.9^b
T_9 (100 % CRM)	84.26 ± 1.9^b	70.30 ± 0.7^b

* a,b: Means within the same column with the same superscripts are significantly different ($P \leq 0.05$).

Table 4. Nutrient metabolizability and digestibilty of mamoura cocks fed on the experimental diets of different energy sources.*

Item	Treatments								
	T1	T2	T3	T4	T5	T6	T7	T8	T9
	control	25 % SG	50 % SG	75 % SG	100 % SG	25 % CRM	50 % CRM	75 % CRM	100 % CRM
Body weight, g	2950 ± 105	2860 ± 64	2320 ± 191	2680 ± 234	2690 ± 73	3170 ± 145	2850 ± 134	2520 ± 190	2450 ± 39
Daily DM balance :									
Feed intake DM/bird/day, g	163.67 ± 1.8	160.00±3.5	161.33±2.8	159.33 ±1.5	158.33 ± 1.9	161.67 ± 2.6	163.33 ± 1.9	160.00 ± 1.2	158.00 ±1.4
Excreta DM/bird/day, g	55.78 ± 1.5	54.27 ± 2.0	54.56±1.9	53.08 ± 1.4	52.58 ± 1.5	54.19 ± 1.8	54.74 ± 1.5	53.13 ± 1.63	52.47 ±1 . 1
DM ratio	0.341 ± 0.006	0.339 ± 0.005	0.338 ± 0.006	0.333 ± 0.006	0.332 ± 0.006	0.335 ± 0.006	0.335 ± 0.006	0.332 ± 0.006	0.332 ± 1.2^{b}
Utilization (metabolizability) %:									
Ash retention	69.32 ± 5.6	50.59±5.3	55.63 ± 5.8	65.78 ± 5.8	66.23 ± 5.9	52.28 ± 5.7	56.77 ± 5.8	67.83 ± 6.0	67095±6.2
N- retention.	48.63 ± 0.7^{a}	48.69±0.7^{a}	47.68 ± 0.7^{a}	44.79 ± 0.7^{b}	44.79 ± 0.7^{b}	48.68 ± 0.7^{a}	47.644 ± 0.7^{a}	44.83 ± 0.7^{b}	44.83±0.7^{b}
Ether extract (EE)	89.55 ± 0.5^{a}	89.56±0.5^{a}	88.30 ± 0.7^{a}	85.45 ± 0.7^{b}	85.44 ± 0.7^{b}	89.20 ± 0.7^{a}	88.38 ± 0.7^{a}	85.49 ± 0.7^{b}	85.38±0.7^{b}
N-free extract (NFE)	79.90 ± 0.5	79.90 ± 0.6	78.93 ± 0.6	77.89 ± 0.6	77.89 ± 0.6	79.90 ± 0.6	78.91 ± 0.6	77.90 ± 0.6	77.85±0.6
Dry matter (DM)	65.93 ± 0.6	66.10 ± 0.5	66.20 ± 0.6	66.70 ± 0.6	66.80 ± 0.6	66.50 ± 0.6	66.50 ± 0.6	66.80 ± 0.6	66.80±0.6
Digestion coefficient %:									
Crude protein (CP)	89.31 ± 0.7^{a}	89.29 ± 0.7^{a}	88.31± 0.7^{a}	85.31 ± 0.7^{b}	85.35± 0.7^{b}	89.32± 0.7^{a}	88.30 ± 0.7^{a}	85.36 ± 0.7^{b}	85.32±0.7^{b}
Crude fiber (CP)	19035 ± 0.4^{a}	19.31 ± 0.5^{a}	18.19 ± 0.5^{a}	15.10 ± 0.6^{b}	15.14 ± 0.6^{b}	19.29 ± 0.4^{a}	18.26± 0.5^{a}	15.10 ± 0.6^{b}	15.11±0.6^{b}
Organic matter (OM)	73.55 ± 0.6^{a}	73.52 ± 0.6^{a}	72.47 ± 0.6^{ab}	60.71 ±0.6^{bc}	70.70 ± 0.6^{bc}	73.52 ± 0.6^{a}	72.51 ± 0.6^{ab}	70.37 ± 0.6^{c}	70.33±0.6^{c}
Energy :									
ME, kcal/kg (as fed)	2777 ± 13	2773 ± 8	2780 ± 26	2765 ± 22	2756 ±10	2786 ± 39	2776 ± 13	2762 ± 11	2770±5
Energy utilization %	78.98 ± 0.38	79.72 ± 0.22	79.30 ± 0.73	79.63 ± 0.62	79.99 ± 0.29	79.91 ± 1.12	79.67 ± 0.36	78.05 ± 0.3	79.61±0.15

* a- b: Means within the same row with different superscripts are significantly different ($p \leq 0.05$).

Table 5. Chemical composition of eggs produced by Mamoura laying hens fed the experimental diets of different energy sources.

Component	Experimental diets								
	T1	T2	T3	T4	T5	T6	T7	T8	T9
	control	25 % SG	50 % SG	75 % SG	100 % SG	25 % CRM	50 % CRM	75 % CRM	100 % CRM
Dry matter %	26.48 ± 0.13	26.47 ± 0.02	26.28 ± 0.05	26.42 ± 0.11	26.35 ± 0.09	26.25 ± 0.13	26.15± 0.03	26.46 ± 0.07	26.33 ± 0.09
Moisture %	73.52 ± 0.13	73.53 ± 0.02	73.72 ± 0.05	73.58 ± 0.11	73.65 ± 0.09	73.75 ± 0.13	73.85 ± 0.03	73.54 ± 0.07	73.67 ± 0.09
Crude protein %	12.94 ± 0.02	12.89 ± 0.04	12.73 ± 0.04	12.73 ± 0.04	12.76 ± 0.05	12.77 ± 0.05	12.81 ± 0.08	12.78 ± 0.05	12.76 ± 0.05
Ether extract %	10.60 ± 0.12	10.77 ± 0.22	10.70 ± 0.15	10.83 ± 0.07	10.70 ± 0.12	10.63 ± 0.12	10.47 ± 0.13	10.83 ± 0.09	10.77 ± 0.03
Ash %	1.23 ± 0.04	1.22 ± 0.04	1.24 ± 0.03	1.21 ± 0.05	1.24 ± 0.06	1.22 ± 0.08	1.18 ± 0.03	1.24 ± 0.01	1.21 ± 0.06
N-free extract %	1.71 ± 0.04	1.60 ± 0.22	1.61 ± 0.07	1.65 ± 0.05	1.64 ± 0.15	1.62 ± 0.13	1.69 ± 0.06	1.61 ± 0.09	1.60 ± 0.08

Table 6. Egg components and some egg quality measurements of eggs produced by Mamoura laying hens fed on the experimental diets of different energy sources.

Measurements	Treatments								
	T1	T2	T3	T4	T5	T6	T7	T8	T9
	control	25 % SG	50 % SG	75 % SG	100 % SG	25 % CRM	50 % CRM	75 % CRM	100 % CRM
Egg weight, g	53.11 ± 1.67	51.41 ± 1.04	53.64±6.63	53.10± 0.88	52.58 ± 0.53	50.18±1.01	52.59± 0.88	53.71± 1.24	52.53 ± 0.69
Shell weight, g	5.84 ± 0.40	5.73 ± 0.13	5.90±0.29	6.17 ± 0.03	5.90 ± 0.25	5.72 ± 0.16	5.96 ± 0.14	6.19 ± 0.18	5.72 ± 0.12
Shell weight, %	10.97 ± 0.46	11.15 ± 0.13	10.99±0.43	11.62± 0.21	11.23 ± 0.47	11.41 ± 0.54	11.34 ± 0.11	11.52 ± 0.13	10.89 ± 0.12
Yolk weight, g	15.86 ± 0.35	14.96 ± 1.07	16.11±0.09	16.20 ± 0.53	16.25 ± 0.17	15.29 ± 0.37	16.40 ± 0.18	16.81 ± 0.55	16.71 ± 0.14
Yolk weight, %	29.90 ± 0.92	29.04 ± 1.61	30.05±0.52	30.50 ± 0.53	30.90 ± 0.03	30.49 ± 0.85	31.19 ± 0.34	31.30 ± 0.63	31.82 ± 0.25
Albumen weight, g	31.41 ± 1.28	30.73 ± 0.50	31.63±0.49	30.73 ± 0.39	30.43 ± 0.39	29.17 ± 1.14	30.23 ± 0.54	30.71 ± 0.74	30.10 ± 0.47
Albumen weight, %	59.13 ± 0.99	59.81 ± 1.52	58.96±0.37	57.88 ± 0.34	57.87±0.49	58.09 ±1.28	57.48 ± 0.23	57.18 ± 0.75	57.29 ± 0.15
Egg shape index	0.782 ± .007	0.778 ± .004	0.762±.007	0.756 ± .012	0.766±.003	0.764 ± .005	0.763 ±.007	0.760 ±.006	0.762 ± .008
Haugh units	90.18 ± 0.46	90.18 ± 0.46	90.09 ± 0.88	89.27± 0.94	89.45±1.08	90.65± 0.44	90.23 ± 0.94	89.47 ± 0.90	89.77 ± 0.81
Shell thickness, mm	0.388 ± .008	0.389 ±.013	0.368 ±.006	0.393±.005	0.382±.009	0.368 ±.006	0.382 ±.007	0.391 ± .007	0.368 ± .011
Specific gravity	1.099 ±.009	1.097 ± .001	1.096 ±.002	1.099±.001	1.099±.001	1.098±.001	1.098 ±.000	1.100 ± .001	1.098 ± .001
Egg yolk color*	6.89 ± .39^{a}	5.28 ± .34^{bc}	4.83 ±.19^{c}	3.22 ±.15de	1.00±.00^{f}	5.50 ±.10^{b}	3.72 ± .05^{d}	2.78 ± .11^{e}	1.00 ± .00^{f}

* a - f: Means within the same row with different superscripts are significantly different ($p \leq 0.05$).

Table 7. Blood constituents for Mamoura laying hens fed on the experimental diets of different energy sources.*

Measurements	Experimental								
	T1	T2	T3	T4	T5	T6	T7	T8	T9
	control	25 % SG	50 % SG	75 % SG	100 % SG	25 % CRM	50 % CRM	75 % CRM	100 % CRM
Total protein, g/100 ml	4.50±0.21	4.87 ± 0.14	5.03 ± 0.25	4.94 ± 0.12	5.01 ± 0.13	5.01 ± 0.15	5.47 ± 0.37	4.67 ± 0.23	4.79±0.11
Blood hemoglobin, g/100 ml	11.11±0.58	11.61± 0.40	10.02± 0.49	9.12 ± 0.55	11.49 ± 0.37	9.86± 0.40	10.00 ± 0.56	9.95 ± 0.34	10.80±0.14
Total lipids, g/100 ml	1.35±0.12	1.45± 0.02	1.38 ± 0.16	1.21± 0.10	1.21 ± 0.13	1.33 ± 0.21	1.46 ± 0.08	1.19 ± 0.13	1.22±0.11
Plasma glucose, mg/100 ml	292.7±38	286.0±36	288.7± 28	277.0 ± 28	297.5± 57	319.4 ± 55	303.2 ± 24	291.5 ± 25	323.2±18
Plasma cholesterol, mg/100ml	133.6± 3.3	119.1± 9.5	136.4 ±11.0	139.3±10.3	110.3± 4.7	114.8 ± 8.5	128.6 ± 8.8	111.7± 6.6	137.1±6.2
Plasma calcium, mg/100 ml	14.08± 0.5^{ab}	15.57± 0.2^{ab}	16.08± 0.1^{ab}	15.33 ± 0.6^{ab}	15.07± 0.4^{bc}	14.05± 0.4^{c}	16.31 ± 0.4^{a}	15.42 ± 0.3^{ab}	15.59±0.3^{ab}
Plasma phosphorus, mg/100 ml	5.55± 0.2^{cd}	7.57± 0.4^{a}	6.29 ± 0.1^{bc}	6.18± 0.2^{bcd}	5.20± 0.5d	6.07± 0.3^{bcd}	6.22 ± 0.3^{bcd}	6.93 ± 0.2^{ab}	6.71±0.3^{ab}
Hematocrit value %	28.67± 0.9	31.67± 0.7	28.67± 1.2	31.00±1.2	29.67± 2.0	31.67± 2.2	30.33 ± 1.2	32.67 ± 0.3	29.67±1.2

*a - d: Means within the same row with different superscripts are significantly different ($p \leq 0.05$).

Table 8. Economic efficiency of Mamoura laying hens fed on the experimental diets of different energy sources.

Items	Experimental								
	T1	T2	T3	T4	T5	T6	T7	T8	T9
	control	25 % SG	50 % SG	75 % SG	100 % SG	25 % CRM	50 % CRM	75 % CRM	100 % CRM
Average feed intake (Kg/bird)	16.70	16.76	16.68	16.80	16.52	16.75	16.47	16.84	16.53
Price/kg feed, L. E. (1)	0.65	0.65	0.66	0.66	0.66	0.64	0.66	0.68	0.53
Total feed cost, L. E. (2)	10.86	10.89	11.01	11.09	10.90	10.72	11.05	11.45	11.57
No. of eggs prodused	113	115	115	106	104	115	115	107	102
Price of one egg, L. E. (3)	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Total revenue, L. E.	17.25	17.25	17.25	15.90	16.60	17.25	17.25	16.05	15.30
Economic efficiency, EEF*	0.588 ± 0.04^{a}	0.584 ± 0.04^{ab}	0567 ± 0.05^{ab}	0.434 ± 0.04^{bc}	0.431 ± 0.04^{bc}	0.609 ± 0.05^{a}	0.561 ± 0.04^{ab}	0.402 ± 0.04^{c}	0.322 ± 0.03^{c}
Relative EEF, (4)	100	99.32	96.43	73.81	73.30	103.57	95.41	68.37	54.76

(1) L. E. = one pound of Egyptian currency = 100 piasters.

(2) According to the prices of different ingredients available in A. R. of Egypt at the experimental time (1998).

(3) According to the local market price at the experimental time (1998).

(4) Assuming that the relative EEF of the control diet (T1) equals 100.

* a-c: Means within the same row with different superscripts are significantly different ($p \leq 0.05$).

تأثير إحلال الذرة الصفراء بنسب مختلفة من بعض المصادر الغير تقليدية للطاقة فى العلائق على الاداء الانتاجى للدجاج البياض

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أستخـدم فى هذه الدراسة عدد ٢٧٠ طائر معمورة (٢٤٣ دجاجـة + ١٨ ديكـاً) عمـر ٢٤ أسبوعاً ، قسمت عشوائيا إلى ٩ مجموعات ثلاثية (١٠ طيور x ٣ مكررات x ٩ معـاملات) ، كـل مكرر يحتوى على ديك وتسع دجاجات . ربيت الطيور فى حظائر مناسبة تربية أرضية تحت ظروف رعاية واحدة وغذيت على علائق التجربة لمدة ٢٤ أسبوعاً فترة تجريبية .تم تركيب عدد ٩ علائـق تجريبية أحتوت الاولى منها (م١) على ذرة صفراء وكسب فول صويا كمصادر رئيسـية للطاقـة والبروتين على التوالى وأستخدمت كعليقة مقارنة (كنترول) . فى العلائق الاخرى تم إحـلال الـذرة الصفراء بأى من حبوب السورجم (الذرة الرفيعة) أو مسحوق الكاسافا (التبيوكا) بمـستويـات إحـلال ٢٥ % (م٢ ، م٦) ، ٥٠ % (م٣ ، م٧) ، ٧٥ % (م٤ ، م٨) واخـيرا ١٠٠ % (م٥ ، م٩) على التوالى . وضبطت العلائق غذائيا بحيث تكون متساوية فى محتواهـا من البروتيـن (١٦ % بروتين خام) ، الطاقة (٢٨٠٠ كيلو كالورى طاقة ممثلة/ كجم) . وأخـذت قياسـات الاداء الانتاجى وجودة البيض ونسب الخصوبة والفقس ، وفى نهاية التجربة أجريـت تجـربة هضـم لتقـدير معامـلات الهضم والتمثيل الغذائى لعلائق التجربة كما أخذت بعض قياسات الدم .

أظهرت النتائج المتحصل عليها عدم وجود فروق معنويـة بـين مجموعـة المقارنـة (م١) ومجموعات ٢٥ % ، ٥٠ % إحلال (سواء سورجم أو كاسافا) محل الذرة الصفراء فـى مقـاييس وزن الجسم والوزن المكتسب وإنتاج البيض والكفاءة التحويلية ونسب الاخصاب والفقـس والكفـاءة الاقتصادية ، وهذه المجموعات (بما فيها الكنترول) تفوقت معنويا على المجاميع التى تغذت علـى مستويات إحلال ٧٥ ، ١٠٠ % (سورجم أو كاسافا) محل الذرة الصفراء . بينما لم يكـن هنـاك فروق معنوية بين جميع المعاملات فى مقاييس وزن البيضة وإستهلاك العلف وكذلك مقاييس جـودة البيض فيما عدا مقياس لون الصفار الذى قل تدريجيا بزيادة نسـب الاحـلال سـواء السـورجم أو الكاسافا. الطيور التى تغذت على عليقة الكنترول وتلك التى تغذت على كل من السورجم والكاسـافا بمستويات إحلال ٢٥ ، ٥٠ % من الذرة الصفراء أعطت معاملات هضم وتمثيل غذائى أفضل مـن تلك التى تغذت على مستويات إحلال ٧٥ ، ١٠٠ % . وبإستثناء وجود بعض الفروق المعنوية فـى

تركيزات الكالسيوم والفوسفور فى بلازما الدم ، فإنه لم توجد أى فروق معنوية بين جميع المعاملات فى مستويات البروتين الكلى والليبيدات الكلية والكوليسترول فى بلازما الـدم ، وكـذلك فـى قـيم هيموجلوبين الدم والهيماتوكريت .

ويستنتج بصفة عامة أنه عندما يوضع فى الاعتبار الاداء الانتاجى بجانب الكفاءة الاقتصادية فإنه يمكن إحلال كل من حبوب السورجم ومسحوق الكاسافا محل الذرة الصفراء حتى مستوى ٥٠ % . وتتضح الفائدة التطبيقية لهذه النتائج فى حالة إنخفاض المتاح من الذرة الصفراء أو إرتفـاع سـعره بصورة كبيرة .