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THE IMPACT OF HEAT STRESS AND ENZYME SUPPLEMENTATION ON THE BIOAVAILABLE ENERGY OF SOME FEEDSTUFFS USED IN POULTRY DIETS

M.N. Makled[1], T.M. El-Sheikh[1], M. A. Metwally[1] and S.H. El Nagar[2]

1- Department of Animal and Poultry Production, Faculty of Agriculture, of Assiut, 2- Department of Animal and Poultry Production, Faculty of Agriculture, University of Sohag

SUMMARY

Four feed ingredients; mung beans, sorghum, rice bran and wheat bran were used in four similar experiments. Each experiment was carried out to evaluate the proximate chemical analyses and bioavailability of energy (apparent metabolizable energy, AME, apparent metabolizable energy corrected to zero nitrogen balance, AME_n; true metabolizable energy, TME and true metabolizable energy corrected to zero nitrogen balance, TME_n) of each of the feed ingredients under study either under thermoneutral (24 ºC) or cyclic heat stress (8 hrs at 38 ºC and 16 hrs at 24 ºC) without or with enzyme supplementation (either optizyme at level of 300 mg/kg or phytase at level of 1500 FTU/kg feed). Forty sixteen-month old mature Dandarawi roosters divided into eight groups of five birds each were used in these experiments. Force feeding was applied for determining apparent and true metabolizable energy. The results showed that:

1. *Mung beans have a high percent of protein (24.83%) which makes it a suitable source of protein in poultry diets; sorghum has a high percent of nitrogen free extract (72.80%) which make it a suitable source of energy; rice bran has a high percent of ether extract (11.01%) and wheat bran has a high percent of crude fiber (6.58%).*
2. *Heat stress had a tendency to decrease AME, AME_n, TME and TME_n for the studied material except sorghum, however, the decrease was not significant.*
3. *Enzyme supplementation tended to increase the values of the different forms of metabolizable energy values especially in case of optizyme supplementation to rice bran and phytase to wheat bran. However, the differences didn't reach a significant level ($P>0.05$).*
4. *The interaction between heat stress and enzyme supplementation seemed to have a slight tendency to improve metabolizable energy values but without any significance at $P <0.05$ for any of the four feedstuffs under study. This slight improvement was more obvious at optizyme supplementation to rice bran and at phytase supplementation to wheat bran both under heat stress.*

It may be concluded that heat stress at 38 ºC tended to have a negative effect on the energetic values of the feedstuffs under study. The impact of enzyme supplementation on energy values tended to be positive in general. However, it may *be more effective at more severe heat stress (>35 ºC) or at higher levels of enzymes supplementation than those used in this study (1500 FTU phytase or 0.3 g optizyme/kg feed).*

Keywords: Metabolizable energy, Dandarawi chickens, heat stress, mung beans

INTRODUCTION

Mung beans (*phaseolus aureus*) is a short summer crop cultivated in some Asian countries (Khalaf Allah, 1995) and warmer parts of Canada and United States (Rosario and Noel, 1980). Mung beans include many species and varieties. In Egypt it named Indian bean (Ashour *et al.,* 1991). Mung bean in Egypt is cultivated in some areas in Nubaria, Giza, Ismailia and Sinai. It contains 20-30% crude protein (El-Sayed, 1999). Mung beans have a favorable amounts of essential amino acids, minerals, vitamins and energy (Khalil, 1996 and El-Alfy, 1998), also, its content of anti-nutritional factors are very low (Chitra *et al*., 1995). The low availability of phytate-phosphorus (NRC, 1994) in plant seeds could be raised by hydrolysis with microbial phytase (Simons, *et al.,* 1990). For these reasons, producers may use mung beans as a feed ingredient for animal and poultry (Ashour *et al*., 1991 and El-Alfy, 1998).

Sorghum grains could replace yellow corn in chick diets and has energy equivalent to 96-98% of yellow corn (Sullivan, 1987 and Nyachoti *et al*., 1997). Although the nutritive value of the Egyptian sorghum grains is not very high (Fayek and Mady, 1989), there is an increase in usage of sorghum in poultry diets during the short supply of corn (Fayek *et al.,* 1989). The tannins and polyphenols in sorghum act as anti-nutritional factors with negative effects varying widely according to their composition and the extent of polymerisation (Gualtieri and Rapaccini, 1990). Improvement in the nutritional value of Egyptian sorghum was achieved by addition of phosphates (Ibrahim *et al.,* 1988) or methionine (Makled and Afifi, 2000).

Oil-extracted rice bran contains over 700 g/kg non-starch polysaccharide (NSPs) of which oraban and xylan are predominant (Annison *et al*., 1995). These may have an adverse effect on the digestion of some dietary components. However, Farrell and Martin (1998) concluded that non-starch polysaccharide fractions were not significant factors in altering the nutritive value of rice bran and the enzymes supplementation were therefore unlikely benefit in diets of chickens and ducks.

The negative effects of heat stress on growth rate and production are due to reduced feed intake of broilers (Hurwitz *et al*., 1980) and laying hens (Savory, 1986). Also, heat stress reduce the availability of important nutrients (Koelkebeck *et al*., 1998) and decrease the digestibility of some amino acids (Wallis and Balnave, 1984; Zuprizal *et al.,* 1993 and Makled *et al.,* 2000).

Makled *et al.* (2000) found that the acute cyclic heat stress (24-35 ºC) reduced the TME_n of corn, sorghum, soybean meal and wheat bran.

Cell wall components and anti-nutritional factors are considered as problems in several feedstuffs. Microbial enzymes with possible impact on these factors have been identified and tested. The possible effects of enzymes on digestion have been outlined by Bedford (1996). It was indicated that the enzymes in feed might improve ingredient digestibility disruption of plant cell walls; destruction of anti-nutritional factors; supplementation of endogenous and manipulation of gut micro-flora populations (Bedford 1996).

Farrell and Martin (1998) and Ravindran *et al.* (1999) reported that phytase addition to chick or duck diets containing corn, cotton seed meal or soybean meal, wheat or wheat bran and rice bran improved metabolizable energy value. This improvement may be due to liberation of calcium ions needed for activation of α-amylase which involved in starch digestion and/or the improvements in protein/amino acid utilization (Ravindran, *et al.* 1999). Wu *et al.* (2004) found that phytase addition improved AME values of wheat-based diets but had little effect on AME of maize-based diets.

Several studies found that enzymes are beneficial to improve the utilization of minerals, growth performance, egg production and blood parameters (Attia *et al.,* 2000; Boling *et al.* 2000 and Keshavarz, 2000). Moreover, phytase enzyme improves phosphorus utilization by breaking down phytate that binds phosphorus in plant materials (Schoner *et al.,* 1991 and Jeroch and Peter, 1994). Other studies reported that phytase can improve the performance of broiler chickens (Simons *et al.,* 1990; Broz *et al.,* 1994; Qian *et al*., 1996 and Van der Klis *et al.,* 1997) and energy utilization (Ravindran and Bryden, 1997 and Namkung and Leeson, 1999).

The aim of the present study was to determine the impact of enzymes supplementation in a single form (Phytase) or a mixture form (Optizyme) under thermoneutral or heat stress conditions on the different values of bioavailable energy of mung beans, sorghum, rice bran and wheat bran.

MATERIALS AND METHODS

1. Birds and management

This study was carried out at the Poultry Research Farm, Faculty of Agriculture, Assiut University, Assiut, Egypt. Four similar experiments were conducted with four feed ingredients: mung beans, sorghum, rice bran and wheat bran. Each experiment was carried out to evaluate the proximate chemical analysis and bioavailable energy values (apparent metabolizable energy,AME; apprent metabolizable enegy corrected to zero nitrogen balance, AME_n; true metabolizable energy,TME and true metabolizable energy corrected to zero nitrogen balance, TME_n) of each one of the feed ingredients under study either under thermoneutral or cyclic heat stress; with or without enzymes supplementation either in a single form (phytase) or in a blend form (optizyme).

In each experiment 40 Dandarawi cockerls 16-month old, were randomly assigned into eight groups of five birds each. Group 1 (general control) in which birds were kept under thermoneutral conditions (24 ºC) and received the feed ingredient understudy without enzyme supplementation. Group 2 (control for group 5) was kept under thermoneutral conditions (24 ºC) and received the feed ingredients understudy beside optizyme supplement at 300 mg/kg feed. Group 3 (control for group 6) was kept under thermoneutral conditions (24 ºC) and received the feed ingredient understudy beside phytase supplement at 1500 FTU/kg feed. Group 4 which kept under cyclic heat stress (8 hrs at 38 ºC and 16 hrs at 24 ºC) and received the feed ingredients understudy without any enzyme supplementation. Group 5 (As group 4, however, birds received the feed ingredient under study beside optizyme supplement at 300 mg/kg feed. Group 6 (As group 4, however, birds received the feed ingredients under study beside phytase supplement at 1500 FTU/kg feed. Group 7 was kept fasted for the whole experimental period under thermoneutral conditions (as fasted control birds). Group 8 was kept fasted for the whole experimental period under cyclic heat stress (as fasted heat stressed control birds).

The experiments were conducted using force feeding methodology of Sibbald (1976). The birds were kept individually in metabolic cages with plastic trays under cages to collect the excreta. Each experiment lasted for 18 days according to the following timetable: Day 1, roosters were moved to the experimental chamber in the afternoon. Day 2 to day 14, adjustment period (feed and water *ad lib.*). Days 15 and 16 fasting period (feed off for 30 hrs). Day 16 (funnel force feeding), at the end of fasting period, birds were fed using funnel and forced with 30 g mung beans or 30g sorghum or 20 g of rice bran or 20g wheat bran. Day 16 to 18 (excreta collection) for 48 hrs, start just after funnel feeding.

The above mentioned steps were done for groups 1, 2, 3 and 7 under thermoneutral conditions and for groups 4, 5, 6 and 8 under cyclic heat stress.

The birds were kept for recovery period (14 days) between each two following experiments.

2. Enzyme preparation

The enzyme preparations used in this study were 1. Micoribial phytase which produced from *Aspergillus neiger* in a powder produced by Gistbrocades, The Netherlands and BASF, Germany, at two levels (0 and 1500 FTU/kg). FTU is the quantity of enzyme required to produce 1 micromol of inorganic phosphorus/min from 5.1 mmol/L of Na phytate at a pH of 5.5 and a water-bath temperature of 37 ºC (Boling *et al*. 2000). The 1500 FTU used in the present study equal to 0.3 g phytase/kg tested material. 2. Optizyme produced by Optivite International LTD, Main street, Laneham, Retford, Nottinghamshire, DN 22 OVA, England, at two levels (0 and 0.3 g/kg tested material). Optizyme is a blend of enzymes which contains proteases, hemicellulases, cellulases, xylanase, β-glucanase and amyloglucosidases.

3. Preparation of excreta samples for analysis

Excreta collected from each bird at the end of each experiment was dried in electric oven at 70 ºC for 24 hrs. Samples of dried excreta were weighed and ground to pass through a 20-mesh sieve, left for 24 hrs in Lab. for moisture equilibrium and stored in glass containers till analysis.

4. Proximate chemical analysis and gross energy determination

Proximate chemical analysis of the tested feed ingredients were determined using methods of AOAC (1984). Nitrogen content of excreta was also determined by the same previous mentioned methods.

Feed and excreta samples were assayed for gross energy content using Ballistic Bomb Calorimeter (H250 Gallenkamp).

5. Calculation of bioavailavle energy (AME, AME_n, TME and TME_n)

Metabolizable energy values were calculated according to Sibbald (1986) as follows:

$$AME/g \text{ of feed} = [(F_i \times GE_f) - (E_f \times GE_e)] / F_i$$

$AME_n = [(F_i \times GE_f) - \{(E_f \times GE_{ef}) \pm K (N_{if} - NO_{ef})\} / F_I$

$TME = [(F_i \times GE_f) - \{(E_f \times GE_{ef}) - (E_c - NO_{ec})\}] / F_I$

$TME_n = [(F_i \times GE_f) - \{(E_f \times GE_{ef}) + K (N_{if} - NO_{ef})\} + \{(E_c \times GE_{ec}) \pm K (NI_c - NO_{ec})\}] / F_I$

Where F_i = feed intake (g).
E_f = excreta output (g) of fed birds.
GE_f = gross energy (g) of feed.
GE_e = gross energy (g) of excreta.
$N_{if} = F_i \times N_f$
NO_{ef} is the amount of nitrogen output per bird fed the tested materials.
$NO_{ef} = E_f \times N_{ef}$.
N_f = the amount of nitrogen of feed (g).
N_{ef} is the amount of nitrogen (g) of the excreta of fed birds.
K = constant which estimates the gross energy content of the excretory Products resulting from the catabolism of a unit weight of tissue Nitrogen. The energy content of uric acid (8.73 kcal/g).
E_c = the excreta output (g) of fasted control birds.
GE_{ec} = gross energy of excreta of fasted control birds.
NI_c = nitrogen input of excreta fasted control birds (g). NI_c = zero.
NO_{ec}=excreta nitrogen output of fasted control birds = $E_c \times N_{ec}$.

6. Statistical analysis

Statistical analysis for bioavailable energy values were conducted using the General Linear Model (GLM) procedure of SAS (1987). The following model was used:

$$Y_{ijk} = \mu + T_i + P_j + (TP)_{ij} + e_{ijk}.$$

Where Y = the observation.
μ = General mean.
T_i = effect due to temperature.
P_j = effect due to enzymes preparation.
TP_{ij} = effect of interaction between enzymes and temperature.
e_{ijk} = the error related to individual observation.

The significant differences between treatment means were tested by Duncan's multiple range test (Duncan 1955). The significant differences between interactions were tested by least square differences.

RESULTS AND DISCUSSION

1. Chemical composition of the feedstuffs understudy

The results of chemical composition of the feedstuffs understudy are represented in Tables 1 and 2. The results showed that mung bean has a high value of protein (24.83 % on as fed basis) which makes it considered as a source of protein in poultry diets. Creswell (1981) found that mung bean contains 23.9% crude protein which supports a good growth of broiler chickens at a level up to 40% of the diet. Moreover, raw mung bean doesn't appear to contain anti-nutritional factors such as those found in soybeans (Kienholz *et al*., 1962).

The chemical composition showed that sorghum has high value of nitrogen free extract (72.80% on as fed basis). Therefore, it may be used as a source of energy; however, it contains ant-nutritional factors such as tannins, non starch polysaccarides

(NSP's), polyphenols and phytates (Luis and Sullivan, 1982 and Gualtier and Rapaccini, 1990), so using enzymes supplementation may be helpful in improving its nutritive value. The same suggestion may be applicable to rice bran which has high ether extract and crude protein contents and NSP's (Annison *et al.,* 1995).

Table 1. Chemical composition of mung beans, sorghum, rice bran, and wheat bran (as fed basis)

Composition (%)	Mung beans	Sorghum	Rice bran	Wheat bran
Moisture	9.54	10.06	13.86	10.04
Dry matter	90.46	89.94	86.14	89.96
Organic matter	86.82	88.43	74.86	85.40
Crude protein	24.83	11.72	11.72	16.49
Ether extract	0.54	2.42	11.01	2.42
Crude fiber	3.63	1.49	6.30	6.58
Ash	3.64	1.51	11.28	4.56
Nitrogen free extract	57.82	72.80	45.83	59.91

Table 2. Gross energy (Kcal/kg) and amino acid (%) contents in mung bean, sorghum, rice bran and wheat bran

Item	Mung beans	Sorghum	Rice bran	Wheat bran
Gross energy (Kcal/kg)	3909	4611	3703	4138
Amino acids (%)				
Threonine	0.77	0.41	0.22	0.54
Serine	1.15	0.48	0.25	0.63
Glutamic acid	4.30	1.40	0.88	2.53
Proline	0.58	0.78	0.69	0.98
Glycine	1.20	0.81	0.33	0.80
Cystine	0.03	0.30	0.02	0.06
Valine	0.75	0.40	0.30	0.47
Methionine	0.20	0.13	0.16	0.10
Isoleucine	1.05	0.64	0.29	0.64
Leucine	1.74	1.17	0.70	0.91
Tyrosine	0.70	0.39	0.21	0.40
Phenylalanine	1.01	0.43	0.31	0.40
Histidine	0.61	0.30	0.24	0.26
Lysine	2.04	0.72	0.19	0.67
Arginine	1.45	0.79	0.40	1.01

The chemical composition of rough wheat bran showed that it has 16.49% crude protein. It is lower than that reported by NRC (1994) and Metwally (1990). Also, it has high crude fiber content (6.58% on as fed basis) which may affect the protein digestion.

Choct (2002) reported that mung bean, rice bran and sorghum have NSP in different percentages. The adverse effects of soluble NSP on the digestion and absorption of nutrients in monogastric animals and poultry are due to their ability to increase the viscosity of the digesta, to modify the physiology of the gastrointestinal tract and to change the ecosystem of the gut. The net effects may include altered of nutrient digestion and absorption pattern, i.e. enzymatic digestion *vs* microbial fermentation.

The results in Table 2 indicate that sorghum is the highest in gross energy value, while rice bran is the lowest. Moreover, mung bean is the highest in amino acid contents, while rice bran is the lowest.

Nevertheless, mung bean showed high values of glutamic, leucine, arginine and lysine. However, wheat bran showed the lowest value in methionine but arginine and lysine in rice bran.

2. Bioavailable energy values

The results in Tables from 3 to 6 reveal the effect of heat stress, enzymes supplementation and their interactions on the different forms of metabolizable energy:

Table 3. The effect of heat stress and enzymes supplementation on apparent and true metabolizable energy values of mung beans

Treatment	**AME**	**AME_n**	**TME**	**TME_n**
Temperature				
Thermoneutral (N)	2716	2716	3221	3221
Heat stress (H)	2627	2627	3130	3130
Enzymes:				
Without (W)	2643	2643	3151	3151
With optizyme (OP)	2692	2692	3194	3194
With phytase (PH)	2680	2680	3181	3181
Interactions:				
N x W	2707	2707	2707	3219
N x OP	2721	2722	2722	3223
N x H	2721	2721	2721	3221
H x W	2580	2580	2580	3083
H x OP	2662	2662	2662	3165
H x PH	2639	2639	2639	3141
		Probability*		
Temperature (T)	NS	NS	NS	NS
Enzymes (E)	NS	NS	NS	NS
T x E	NS	NS	NS	NS

*Probability at 0.05.

2.1. Effect of heat stress on energy bioavailability

There was general trend that all the values of different forms of metabolizable energy (AME, AME_n, TME and TME_n) for all feed ingredients under study except sorghum decreased under heat stress. However, the differences were not significant. The obtained results are in partial agreement with those obtained by El-Husseiny and Greger (1980); Keshavaraz and Fuller (1980); Wallis and Blanve (1984); Geraert *et al.* (1992) and Bonnet *et al.* (1997). They all reported that heat stress decreased the values of metabolizable energy in the different feedstuffs under study. The reduction of energy values of mung bean, rice bran and wheat bran are also in agreement with the results reported by Makled *et al.* (2000). The reason of reducing metabolizable values under heat stress may be due to the increase of fat percentage in excreta that caused high quantities of energy loss. From the obtained results, the AME_n and

TME_n values had slightly increased than AME and TME because the value of nitrogen in excreta was very low.

Table 4. The effect of heat stress and enzymes supplementation on apparent and true metabolizable energy values of sorghum

Treatment	AME	AME_n	TME	TME_n
Temperature				
Thermoneutral (N)	2863	2863	3365	3364
Heat stress (H)	2855	2855	3358	3358
Enzymes:				
Without (W)	2841	2841	3344	3343
With optizyme (OP)	2872	2872	3375	3375
With phytase (PH)	2864	2864	3365	3365
Interactions:				
N x W	2837	2837	3339	3338
N x OP	2884	2884	3386	3386
N x PH	2869	2869	3369	3369
H x W	2845	2846	3348	3348
H x OP	2860	2861	3363	3363
H x PH	2858	2859	3361	3361
		Probability*		
Temperature (T)	NS	NS	NS	NS
Enzymes (E)	NS	NS	NS	NS
T x E	NS	NS	NS	NS

*Probability at 0.05.

Table 5. The effect of heat stress and enzymes supplementation on apparent and true metabolizable energy values of rice bran

Treatment	AME	AME_n	TME	TME_n
Temperature				
Thermoneutral (N)	2611	2611	3363	3363
Heat stress (H)	2562	2563	3317	3317
Enzymes:				
Without (W)	2470	2470	3224	3224
With optizyme (OP)	2707	2707	3461	3460
With phytase (PH)	2586	2586	3338	3337
Interactions:				
N x W	2458	2458	3211	3211
N x OP	2705	2705	3458	3458
N x PH	2669	2570	3420	3420
H x W	2482	2483	3237	3237
H x OP	2709	2709	3460	3463
H x PH	2480	2480	3034	3034
		Probability*		
Temperature (T)	NS	NS	NS	NS
Enzymes (E)	NS	NS	NS	NS
T x E	NS	NS	NS	NS

*Probability at 0.05.

Table 6. The effect of heat stress and enzymes supplementation on apparent and true metabolizable energy values of wheat bran

Treatment	AME	AME_n	TME	TME_n
Temperature				
Thermoneutral (N)	1662	1663	2417	2742
Heat stress (H)	1609	1610	2384	2384
Enzymes:				
Without (W)	1585	1586	2372	2373
With optizyme (OP)	1664	1665	2418	2418
With phytase (PH)	1559	1659	2411	2411
Interactions:				
N x W	1568	1569	2389	2389
N x OP	1653	1654	2406	2406
N x PH	1607	1608	2357	2357
H x W	1602	1602	2356	2356
H x OP	1675	1676	2430	2430
H x PH	1710	1711	2465	2465
		Probability[*]		
Temperature (T)	NS	NS	NS	NS
Enzymes (E)	NS	NS	NS	NS
T x E	NS	NS	NS	NS

[*]Probability at 0.05.

2.2. Effect of enzyme supplementation on energy bioavailability

The impact of enzymes supplementation on the different values of metabolizable energy tended to be positive in case of rice bran and wheat bran and the effect was more pronounced in case of optizyme supplementation than in case of phytase supplementation specially for rice bran (Tables 5, 6). However, the differences didn’t reach a significant level. The improvements in the forms of metabolizable energy at optizyme supplementation in these two feedstuffs may be mainly related to some increase in nutrient digestibility (fat, starch) and due to the non-starch polysaccharide (NSP) become partially available to the birds as a substantial energy source (Broz, 1993 and Annison, 1995).

Also, similar trend for improvement was found with phytase supplementation in regard to the energy values of rice bran and wheat bran ; however the improvement was less with mung bean and sorghum. The improvements of metabolizable energy values in the present study due to the effect of phytase may be due to a partial increase in hydrolyzing phytic acid, which in turn may enhance the digestion of protein, starch and fat. Many authors mentioned that phytase enhanced starch digestion (Farrell and Martin, 1998; Ravindran *et al.* 1999 and Ravindran *et al.* 2000).

2.3. Effect of interaction between heat stress and enzymes supplementation on energy bioavailability

The interaction between thermoneutral conditions and enzymes supplementation was not significant in case of mung beans and sorghum, however, there was an insignificant increase in case of wheat bran and rice bran, where it led to higher metabolizable energy values specially for optizyme supplementation with rice bran.

The interaction between heat stress and enzyme supplementation (optizyme or phytase) was not significant, however, it led to numerical increase in metabolizable energy values of mung beans and wheat bran. Also, there was an insignificant increase in case of rice bran at optizyme supplementation. Therefore, it could be summarized that metabolizable energy values tended to be negatively affected by heat stress for mung beans, wheat bran and rice bran but not for sorghum. Also, enzyme supplementation specially optizyme tended to increase different forms of metabolizable energy values under both neutral and high temperatures in case of rice bran and wheat bran. Rice bran was more positively affected by enzymes supplementation.

CONCLUSION

It may be concluded that the effect of heat stress (at 38ºC) on different metabolizable energy values tended to be negative. This may raise the risk which could happened at higher temperatures in summer times where it is almost always higher than 38ºC and some times exceeding 40ºC. The impact of enzymes supplementation on energy values was positive in general. However, it may be more effective at higher levels of supplementation than those used in this study (1500 FTU phytase or 0.3 g optizyme/kg feed). It is hard to generalize a recommendation as regards enzymes supplementation to the different feedstuffs under thermoneutral or heat stress conditions. Optizyme and phytase seemed to be better for rice bran and wheat bran than for mung bean and sorghum, however, optizyme may be better for rice bran under heat stress while phytase may be better for wheat bran under similar conditions.

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تأثير الإجهاد الحراري وإضافة الأنزيمات على الطاقة الممثلة حيويا لبعض مواد العلف المستخدمة فى أعلاف الدواجن

محمد نبيل مقلد[1] . طلعت مصطفى الشيخ[2] . محمد متولى احمد[1] . سناء النجار[2]

١ – قسم الإنتاج الحيواني والدواجن، كلية الزراعة، جامعة أسيوط، ٢– قسم الإنتاج الحيواني والدواجن، كلية الزراعة جامعة سوهاج.

أجريت أربع تجارب متشابهة استخدم فيها اربع مواد علف وهى فول المانج ، الذرة الرفيعة، رجيع الكون وردة القمح. أجريت كل تجربة لتقييم التحليل الكيماوي التقريبي والطاقة الممثلة حيويا بصورها الاربع وهى (الطاقة الممثلة ظاهريا AME والطاقة الممثلة ظاهريا المصححة النيتروجين AME_n والطاقة الممثلة حقيقيا TME والطاقة الممثلة حقيقيا المصححة النيتروجين TME_n) لكل مادة من مواد العلف المستخدمة فى الدراسة وذلك تحت ظروف الحرارة المعتدلة (٢٤ درجة مئوية) او الاجهاد الحرارى الدورى (٨ ساعات على درجة ٣٨ درجة مئوية و ١٦ ساعة على درجة ٢٤ درجة مئوية) بدون او مع إضافة الانزيمات (انزيمات فى صورة مختلطة (الاوبتزايم) بمستوى ٣٠٠ مجم/ كجم او فى صورة مفردة (انزيم الفيتيز) بمستوى ١٥٠٠ وحدة FTU لكل كجم. استخدم فى هذه التجارب عدد ٤٠ ديك دندراوى ناضج عمر ١٦ شهر تم تقسيمها الى ثمانية مجموعات كل منها خمس ديوك وتم تغذيت الديوك بتكنيك الدفع الغذائي لتقدير الطاقة الممثلة الظاهرية والحقيقية واظهرت النتائج مايلى:

١- ان نسبة البروتين فى فول المانج ٢٧.٤٤% والتى تجعله كمصدر مناسب للبروتين فى اعلاف الدواجن. وان الذرة الرفيعة بها نسبة عالية من المستخلص الخالى من النيتروجين (٨٠.٩٦%) مما يجعلها مصدر مناسب للطاقة، رجيع الكون به نسبة عالية من مستخلص الاثير (١٢.٧٦%) وان ردة القمح بها نسبة عالية من الألياف الخام (٧.٣١%).

٢- ادى الإجهاد الحرارى الى انخفاض قيم AME, AME_n , TME , TME_n فى كل مواد العلف تحت الدراسة ماعدا الذرة الرفيعة حيث ان الانخفاض فيها لم يكن معنويا.

٣- إضافة الأنزيمات أدت الى زيادة قيم الصور المختلفة للطاقة الممثلة خاصة فى حالة إضافة الاوبتزايم الى رجيع الكون وكذلك إضافة أنزيم الفيتيز الى ردة القمح، الا ان الفروق لم تصل الى مستوى المعنوية.

٤- التداخل بين الإجهاد الحراري و إضافة الأنزيمات أدى الى تحسين غير معنوي عند مستوى معنوية ٠.٠٥ لقيم الطاقة الممثلة فى كل المواد تحت الدراسة. وكان التحسين اكثر وضوحا فى حالة إضافة الاوبتزايم الى رجيع الكون وكذلك إضافة الفيتيز الى ردة القمح تحت الإجهاد الحرارى.